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WÜRTTEMBERG**

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Waste**

**Volume 73  
Part A**

**Ministry for the Environment and Transport  
Baden-Württemberg**

**Handbook  
“How to apply the  
European Waste List 2001/118/EC”**

**Proposals for classifying wastes in accordance with  
the EWL, for waste disposal and recovery as well as  
description of waste generating processes  
and material flow for selected branches of industry**

**Part A: Legal basis; EWL to sub-chapter 10 13**



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Kernerplatz 9, 70182 Stuttgart, Germany
- Author:** ABAG-itm GmbH,  
Stauferstr. 15, 70736 Fellbach, [www.abag-itm.de](http://www.abag-itm.de)
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**Stuttgart/Fellbach, February 2003**

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## Preface

The European Waste List (mainly the Commission Decisions 2000/532/EC and 2001/118/EC) contains 839 waste categories and serves EU-wide as a nomenclature system for the description of waste. It offers the basis for a possible common enforcement of legislation regarding waste inside the European Union. There are also some Candidate Countries which already have introduced the EWL.

The editors of the European Waste List have succeeded in compiling an extensive self-explanatory index. Nevertheless, uncertainties can not be ruled out and will have to be resolved in dialogues between the different parties. The accompanying handbook should contribute to a mutual understanding. In addition it can serve as a reference literature for those who want to get familiar with technical waste management quickly.

The basis of this handbook were inquiries into individual industrial fields.

It is not the aim of this handbook to go into legal implications or to describe in detail industrial processes in which certain wastes arise, or to pass judgement on them. It is much more the aim of this handbook to correctly classify real waste in the appropriate waste code. To this purpose, the handbook for every waste subchapter is structured as follows:

1. Description of industrial process
2. Description of material flows "Waste" and classification in waste categories
3. Matrix waste code/material flow

The appendix contains a proposal for the classification of waste categories to according disposal and recovery processes.

In addition the so-called mirror entries were taken into consideration. In some cases it was possible to solve potentially contentious classification and allocate waste to hazardous or non-hazardous categories.

In order to achieve EU-wide distribution of the handbook, it has been translated into English.

Any readers' requests for corrections or other suggestions will be gratefully received.

Stuttgart, December 2002  
Ministry for the Environment and Transport  
Baden-Württemberg

Fellbach  
ABAG-itm GmbH

## Content

### Part A

<b>I Legal Basis</b>	<b>3</b>
<b>I.1 The origin of the European Waste List</b>	<b>3</b>
<b>I.2 Using the European Waste List</b>	<b>4</b>
<b>I.3 Structure of the European Waste list</b>	<b>5</b>
<b>I.4 Classification rules</b>	<b>8</b>
<b>I.5 Special hints to the 190 so-called mirror entries</b>	<b>11</b>
<b>II Considered EWL-Sub-chapters</b>	<b>12</b>
○ <b>03 03</b> wastes from pulp, paper and cardboard production and processing	
○ <b>04 01</b> wastes from the leather and fur industry	
○ <b>04 02</b> wastes from the textile industry	
○ <b>06 01</b> wastes from the MFSU of acids	
○ <b>06 02</b> wastes from the MFSU of bases	
○ <b>08 01</b> wastes from MFSU and removal of paint and varnish wastes from MFSU and removal of paint and varnish	
○ <b>08 02</b> wastes from the MFSU of other coatings (including ceramic materials)	
○ <b>08 03</b> wastes from MFSU of printing inks	
○ <b>08 04</b> wastes from MFSU of adhesives and sealants (including water-proofing products)	
○ <b>09 01</b> wastes from the photographic industry	
○ <b>10 01</b> wastes from power stations and other combustion plants (except 19)	
○ <b>10 02</b> wastes from the iron and steel industry	
○ <b>10 03</b> wastes from aluminium thermal metallurgy	
○ <b>10 04</b> wastes from lead thermal metallurgy	
○ <b>10 05</b> wastes from zinc thermal metallurgy	
○ <b>10 06</b> wastes from copper thermal metallurgy	
○ <b>10 07</b> wastes from silver, gold and platinum thermal metallurgy	
○ <b>10 08</b> wastes from other non-ferrous thermal metallurgy	
○ <b>10 09</b> wastes from casting of ferrous pieces	
○ <b>10 10</b> wastes from casting of non-ferrous pieces	
○ <b>10 11</b> wastes from manufacture of glass und glass products	
○ <b>10 12</b> wastes from manufacture of ceramic goods, bricks, tiles and construction products	
○ <b>10 13</b> wastes from manufacture of cement, lime and plaster and articles and products made from them	

## Part B

- **11 01** wastes from chemical surface treatment and coating of metals and other materials (for example galvanic process, zinc coating processes, pickling processes, etching, phosphating, alkaline degreasing, anodising)
- **11 02** wastes from non-ferrous hydrometallurgical processes
- **11 03** sludges and solids from tempering processes
- **11 05** wastes from hot galvanising processes
- **12 01** wastes from shaping and physical and mechanical surface treatment of metals and plastics
- **12 03** wastes from water and steam degreasing processes (except 11)
- **13 05** oil/water separator contents
- **16 02** wastes from electrical and electronic equipment
- **16 06** batteries and accumulators
- **16 08** spent catalysts
- **16 11** waste linings and refractories
- **19 01** wastes from incineration or pyrolysis of waste
- **19 02** wastes from physico/chemical treatments of waste (including dechromatation, decyanidation, neutralisation)
- **19 03** stabilised/solidified wastes
- **19 04** vitrified waste and wastes from vitrification
- **19 05** wastes from aerobic treatment of solid wastes
- **19 06** wastes from anaerobic treatment of waste
- **19 07** landfill leachate
- **19 08** wastes from waste water treatment plants not otherwise specified
- **19 09** wastes from the preparation of water intended for human consumption or water for industrial use
- **19 10** wastes from shredding of metal-containing wastes
- **19 11** wastes from oil regeneration
- **19 12** wastes from the mechanical treatment of waste (for example sorting, crushing, compacting, pelletising) not otherwise specified
- **19 13** wastes from soil and groundwater remediation

## Part C

### III Options for Disposal and Recovery

#### III.1 Introduction and Instructions for Use

#### III.2 Notes / Abbreviations used

#### III.3 Table: 839 Wastes and their Disposal and Recovery Options

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## **I Legal Basis**

### **I.1 The creation of the European Waste List**

The creation of the European Waste List is based on Article 1(a) of the Council Directive 75/442/EEC, in the version of the Framework-Directive 91/156/EEC. In accordance with this, the European Commission should produce a detailed waste list to clarify appendix I of the aforementioned directive (Q-List). The European Commission complied with this decision of 20.12.1993 (94/3/EEC) with the publication of the European Waste Catalogue.

In the meantime, the European Waste Catalogue has been revised twice and re-named Waste List. The first revision led to the Commission Decision 2000/532/EC of 03.05.2000. It takes into account around 200 proposed changes from member states and combines the list of hazardous waste 94/904/EC with the European Waste List 94/3/EC. The waste categories of types of waste considered to be hazardous have been marked with an asterisk \* since then. The second revision took further proposed changes from member states into consideration and was adopted in the commission's decisions 2001/118/EC and 2001/119/EC of 16.01.2001 and 22.01.2001 as well as 2001/573/EC of 23.07.2001.

Following the two revisions, the number of waste categories was increased from 645 to 839. This was not a simple addition of 194 waste categories but rather more complicated with the removal of 170 waste categories and the addition of 370 new ones. As a result industry and government authorities are faced with nearly 400 new waste categories rather than just under 200.

It is remarkable that the waste list was drawn up and revised within the framework of the committee in accordance with article 18 of the waste framework directive guidelines. This committee comprises expert representatives from the relevant departments of member states and the presiding commission. The member states who already had a waste nomenclature system tried as far as was possible to retain their system, which was only partly successful. As far as Germany is concerned, the resulting waste list can be seen as a compromise solution compared to the LAGA system used previously. Luxemburg and Austria had a nomenclature system similar to

the LAGA system. France, on the other hand, had a very different system which in the end had to be abandoned as well.

## **I.2 Using the European Waste List**

The European Waste List is to the waste industry what the € is to the financial markets; a standardised nomenclature, i.e. reference system used across Europe. On the one hand this should serve to implement standardised EU waste laws and on the other to speed up proceedings, especially in cross-border cases. The EWL includes not only the EU states but also Norway, and Iceland. Candidate Countries Poland, The Czech Republic, Hungary, Latvia, Lithuania, Estonia, Slovenia, Slovakia, Malta and Cyprus, can also be included after accession in 2004.

EU legislation includes a range of directives to be implemented or translated into the legal system of member states, which makes the adoption of the European Waste List essential, especially:

- In accordance with article 13, paragraph 2 of regulation (EEC) Nr. 259/93, member states are required to monitor their waste production in accordance with the regulations of the community. In accordance with article 5, par. 3 of directive 91/689/EEC regarding hazardous waste, accompanying documentation must be produced, for hazardous waste produced in the country. Now that the European Waste list is available for a joint, standardised legal system, the implementation of the law regarding the monitoring and control of country-specific waste production demands that the list be used.
- In accordance with article 9, of the Directive 75/442/EEC, plant and contractors carrying out disposal measures must have a licence. For the licence to be legally valid, the permitted waste categories must be stated. For this, member states have the European Waste List to refer to. This also applies to the exemption from licence requirements in accordance with article 11 of the directive 75/442/EEC and article 3, par. 2 of the Directive 91/689/EEC regarding hazardous waste.
- In accordance with article 12 of the Directive 75/442/EEC, requiring contractors transporting, handling or dealing in waste to notify the authorities, the waste in question must be identified in accordance with the European Waste List.

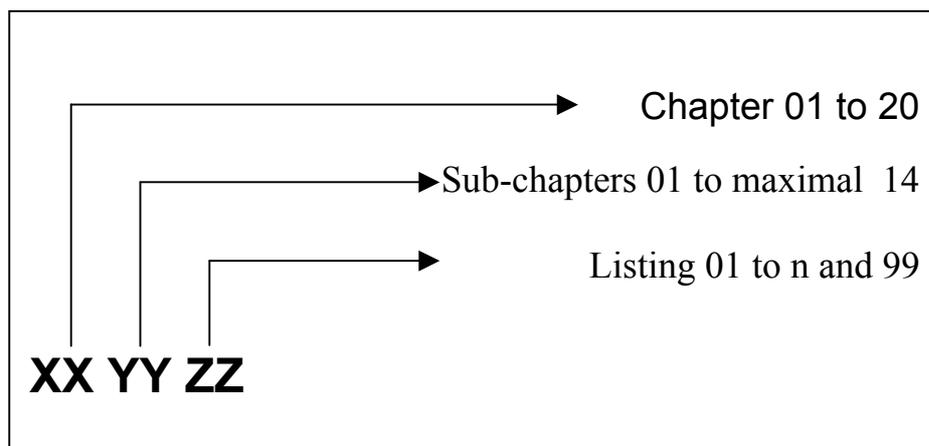
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- To run the register of hazardous waste as required in Article 14 of the Directive 75/442/EEC in connection with Article 4 par. 3 of the Directive 91/689/EEC, descriptions of waste as used in the European Waste List are to be used.

### **I.3 Structure of the European Waste list**

The European Waste List includes 839 types of waste. Of these, 405 are waste categories for hazardous waste and are marked with a star \*. The 839 types of waste are divided into 20 chapters. Each of the 20 chapters represents either an industrial or commercial activity (chapters 1 to 12 and 17 to 19) or an industrial process (chapters 6 and 7) or a specific material (chapters 13 to 15). Chapter 20 contains municipal waste. Chapter 16 is miscellaneous waste which has not been allocated to other chapters. The chapters are further divided into sub-chapters. This sub-division varies: chapter 9, for example, contains only one sub-chapter, chapter 10 on the other hand is further divided into 14 sub-chapters (see fig. 1). A six-digit decimal classification system, XX YY ZZ, is used in the European Waste List for coding. XX stands for 01 to 20 for the 20 chapters. YY is the grouping where YY = 01 to maximal 14 and under ZZ, the types of waste with 01 ff are listed (see fig 2). In addition, a range of sub-chapters includes a waste code that is identified with the decimal point ZZ = 99 which includes miscellaneous wastes in that specific sub-chapter.

Chapter	Sub-chapters													
<b>0100</b> Mining	0101	--	0103	0104	0105									
<b>0200</b> Agriculture.	0201	0202	0203	0204	0205	0206	0207							
<b>0300</b> Wood/ paper	0301	0302	0303											
<b>0400</b> Leather/ textiles	0401	0402												
<b>0500</b> Oil/coal	0501	--	--	--	--	0506	0507	--						
<b>0600</b> <i>Inorganic chemicals.</i>	0601	0602	0603	0604	0605	0606	0607	0608	0609	0610	0611	--	0613	
<b>0700</b> Org.Chem	0701	0702	0703	0704	0705	0706	0707							
<b>0800</b> Coatings/ adhesives	0801	0802	0803	0804	0805									
<b>0900</b> Photo	0901													
<b>1000</b> Therm. Processes	1001	1002	1003	1004	1005	1006	1007	1008	1009	1010	1011	1012	1013	1014
<b>1100</b> Surface treatment	1101	1102	1103	--	1105									
<b>1200</b> Mechanical treatment	1201	--	1203											
<b>1300</b> Oil waste	1301	1302	1303	1304	1305	--	1307	1308						
<b>1400</b> Solvents	--	--	--	--	--	1406								
<b>1500</b> Packaging	1501	1502												
<b>1600</b> Misc.	1601	1602	1603	1604	1605	1606	1607	1608	1609	1610	1611			
<b>1700</b> Construc- tion waste	1701	1702	1703	1704	1705	1706	--	1708	1709					
<b>1800</b> Medicine	1801	1802												
<b>1900</b> Waste treatment	1901	1902	1903	1904	1905	1906	1907	1908	1909	1910	1911	1912	1913	
<b>2000</b> Municipal waste .	2001	2002	2003											

**Fig. 1:** Structure of the European Waste List



**Fig. 2: Coding system**

No changes were made to this basic structure in the two revisions of the catalogue. However, it is to be noted that there is no longer continuity in the sub-chapters, but rather gaps exist (for example, sub-chapters 1401 to 1405 have been deleted). There is also no longer continuity in the listing of individual wastes, ZZ so gaps exist. The reason for this is that waste codes for which the respective texts were heavily reworded in the revisions so that they describe another waste or only part of the earlier subsumed waste, should be left empty. The aim of this process was to prevent unquantifiable overlap between the original and new nomenclature systems.

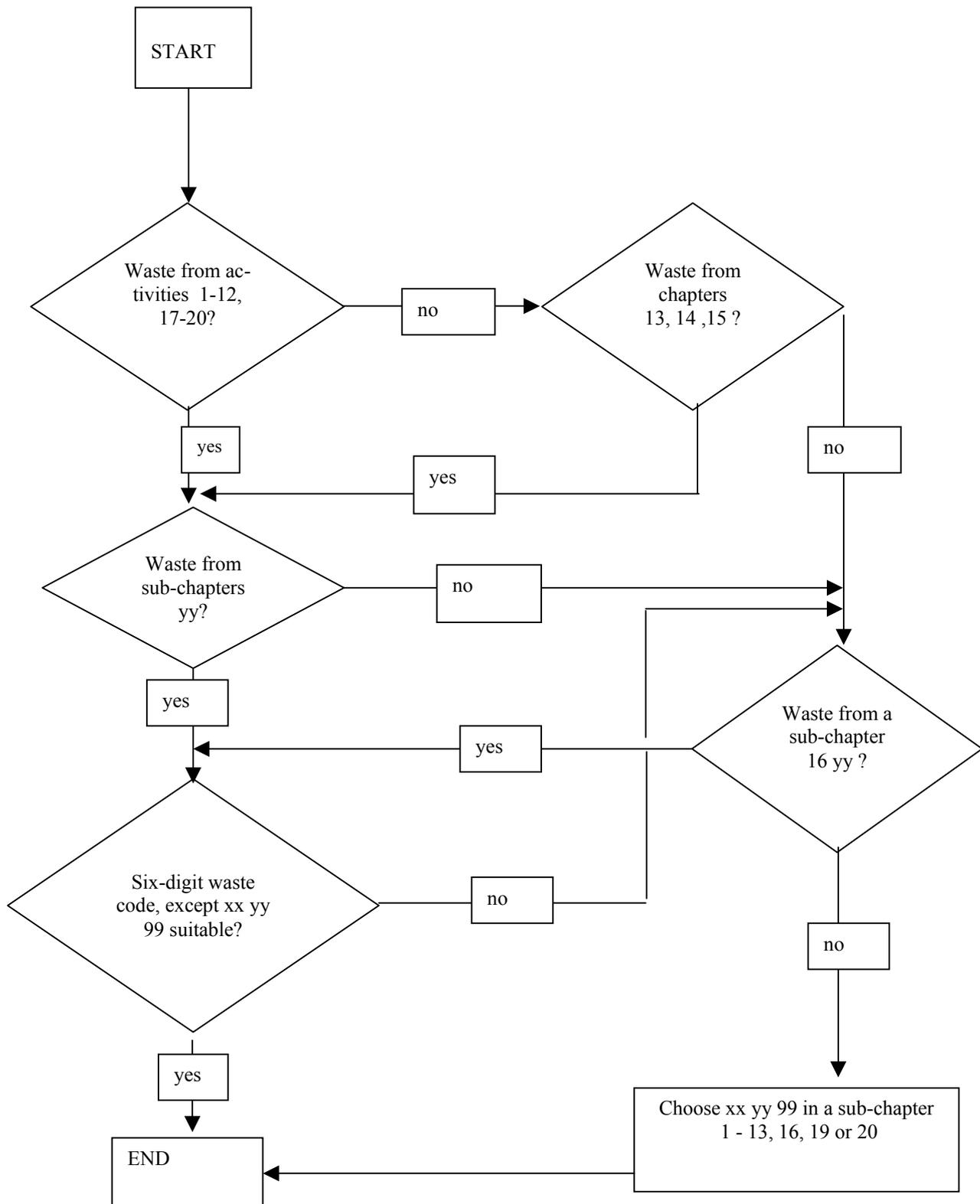
#### **I.4 Classification rules**

If a specific waste is to be identified in a waste category, this must be done in accordance with No.3 of the introduction to the Commission's decision 2001/118/EC as follows (see fig. 3):

1. Identify the field of activity to which the waste producer belongs, i.e. chapters 1 to 12 or 17 to 20.
2. Identify the sub-chapter within the chapter which best characterises the source of the waste.
3. Within the sub-chapter, identify the waste category which best characterises the waste. The specific is always to be identified over the general.
4. If no appropriate waste category can be found in chapters 01 to 12 or 17 to 20, chapters 13, 14 and 15 should be examined as described above in steps 2 and 3 before resorting to waste categories XX YY 99.

- 
5. If only one waste category XX YY 99 comes into question, the waste should be identified with a waste category in chapter 16, in accordance with steps 2 and 3 above.
  6. If a suitable waste category cannot be found in chapter 16, then XX YY 99 is to be used in the chapter and sub-chapter corresponding to the most appropriate source producing the waste.

In the existing handbook, this process was used to classify wastes in the appropriate waste category.



**Fig. 3:** Flow diagram to identify the appropriate waste category in accordance with No. 3 of the introduction to annex to the commission’s decision 2001/118/EC.

## I.5 Special hints to the 190 so-called mirror entries

The term mirror entries has become fixed over the period of consultation at EU level. It really refers more to additional entries which would make the term complementary entries more appropriate. As a rule, mirror entries are formulated in the Waste List as follows:

<b>Waste category</b>	<b>Waste description</b>
XX YY ZZ*	Waste A, containing dangerous substances

and the complementary :

XX YY Z (Z+1)	Waste A other than those mentioned in XX YY ZZ
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### Example:

Wastes from aluminium thermal metallurgy

10 03 19*	Flue-gas dust containing dangerous substances
10 03 20	Flue-gas dust other than those mentioned in 10 03 19

The creation of the term mirror entries arose from the fact that with certain types of waste, significantly different levels of contamination could be present and therefore the same type of waste can arise as either hazardous or not hazardous.

At a first glance it looks as though the question about correctly distinguishing complementary mirror entries has been dealt with, as Article 2 of the commission's decision 2001/118/EC identifies limits beyond which a waste is considered to be hazardous. Therefore, the case seems to have been solved. However, closer inspection reveals a loophole in the regulations with the following two dimensions:

### First Dimension:

Article 2 can only be applied to waste made up of or containing material or preparations included in the 2,500 to 3,000 materials listed in the comprehensive annex I of EU Directive 67/548/EEC. As this list serves chemicals legislation, only materials and preparations which have been intentionally produced or are still in production are included. If one looked for copper hydroxide which represents considerable pollution

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from surface treatment sludge from copper coating, it would not be found. The conclusion that surface treatment sludges containing copper are not hazardous is false because the loophole in the regulations includes the following second dimension:

**Second Dimension:**

Article 2 does not use all 14 H-criteria, which are used to classify waste as dangerous. Although all criteria are significant, none was discounted. Among other things, the fourteenth criterium H14 „ecotoxic“ was missing. When judging waste, this criterium is of considerable importance. The EU Commission assumed that the biotests used in chemicals legislation could simply be applied to waste too.

## II Considered EWL-Sub-chapters

- **03 03** wastes from pulp, paper and cardboard production and processing
- **04 01** wastes from the leather and fur industry
- **04 02** wastes from the textile industry
- **06 01** wastes from the MFSU of acids
- **06 02** wastes from the MFSU of bases
- **08 01** wastes from MFSU and removal of paint and varnish wastes from MFSU and removal of paint and varnish
- **08 02** wastes from the MFSU of other coatings (including ceramic materials)
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- **11 01** wastes from chemical surface treatment and coating of metals and other materials (for example galvanic process, zinc coating processes, pickling processes, etching, phosphating, alkaline degreasing, anodising)
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- **19 04** vitrified waste and wastes from vitrification
  - **19 05** wastes from aerobic treatment of solid wastes
  - **19 06** wastes from anaerobic treatment of waste
  - **19 07** landfill leachate
  - **19 08** wastes from waste water treatment plants not otherwise specified
  - **19 09** wastes from the preparation of water intended for human consumption or water for industrial use
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  - **19 12** wastes from the mechanical treatment of waste (for example sorting, crushing, compacting, pelletising) not otherwise specified
  - **19 13** wastes from soil and groundwater remediation

## 03 03 Wastes from pulp, paper and cardboard production and processing

1. PROCESSES .....	1
1.1 Production of paper from natural materials (figure 1) .....	1
1.2 Paper production from recycled paper (figure 4) .....	3
2 WASTES .....	4
3 OVERVIEW OF WASTE CLASSIFICATION – MATERIAL FLOW .....	7

### 1. Processes

Paper is made from cellulose obtained from either natural raw materials (e.g. wood, hemp), recycled paper or to some extent textiles (rags). The processes used to produce paper from natural materials and from recycled materials are illustrated separately.

#### 1.1 Production of paper from natural materials (figure 1)

First of all bark is removed and then the wood is shredded. The resulting ground wood pulp can be used directly in the production of low grade paper (e.g. newspaper or wrapping paper).

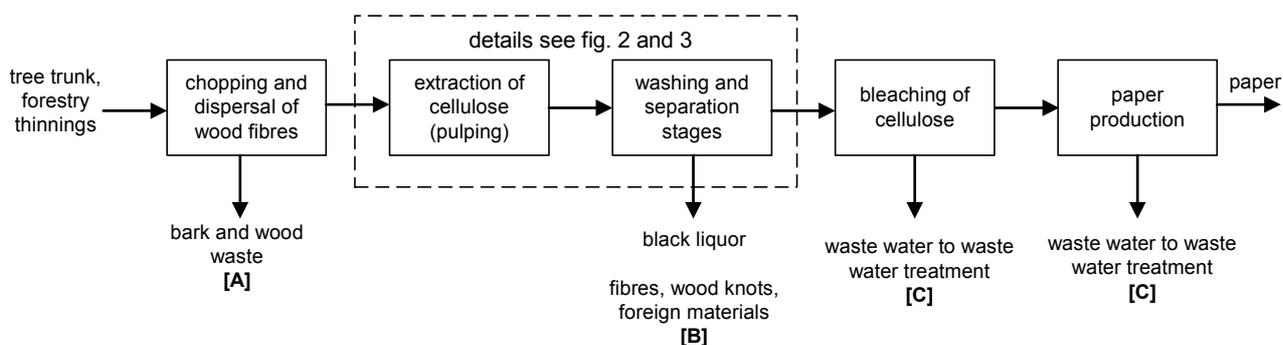
For high grade, wood-free paper, chemical processes are used to separate out the cellulose contained in the ground wood pulp, and accompanying substances such as lignin, hemicellulose and resin are removed. Two different processes are employed to produce cellulose; cooking with either  $\text{Na}_2\text{S}$  and  $\text{NaOH}$  (sulphate process) or  $\text{Mg}(\text{HSO}_3)_2$  (sulphite process). In rare cases, the “Organosolv” process may be used, whereby pulping is achieved using acetic acid.

Following the cooking process, the spent cooking liquor (black liquor) is separated from cellulose in several washing stages. Modern washing systems can recover up to 99% of the chemicals used in the pulping process. Vacuum drum filters, wash presses, diffusion equipment etc. are used. The separation and removal of rejects, fibre bundles, wood knots, etc. follows.

Bleaches are used to remove the residual lignin in the cellulose after pulping. Three different bleaching processes can be identified here: chlorine bleach, reduced chlorine and chlorine-free bleach. The bleaching agents used are chlorine, a mixture of chlorine and hydrogen peroxide and pure hydrogen peroxide respectively.

The actual production of paper follows this bleaching process. For this, cellulose is mixed with water and additives (dye, alum, kaolin), homogenised and spread on a fine screen. Raw paper is drained as it is pressed between two rollers covered with felt and then dried by heated hollow cylinders before being finally rolled out.

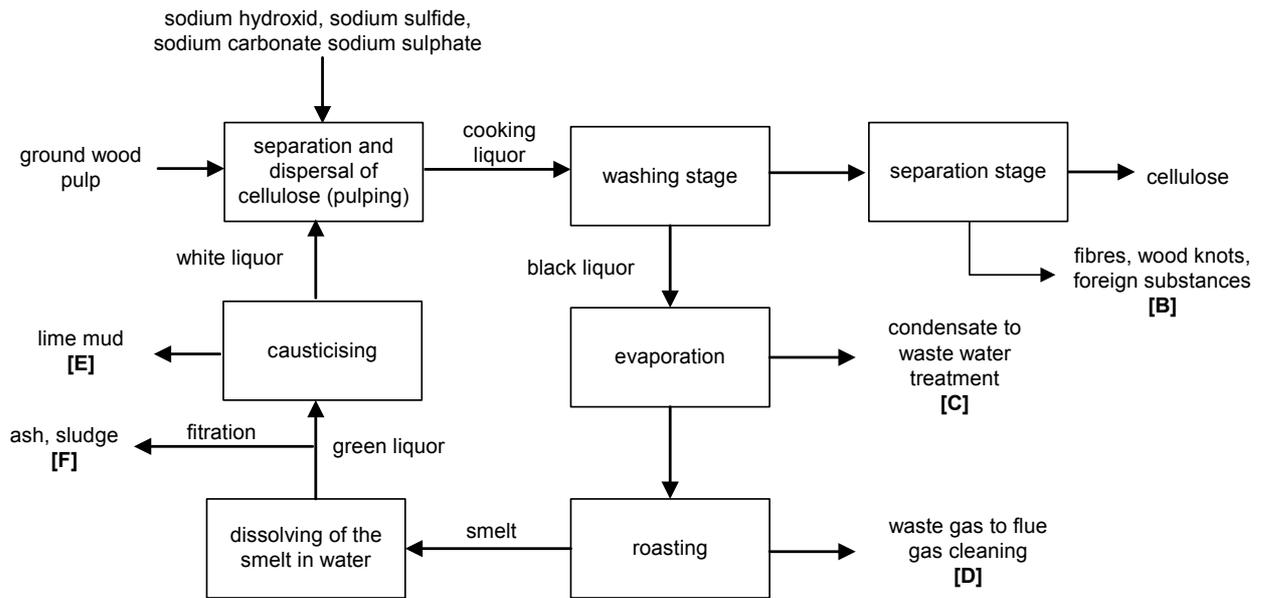
Depending on the quality of paper required, there may be further production steps, for example, mechanical flattening in calendaring. For high quality printing paper (e.g. photographic printing paper) additional binders such as kaolin and starch are applied to the surface. After that the paper is cut and packaged ready for use.



**Fig. 1:** The production of paper from natural materials

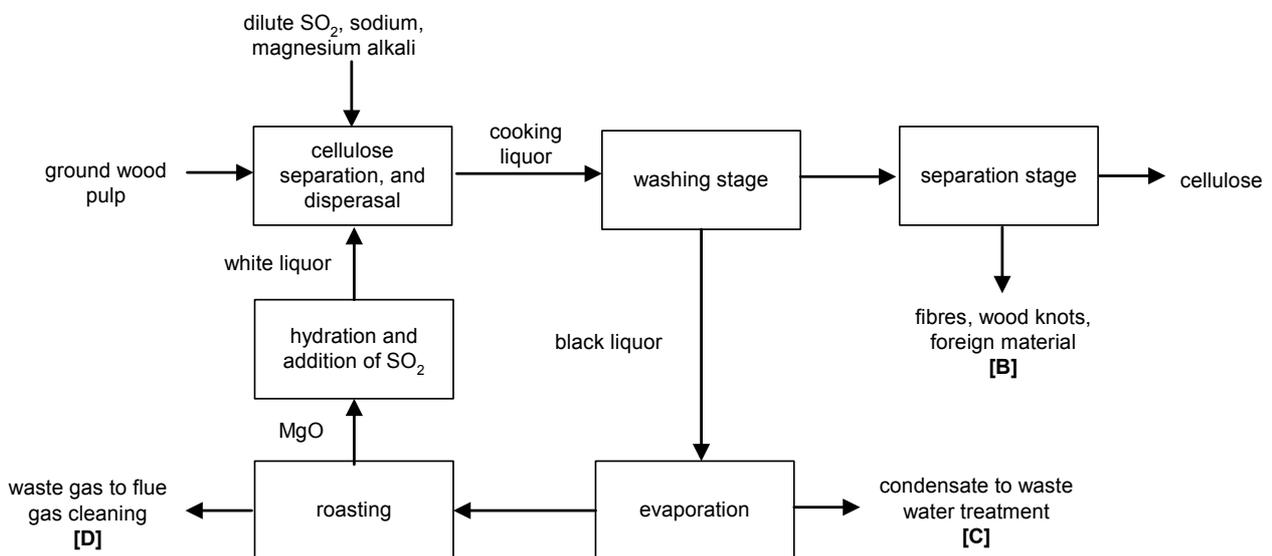
Approximately 90% of cellulose produced world-wide is produced using the sulphate/kraft process. The sulphite process is used for roughly 10%. The “Organosolv” process is only used in rare cases. During the sulphate/kraft and sulphite processes, around 99% of the process chemicals contained in the cooking liquor (black liquor) can be recovered. Wood substances contained in the black liquor are used on-site as fuel (for steam production).

In the sulphate/kraft process, the black liquor is evaporated and then roasted. Chemicals contained in the „smelt“ (sodium carbonate and sodium sulphite) are dissolved in water (green liquor) and filtered. The so-called ‚causticising‘, calcium hydroxide is added to convert the dissolved sodium compounds into sodium hydroxide which is then returned to the cooking process as fresh cooking liquor (white liquor). Causticising produces lime mud sludge which, as a rule, is roasted on-site and then returned to the process.



**Fig. 2:** Sulphate/kraft separation and dispersal process with liquor recycling

In the **sulphite process** the black liquor is also evaporated and roasted. Magnesium oxide produced during the roasting is removed from boiler waste gases using cyclones, and then hydrated. The magnesium hydroxide is used in flue gas washers. The concentration of the resulting solution of magnesium hydrogen sulphite and magnesium sulphite is then adjusted to that required for cooking by adding  $\text{SO}_2$ .



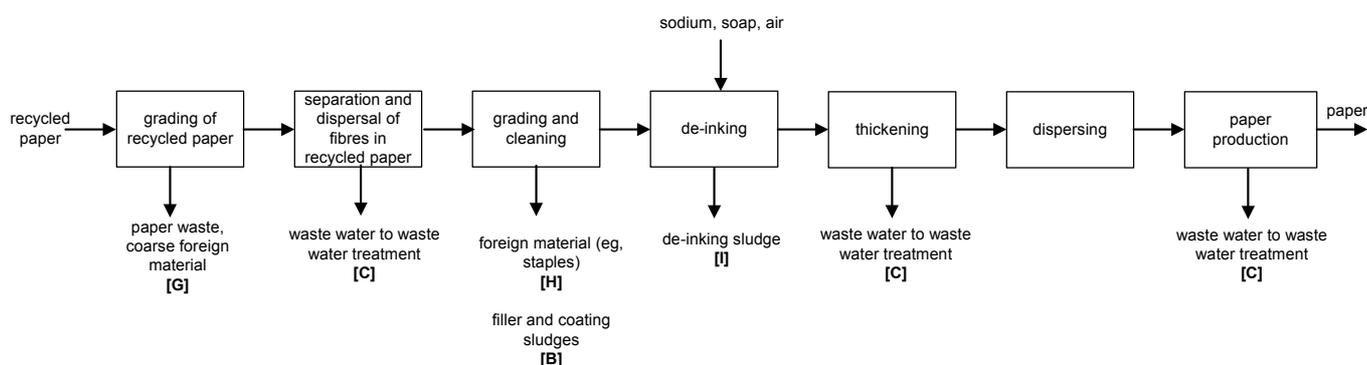
**Fig. 3:** Sulphite separation and dispersal process

## 1.2 Paper production from recycled paper (figure 4)

In this process, the raw material (cellulose) is obtained from recycled paper and in special cases from textiles. The recycled paper is first of all graded according to quality and foreign materials are removed. In each recycled paper fraction, fibres are separated and soaked in water. In several cleaning stages, (sieve and hydrocyclone)

further foreign materials (e.g. paper clips, adhesive strips) are separated. In the de-inking stage, which is only used when white paper is being produced, printing inks are removed. Agents such as detergents are used in this process. The printing inks are gathered and creamed off in the foam produced by blowing air across the suspension (flotation).

Depending on the quality of paper required, fresh cellulose from wood is added to the cellulose thus obtained in order to raise the average length of the cellulose fibres and thereby the strength of the paper. After thickening and dispersing, the pulp stock is used for the production of paper. Further paper production processes are in accordance with in paragraph 1.1.



**Fig. 4: paper production from recycled paper**

## 2 Wastes

### **Wood waste [A]**

As a rule, the bark is removed from tree trunks or forest thinnings that are delivered to paper and cellulose factories before the process of pulping.

#### Classification of waste in accordance with EWL:

03 03 01 waste bark and wood

#### Notes on recycling, utilization and disposal:

As a rule, bark and wood waste are free of dangerous substances and are normally used on-site as fuel. In principle, bark and wood waste can also be used in landscape gardening.

In exceptional cases disposal together with municipal waste.

### **Fibres and knots [B]**

After pulping to obtain cellulose fibres, fibre bundles and knots are removed from the cellulose suspension. During the recovery of recycled paper, sludges of paper filler and coatings (starch, kaolin, silicate, sulphide, sulphite, diatomite) are produced.

Classification of waste in accordance with EWL:

03 03 10 fibre rejects, fibre-, filler- and coating-sludges from mechanical separation

Notes on recycling, utilization and disposal:

This waste which is mainly organic can, in principle, be used as a fuel (e.g. at cement works, power stations).

Otherwise, incineration, as a rule together with municipal waste.

***Waste water to waste water treatment [C]***

Waste water, heavily laden with organic matter from the various process stages of paper production, is treated in waste water treatment plants which produces a waste water treatment sludge. For a description of this process see chapters 19 02 and 19 08. The cleaned waste water is fed into rivers or canals or into the sewage system.

Classification of waste in accordance with EWL:

03 03 11 sludges from on-site effluent treatment other than those mentioned in 03 03 10

Notes on recycling, utilization and disposal:

At present there are no known viable treatment processes.

As a rule, disposal with municipal waste.

***Waste gas to flue gas treatment [D]***

Gases from the roasting of concentrated black liquor (spent cooking liquor) are treated in several stages. For a description of the resulting wastes see subchapter 19 01.

***Lime mud waste [E]***

Lime mud waste is produced during causticising of green liquor (dissolved smelt from the roasting of black liquor) due to precipitation resulting from a change in pH.

Classification of waste in accordance with EWL:

03 03 09 lime mud waste

Notes on recycling, utilization and disposal:

As a rule, lime mud waste is reprocessed on-site to produce lime and then re-used.

Otherwise disposal to landfill, as a rule, together with municipal waste.

### ***Ash and sludge [F]***

During the filtration of green liquor, ash (from roasting) and sludges containing sulphite are produced.

#### Classification of waste in accordance with EWL:

03 03 02 green liquor sludge (from recovery of cooking liquor)

#### Notes on recycling, utilization and disposal:

At present there are no known viable treatment processes.

Disposal to landfill, as a rule, together with municipal waste.

### ***Paper waste, coarse foreign materials [G]***

While sorting recycled paper, unsuitable types of paper and materials (materials other than paper) are separated.

#### Classification of waste in accordance with EWL:

03 03 08 wastes from sorting of paper and cardboard destined for recycling

#### Notes on recycling, utilization and disposal:

Incineration, as a rule, together with municipal waste.

### ***Rejects, foreign materials [H]***

After recycled paper has been pulped, foreign materials are separated out. These include, for example, staples, adhesive strips, unseparated fibres and sand.

#### Classification of waste in accordance with EWL:

03 03 07 mechanically separated rejects from pulping of waste paper and cardboard .

#### Notes on recycling, utilization and disposal:

At present there are no known viable treatment processes.

Disposal to landfill or incineration, as a rule, together with municipal waste.

### ***De-inking sludge [I]***

De-inking sludge is produced when printing inks are removed from the pulp stock.

#### Classification of waste in accordance with EWL:

03 03 05 de-inking sludges from paper recycling

#### Notes on recycling, utilization and disposal:

At present there are no known viable treatment processes.

Following pre-treatment (removal of water), incineration, as a rule, together with municipal waste.

### 3 Overview of waste classification – material flow

Extract from EWL		Material flow	Treatment
<b>03 03</b>	<b>Wastes from pulp, paper and cardboard production and processing</b>		
03 03 01	waste bark and wood	A	1) on-site incineration, 2) landscape gardening 3) with municipal waste
03 03 02	green liquor sludge (from recovery of cooking liquor)	F	with municipal waste
03 03 05	de-inking sludges from paper recycling	I	incineration, with municipal waste
03 03 07	mechanically separated rejects from pulping of waste paper and cardboard	H	incineration, with municipal waste
03 03 08	wastes from sorting of paper and cardboard destined for recycling	G	incineration, with municipal waste
03 03 09	lime mud waste	E	1) on-site recycling, 2) with municipal waste
03 03 10	fibre rejects, fibre-, filler- and coating-sludges from mechanical separation	B	incineration, with municipal waste
03 03 11	sludges from on-site effluent treatment other than those mentioned in 03 03 10	C	with municipal waste
03 03 99	wastes not otherwise specified	not normally required	

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## 04 01 Wastes from the leather and fur industry

1	PROCESS.....	1
1.1	Fur production .....	1
1.2	Leather production.....	4
2	WASTES .....	7
3	OVERVIEW OF WASTE CLASSIFICATION – MATERIAL FLOW .....	12

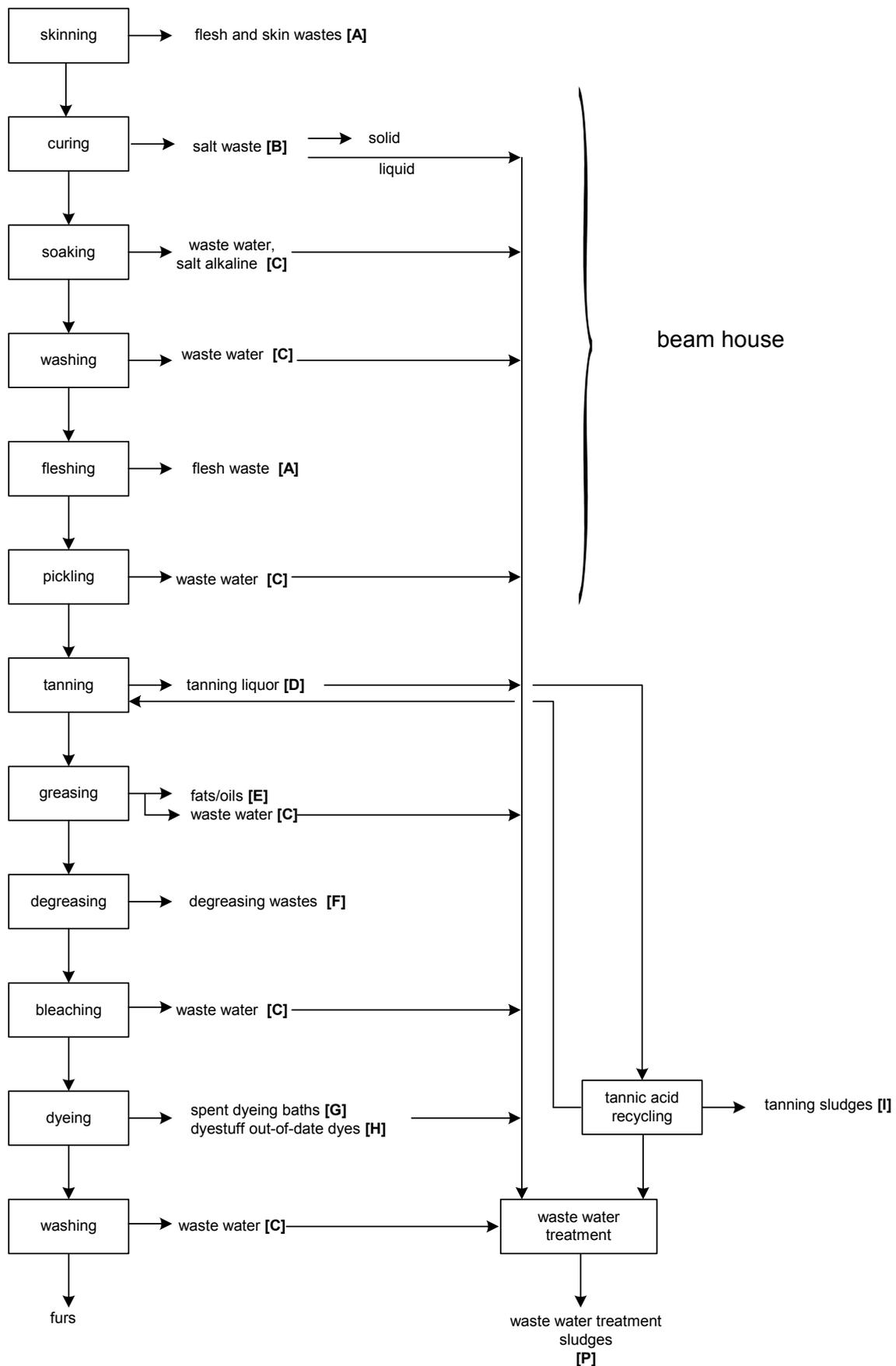
### 1 Process

The leather and fur industry aims to make animal skins and fur durable. The central process is tanning in which tannic acids chemically combines with skin proteins to form leather.

Leather manufacture uses mainly skins from cattle, sheep, goats and pigs. Fur production uses fur from more than 100 different animals. Over 80% of furs come from specially farmed animals (e.g. mink, fox, chinchilla) and agricultural stock (e.g. lambs, goats, persian lamb). Approx. 15% of furs come from wild animals (e.g. musquash, weasel, big cats).

#### 1.1 Fur production

Animals are skinned. Care must be taken to avoid damaging the fur. The main process steps are shown in **fig. 1**.



**Fig. 1:** An overview of the processes in fur production

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## **Curing**

Normally the furs (pelts) are not processed immediately after skinning. In order to avoid rotting during storage and transport, the pelts are cured either by drying or by treating with salt (pickling). Wet and dry processes are used for salt treatment.

## **Soaking**

The cured pelt is rinsed with water in the soaking process. By reabsorbing water, the fur returns to its original condition. In addition, dirt, blood, water-soluble and salt-soluble proteins as well as curing salts are removed.

## **Washing**

Heavily soiled or greasy pelts (e.g. sheepskin) are also washed, using alkyl ether sulphates, soda and often organic solvents. Then, the raw material is rinsed.

## **Fleshing (mechanical treatment)**

Tissue below the skin, fat and flesh remains are removed either manually or mechanically on a furriers' bench. At this stage, large pelts are thinly split or shaved. Part of the leather skin is removed so that the pelt acquires a uniform strength. For smaller pelts, this step is carried out after pickling or greasing.

## **Pickling**

In preparation for the tanning process, collagen in the skin is broken down to allow tanning stuffs to penetrate the fibre more easily. This treatment also serves to improve the suppleness of the fur by removing soluble proteins. The treatment chemicals used are acid/salt solutions, most commonly sulphuric acid, organic acids and cooking salt.

## **Tanning**

Tanning transforms skin into leather. In order to achieve a soft, light fur, the treatment chemicals used are almost exclusively aluminium salts, formaldehyde as well as chromium salts. Vegetable tannic acids are seldom used because of these desired properties.

## **Greasing and degreasing**

To make the pelt soft and supple it is greased. Animal and vegetable oils as well as mineral oil products are used.

Following that, solvent-soluble substances are removed from the hair and the leather in order to reduce the weight of the fur. Solvents used are chlorine and fluoride hydrocarbons.

## **Bleaching**

Bleaching is used, on the one hand, to remove yellowing by oxidation or reduction in the production of white furs and, on the other hand, to remove the colour of dark coloured furs in preparation for the subsequent dyeing process. Bleaching agents used are hydrogen peroxide as well as sulphite, bisulphite and hyposulfit.

## **Dyeing**

Furs, especially less valuable ones such as sheepskin, are coloured or dyed. Natural black Persian furs acquire their typical sheen by dyeing. Dyeing is carried out in dye

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baths where different dyes are used depending on the type of fur and colour to be achieved. Dyes used include:

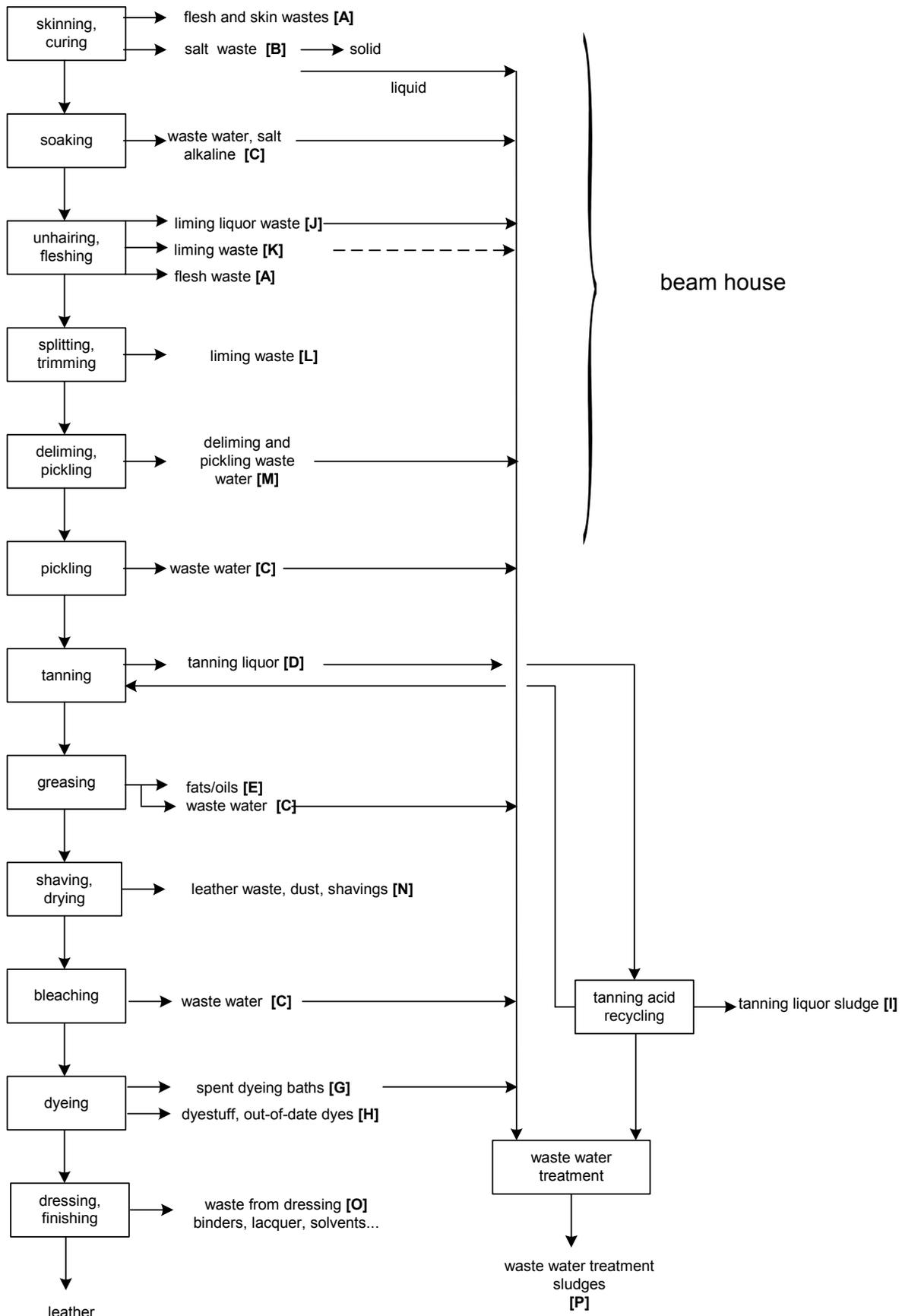
- Natural dyes, e.g. extract from red, blue and yellow wood,
- oxidation dyes, e.g. p-phenylenediamine, catechol,
- synthetic dyes, e.g. dispersions and metal compound dyes.

In addition to dyeing, furs are also printed, for example in the production of imitations (leopard-look). As a rule the same printing processes are used here as in the textile industry. Oxidising dyes are normally used for printing.

After dyeing and printing, the furs are washed in water baths.

## 1.2 Leather production

The production of leather is to a greater extent the same as the production of fur. The leather production process is shown in **fig. 2**. The most significant addition is the unhairing process, and tanning involves the use of different agents. As a result, only the most important differences for leather production will be described.



**Fig. 2:** Overview of the processes in leather production

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## **Unhairing (liming) and fleshing**

The processes of skinning, curing and soaking are similar to those in fur production. During fleshing, animal hair is also removed. The method used depends on whether the hair should be discarded (e.g. cow hide) or preserved (e.g. sheep and goats skin). In both cases liming agents are used, mainly calcium hydroxide, sodium sulphide, sodium hydrogen sulphite. These chemicals loosen the hair roots in the skin tissue and destroy the hair substance (keratin) at high concentrations.

After unhairing, flesh remains are scraped from the skins.

## **Leather splitting and trimming**

Strong skins (e.g. cow hide) are split and in some cases cut. Splitting results in two skin layers, the grain split and the flesh split.

In addition, the leather can be cut at this stage. The resulting skin waste can be used in the production of glue.

## **Deliming and pickling**

Before tanning, the swelling of the hide caused by liming has to be reversed. For this, weak organic acids (aliphatic or aromatic dicarboxylic acids) or alkali salts (ammonium sulphate, chloride) are used to improve the leather.

## **Pickling**

Pickling with acids and salts prepares the skins for tanning.

## **Tanning**

In tanning a distinction is made between the two processes, chromium and vegetable tanning. As in the past, leather is normally tanned with trivalent chromium salts. In exceptional cases, the two-bath process with chromate is used.

Vegetable tanning uses plant extract, especially tanning bark. The process using natural tannic acid is much more time consuming than chromium tanning.

## **Bleaching**

Bleaching removes stains or stripes which may be caused during tanning and is particularly used with vegetable tanning.

## **Shaving**

Shaving involves removing loose fibres on the underside of the leather using blade rollers.

## **Dyeing**

A large number of different dyes are used in the dyeing of leather. A distinction is made between:

- Acid and direct dyes, e.g. mono and diazo dyes,
- metal compound dyes,
- dissolved or liquid dyes,
- reactive dyes and
- basic dyes.

Dyeing is mainly carried out in a dye bath. Spray dyeing and printing are used when leather is dyed on only one side or when a special decorative effect is desired.

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## Dressing and finish

After dyeing and drying, a protective coating, which may also have a decorative effect, is applied to the leather. This layer serves to protect the leather from damage such as bumps, scratches, and rubbing, improves the comfort (softeners) and produces decorative effects (e.g. lacquer).

The application may be in several layers, but is mainly a base coat and a covering layer. For the base coat, binders, e.g. aqueous polymer dispersions, nitrocellulose dissolved in organic solvents, proteins or resins are used. For the covering layer lacquer is, for example, used.

Various techniques are used to apply the coats. These include spraying and pouring or printing processes, but other processes commonly used include iron-on, padding and covering with PVC foil.

## 2 Wastes

### *Flesh and skin waste [A] [K]*

After skinning and fleshing, the skins are cut and flesh remains removed. Sludges from liming (hair, organic substances) are also classified in this category.

#### Classification of waste in accordance with EWL:

04 01 01 fleshings and lime split wastes

#### Notes on recycling, utilization and disposal:

In the past this waste was further processed to produce glue, gelatine, photogelatine, ointments or oil-emulsions. These processes to utilize the waste, especially glue and gelatine production are seldom used today.

Otherwise, incineration, as a rule together with municipal waste.

### *Salt waste [B]*

Salt used in the curing of untreated pelts and hides is disposed of as a solid during dry treatment. During wet treatment, spent salt solutions arise. Salt waste contains skin, fur and flesh remains.

#### Classification of waste in accordance with EWL:

06 03 14 solid salts and solutions other than those mentioned in 06 03 11 and 06 03 13

#### Notes on recycling, utilization and disposal:

Salt waste and solutions can to some extent be recovered and re-used.

As a rule, salt solutions are treated on-site together with other wastewater material flows (see **wastewater treatment**).

Solid salts with a high organic content are thermally treated in waste incinerators, as a rule together with municipal waste, or otherwise disposed to landfill (UGL).

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### ***Wastewater treatment sludge [P]***

The different types of wastewater produced during leather and fur production, [B], [C], [E], [F], [G], [J], [K], [M], can normally be treated on-site in wastewater treatment plants with the exception of tanning liquor. To some extent, wastewater from beam house (every process before tanning) is treated separately in a biological wastewater treatment plant due to its high organic content. Tanning liquor containing chromium is often regenerated or treated separately. Particularly problematic are liming liquor residue, because of its high oxygen demand, and wastewater from soaking because of its high salt content.

#### Classification of waste in accordance with EWL:

- 04 01 06 sludges, in particular from on-site effluent treatment containing chromium
- 04 01 07 sludges, in particular from on-site effluent treatment free of chromium (*particularly in the case of vegetable tanning*)

#### Notes on recycling, utilization and disposal:

Sludges free of chromium can be used in horticulture or composted.

Otherwise, thermal treatment in waste incinerators or disposal to landfill, as a rule together with municipal waste.

### ***Tanning liquor and sludge [D], [I]***

Tanning liquor may contain chromium (as a rule Cr III) or may be chromium free in the case of vegetable tanning.

#### Classification of waste in accordance with EWL:

- 04 01 04 tanning liquor containing chromium (*for external treatment*)
- 04 01 05 tanning liquor free of chromium (*for external treatment*)
- 04 01 06 sludges, in particular from on-site effluent treatment containing chromium (*for on-site chromium precipitation*)
- 04 01 07 sludges, in particular from on-site effluent treatment free of chromium (*for on-site wastewater treatment and vegetable tanning*)

#### Notes on recycling, utilization and disposal:

Tanning liquor containing chromium and vegetable tanning liquor can be regenerated on-site and recycled to the tanning process.

Wastewater from chromium regeneration is, as a rule, treated on-site together with other wastewater flows (see **wastewater treatment**).

In the case of external treatment, tanning liquor is fed to a CPT plant. There, solid and dissolved components are separated from the water phase which can then be fed into the sewerage system.

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### ***Fats/oils [E]***

Free oil is removed from spent greasing baths by using, for example, skimming equipment. Following that, aqueous baths are treated together with other wastewater flows.

#### Classification of waste in accordance with EWL:

19 02 07\* oil and concentrates from separation (*for separated fats and oil*)

#### Notes on recycling, utilization and disposal:

At present there are no known viable treatment processes.

19 02 07\*: Incineration

As a rule, the aqueous phase is treated on-site together with other wastewater flows (see **wastewater treatment**).

### ***Degreasing waste [F]***

Especially furs are degreased after greasing using solvents – sometimes halogenated. This results in sludges containing solvents.

#### Classification of waste in accordance with EWL:

04 01 03\* degreasing wastes containing solvents without a liquid phase

#### Notes on recycling, utilization and disposal:

At present there are no known viable treatment processes.

Incineration, HWI.

### ***Spent dye baths [G]***

As a rule, spent dye baths are treated on-site, together with other wastewater flows (see **wastewater treatment**).

### ***Dye remains and out-of-date dyes [H]***

Dye and pigment remains from the use of dye baths, from the cleaning of machines and pipes as well as out-of-date dyes and pigments arise.

#### Classification of waste in accordance with EWL:

04 02 16\* dyestuffs and pigments containing dangerous substances

04 02 17 dyestuffs and pigments other than those mentioned in 04 02 16

#### Notes on recycling, utilization and disposal:

Dye and pigment remains can to a limited extent be recycled.

Otherwise, incineration, HWI or in the case of minimal organic components, disposal to landfill; if it does not contain dangerous substances, together with municipal waste.

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### ***Liming liquor remains, sludges [J, K]***

Liming liquor remains contain a high level of dangerous organic substances. As a rule, it is treated on-site together with other wastewater flows (see wastewater treatment). The sludges may contain valuable substances (e.g. wool, wool fat) and can be treated separately. Otherwise, the sludges are either treated in wastewater treatment plants or disposed of together with flesh and skin waste.

#### Classification of waste in accordance with EWL:

04 01 01 fleshings and lime split wastes

#### Notes on recycling, utilization and disposal:

Valuable materials (e.g. wool, wool fat) can be utilized.

Otherwise, incineration, as a rule together with municipal waste.

### ***Liming waste [L]***

Liming waste arises during leather splitting and cutting following the unhairing process.

#### Classification of waste in accordance with EWL:

04 01 02 liming waste

#### Notes on recycling, utilization and disposal:

Liming waste can be used for glue production.

Otherwise, incineration, as a rule together with municipal waste.

### ***De-liming and pickling wastewater [M]***

This wastewater is, as a rule, treated on-site together with other wastewater flows (see **wastewater treatment**).

### ***Leather waste, dust, shavings [N]***

During shaving, loose fibres are sanded and planed off. This results in leather dust and shavings.

#### Classification of waste in accordance with EWL:

04 01 08 waste tanned leather (blue sheetings, shavings, cuttings, buffing dust) containing chromium

04 01 99 wastes not otherwise specified. (chromium-free pre-tanned skins that have not been treated) (*for vegetable tanning*)

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Notes on recycling, utilization and disposal:

Shredded, tanned waste can be processed in leather workshops (e.g. insoles, slipper soles) or added to textile fleeces.

Otherwise, incineration, as a rule together with municipal waste.

***Waste from dressing [O]***

Different kinds of waste can arise during dressing, especially spent binders, lacquer, solvents, foil remains and impregnators.

Classification of waste in accordance with EWL:

04 01 09 wastes from dressing and finishing

Notes on recycling, utilization and disposal:

At present there are no known viable treatment processes.

Incineration, if it does not contain dangerous substances, together with municipal waste.

### 3 Overview of waste classification – material flow

	<b>Extract from EWL</b>	<b>Material flow</b>	<b>Treatment</b>
<b>04 01</b>	<b>wastes from the leather and fur industry</b>		
04 01 01	fleshings and lime split wastes	A, K	1) recycling, incineration, 2) with municipal waste
04 01 02	liming waste	L	1) recycling, 2) with municipal waste
04 01 03*	degreasing wastes containing solvents without a liquid phase	F	1) incineration, 2) HWI
04 01 04	tanning liquor containing chromium	D	1) recycling, 2) CPT
04 01 05	tanning liquor free of chromium	D	1) recycling, 2) CPT
04 01 06	sludges, in particular from on-site effluent treatment containing chromium	I, P	with municipal waste
04 01 07	sludges, in particular from on-site effluent treatment free of chromium	I, K, P	1) landscape gardening, composting, 2) with municipal waste
04 01 08	waste tanned leather (blue sheetings, shavings, cuttings, buffing dust) containing chromium	N	1) recycling, 2) with municipal waste
04 01 09	wastes from dressing and finishing	O	1) incineration, 2) with municipal waste
04 01 99	wastes not otherwise specified	N	1) incineration, 2) with municipal waste

	<b>wastes from the leather and fur industry to be classified under other waste categories</b>		
04 02 16*	dyestuffs and pigments containing dangerous substances	H	1) recycling, 2) incineration, 3) HWI

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04 02 17	dyestuffs and pigments other than those mentioned in 04 02 16	H	1) recycling, 2) with municipal waste
06 03 14	solid salts and solutions other than those mentioned in 06 03 11 and 06 03 13	B	1) recycling, 2) with municipal waste
19 02 07*	oil and concentrates from separation	E	incineration

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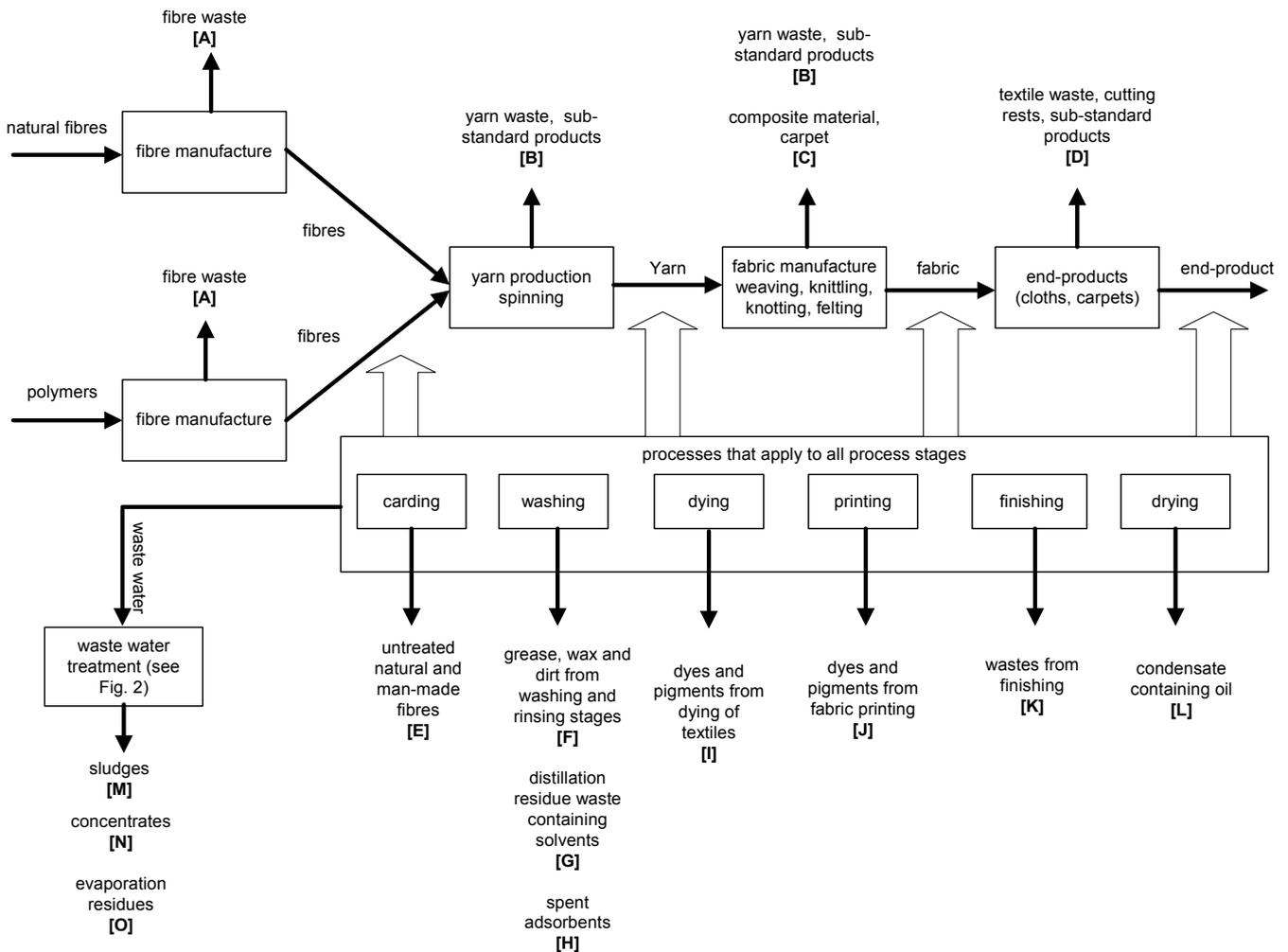
## 04 02 Wastes from the textile industry

<b>1. PROCESSES</b> .....	<b>1</b>
1.1 Foreword .....	1
1.2 Fibre treatment and manufacture .....	2
1.3 Yarn production .....	3
1.4 Size application .....	3
1.5 Cloth and fabric manufacture .....	3
1.6 Dyeing .....	3
1.7 Printing .....	4
1.8 Finishing .....	4
1.9 Waste water treatment .....	4
<b>2 WASTES</b> .....	<b>5</b>
<b>3 OVERVIEW OF WASTE CLASSIFICATION – MATERIAL FLOW</b> .....	<b>11</b>

### 1. Processes

#### 1.1 Foreword

The manufacture of textiles comprises mechanical processes (spinning, weaving, knitting) and, more significantly, wet chemical textile finishing (size application, dyeing, treating). Some companies which carry out the whole production process from raw materials to finished textiles still exist, however, in this industrial field, specialisation has taken place so that a large number of companies deal exclusively with textile finishing. As a general rule, it is necessary to study each individual company because of the wide range of finishing processes. In terms of classifying waste flows to waste categories, the process stages described below should be seen as building blocks which may exist in various configurations. With regard to waste management, textile finishing is of greater significance than mechanical textile production.



**Fig. 1: Overview of processes involved in textile manufacture**

## 1.2 Fibre treatment and manufacture

Fibres used include man-made and natural fibres. Man-made fibres are usually made from polymers (e.g. cellulose, polyacrylate, polyethylene) and, in rare cases, mineral materials such as glass or carbon fibres are processed. Natural fibres are principally animal hair (e.g. sheep wool), cotton, bast (e.g. flax) and silk.

Before the fibres are spun to form yarn, they have to be washed and, if necessary, pre-treated. Waste, arising mainly from natural fibres especially from raw wool, is produced during the washing process which is usually carried out in a water medium, but in some rare cases with organic solvents.

Raw wool from animals is soiled with grease (wool grease), salts (sweat), dirt (soil, sand, plant matter) and sometimes with pesticides (against parasites). Some of these are removed mechanically (combing) or are washed out as sludge or grease. During chemical cleaning processes, solvents (e.g. perchloroethylene) are recycled and the impure air is cleaned in activated carbon filters.

In the case of man-made fibres, there is only a little soiling.

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### 1.3 Yarn production

The spinning process turns the fibres into a more suitable process yarn. In order to assist the spinning process, the fibres are mixed with spinning oil (mineral oil) and other conditioning substances (e.g. silicon oil).

Yarn production takes place in several processes (carding, drawing, production of pre-yarn, spinning, twisting and winding). The finished yarn can be dyed if required (see paragraph 1.6) and conditioned for subsequent processes.

### 1.4 Size application

In order to transfer the yarn to fast moving looms without breaking the thread, a size is applied to the yarn before weaving. This provides the required softness by creating a film around the yarn. Sizes or sizing materials are polymers (especially starch, starch derivatives, polyvinyl alcohol, polyacrylate, carboxymethylcellulose). The sizes have to be removed again before dyeing.

Before knitting, yarn is treated with grease or wax (as a rule paraffin wax) in order to enable processing at higher speeds and to protect the yarn from mechanical damage. When finished, the oil and wax are washed out.

### 1.5 Cloth and fabric manufacture

In the manufacture of cloth and fabric we distinguish between the following processes: weaving, knitting and knotting (rugs, carpets).

In weaving and knitting, a flat textile is manufactured by weaving yarn or threads.

In knotting, the threads are pulled through a textile net and then fixed with a synthetic material. The woven product is stabilised using a textile or foam backing.

### 1.6 Dyeing

In textile dyeing, either the yarn or the woven cloth can be dyed. Before dyeing, impurities and agents such as sizes and grease that have been applied in previous processes, have to be removed. The cleaning method used depends on the type of substance to be removed; usually in water with the addition of solutions and enzymes. Active surface substances and complexing agents are used as additional agents. If the fibres are heavily soiled with oil from previous processes, organic solvents (e.g. perchloroethylene) are used for cleaning. To improve the ability of the fibres to absorb dye, after being washed, they are mercerised with NaOH or in rare cases with ammonia solution.

Organic and pigment dyes which could contain heavy metals are primarily used for dyeing. After dyeing, the dye is fixed and the textile rinsed.

## 1.7 Printing

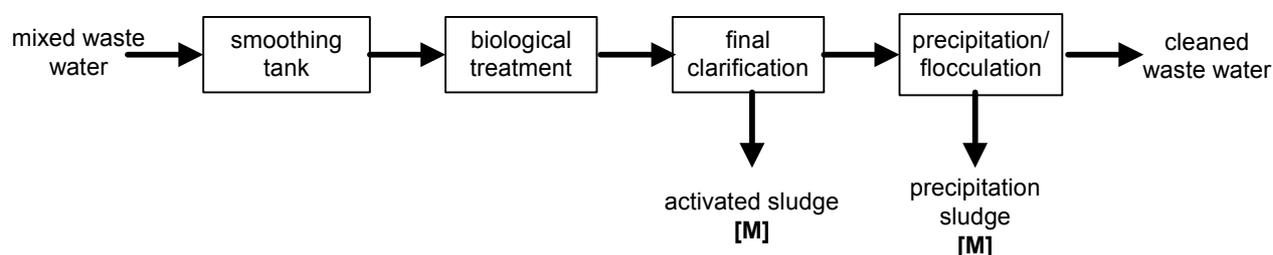
A pattern or picture are printed onto a fabric in the printing process. Printing processes used are mainly screen printing, transfer and cylinder press processes. After drying and fixing the dye, the textiles are again rinsed (see chapter 08 01).

## 1.8 Finishing

Once the textiles have been made, they are finished (functional finishing) in order to provide specific qualities for their end-use. Agents are applied to make them easier to care for, more comfortable to wear, increase hygiene and make them more functional (e.g., impregnation, flame-retardancy). Textile agents for this are, for example, synthetic resin for laminating, polybromide organic substances as flame-retardants, formaldehyde and methanol for easy-care treatment, polyvinyl acetate and polyacrylate as handling finishes, etc.

## 1.9 Waste water treatment

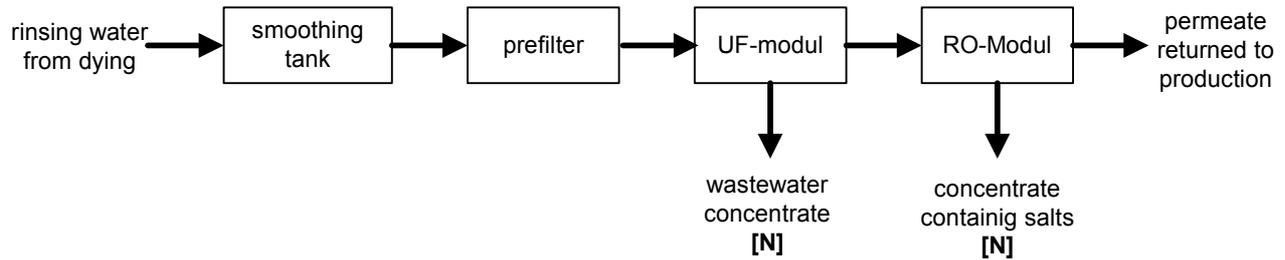
One kg of cloth, manufactured as described above, uses a total of approximately 1 kg of agents, mainly delivered in a water solution. On-site waste water treatment does not contribute directly to the production process but, nevertheless, affects the amount of waste produced by a textile finishing company. For this reason, on-site waste water treatment is seen as a separate process in terms of the production of waste. Agents, mainly organic in nature (dyes, coatings, oil), appear in waste water from emptying residue and washing processes even though water regulations try to isolate separately collected material flows (especially residue from coating processes, dyeing and treatments) from on-site waste water regimes and to dispose of them as waste. The aim of waste water treatment is to reduce COD and remove dyes from waste water. Several waste water treatment processes are used for this. Most waste water is treated biologically followed by precipitation of heavy metals.



**Fig. 2:** Biological waste water treatment with subsequent elimination of heavy metals

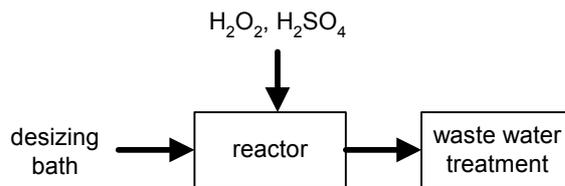
As so-called part material flow treatment, the following processes can be introduced before mixing with other on-site waste water:

Dye rinse baths may be cleaned using membrane processes. This also allows water to be recovered for the production process.



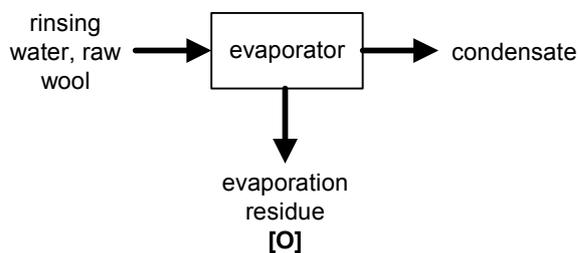
**Fig. 3:** Wastewater treatment with a combined membrane process  
(UF = ultrafiltration, RO = reverse osmosis)

Biological substances which cannot be broken down or which are difficult to break down (baths for removing coatings, pigment dyes) are chemically oxidised in a reactor with the addition of  $H_2O_2$  and  $H_2SO_4$ . As a rule, the treated water is fed into the municipal sewage plant.



**Fig. 4:** Chemical oxidation at 80 – 130 °C and 3-5 bar pressure

Heavily laden waste water from the cleaning of wool can be concentrated over an evaporator. The condensate is either fed into the sewage system or can be returned to the manufacturing process after further treatment. The resulting sludge contains grease, salt and dirt.



**Fig. 5:** Evaporation of spent rinsing baths

## 2 Wastes

### **Fibre waste [A]**

During the treatment of fibres before spinning, e.g. carding and finishing of fibres, untreated natural and man-made fibres arise.

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Classification of waste in accordance with EWL:

04 02 21 wastes from unprocessed textile fibres

Notes on recycling, utilization and disposal:

Waste fibre which has not been treated with chemicals can be returned to the production process or used in other processes (e.g. plant fibres can be used for cellulose production).

Otherwise, incineration or disposal to landfill, as a rule, together with municipal waste.

***Yarn, cloth waste and sub-standard products [B]***

This waste comprises fibres and cloth that has already been treated (e.g. with spinning oil, coatings).

Classification of waste in accordance with EWL:

04 02 22 wastes from processed textile fibres

Notes on recycling, utilization and disposal:

After treatment (e.g. washing) partial return to the production processes or use in other processes (e.g. cellulose production, cleaning rags, cleaning wool).

Otherwise, incineration or disposal to landfill, as a rule, together with municipal waste.

***Composite materials and carpet [C]***

Yarn and fabric that has already been coated (e.g. impregnation, flame-retardancy), laminated with man-made coating (e.g. waterproof material), or fixed with adhesives should be classified as composite material.

Classification of waste in accordance with EWL:

04 02 09 wastes from composite materials (impregnated textile, elastomer, plastomer)

Notes on recycling, utilization and disposal:

Can be used in brickworks (as swelling agent).

Otherwise, incineration or disposal to landfill, as a rule, together with municipal waste.

***Textile waste, cutting rests and sub-standard products [D]***

During textile production, fabric rests, which are coated or impregnated or uncoated, arise.

Classification of waste in accordance with EWL:

04 02 09 wastes from composite materials (impregnated textile, elastomer, plastomer)

04 02 22 wastes from processed textile fibres

---

Notes on recycling, utilization and disposal:

04 02 09: Can be used in brickworks (as swelling agent).

04 02 22: After treatment (e.g. washing) partial return to the production processes or use in other processes (e.g. cellulose production, cleaning rags, cleaning wool).

Otherwise incineration or disposal to landfill, as a rule, together with municipal waste.

***Untreated natural and man-made fibre waste [E]***

This waste arises during the treatment and manufacture of fibres or yarn, e.g. during combing of wool and finishing for spinning.

Classification of waste in accordance with EWL:

04 02 21 wastes from unprocessed textile fibres

Notes on recycling, utilization and disposal:

Return to the production process or use in other processes (e.g. plant fibres can be used for cellulose production).

Otherwise incineration or disposal to landfill, as a rule, together with municipal waste.

***Grease, wax and dirt from washing and rinsing stages [F]***

Separated waste such as wool grease, salt, plant matter and soil arise in washing and rinsing baths, that are normally recycled. Sometimes, waste from wool washing processes is contaminated with pesticides and from cotton washing processes with herbicides.

Classification of waste in accordance with EWL:

04 02 10 organic matter from natural products (for example grease, wax) (*the rule*)

04 02 19\* sludges from on-site effluent treatment containing dangerous substances (*exception*)

Notes on recycling, utilization and disposal:

Wool grease is a valuable raw material and can be used, for example, in the cosmetics industry. In addition, the mixed sludge (grease, soil, salt) can be used in brickworks as swelling agent.

Otherwise, incineration, or if the organic content is low, disposal to landfill. If it does not contain dangerous substances, together with municipal waste.

***Distillation residue, waste containing solvents [G]***

Fibres and textiles are sometimes washed with solvents (e.g. perchloroethylene). The solvents are recycled and sometimes reprocessed on-site. Distillation residue arises during this recycling process.

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Classification of waste in accordance with EWL:

14 06 04\* sludges or solid wastes containing halogenated solvents

14 06 05\* sludges or solid wastes containing other solvents

Notes on recycling, utilization and disposal:

At present there are no known viable treatment processes.

Incineration in HWI.

***Spent adsorbents [H]***

When washing with solvents the extracted air is cleaned in activated carbon filters which have to be regularly renewed or regenerated.

Classification of waste in accordance with EWL:

19 01 10\* spent activated carbon from flue-gas treatment

Notes on recycling, utilization and disposal:

Laden activated carbon filters can be regenerated and reused.

Otherwise, incineration.

***Dyes and pigments from dyeing of textiles [I]***

Dye and pigment residue from the use of dye-baths, from the cleaning of machines and pipe work as well as out-of-date dyes and pigments. Especially during the dyeing of wool, metal compound dyes, which contain chrome and other metals, are used.

Classification of waste in accordance with EWL:

04 02 16\* dyestuffs and pigments containing dangerous substances

04 02 17 dyestuffs and pigments other than those mentioned in 04 02 16

Notes on recycling, utilization and disposal:

Dye and pigment residue can be recycled to some extent.

Otherwise, incineration, or if the organic content is low, disposal to landfill. If it does not contain dangerous substances, together with municipal waste.

***Dyes and pigments from fabric printing [J]***

Unused dyes and printing pastes from printing processes, sub-standard products and cleaning processes as well as out-of-date dyes.

Classification of waste in accordance with EWL:

04 02 16\* dyestuffs and pigments containing dangerous substances

04 02 17 dyestuffs and pigments other than those mentioned in 04 02 16

Notes on recycling, utilization and disposal:

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Dye and pigment residue can be recycled to some extent.

Otherwise, incineration, or if the organic content is low, disposal to landfill. If it does not contain dangerous substances, together with municipal waste.

### ***Waste from finishing [K]***

During functional finishing, various substances are used. In particular, the waste from coating and laminating processes (e.g. man-made resin) may contain solvents. In addition, during these finishing stages, solvents (e.g. perchloroethylene) are required as carriers to support the coating processes. Waste arises as production residue, from cleaning processes and as sub-standard products.

#### Classification of waste in accordance with EWL:

04 02 14\* wastes from finishing containing organic solvents

04 02 15 wastes from finishing other than those mentioned in 04 02 14

#### Notes on recycling, utilization and disposal:

At present there are no known viable treatment processes.

Incineration (waste containing organic solvents), otherwise disposal to landfill. If it does not contain dangerous substances, it can be disposed of with municipal waste.

Note: In the textile industry, finishing covers a large number of treatment processes. If these were all considered in depth, waste would have to be classified in almost every waste category. Here, only waste from functional finishing has been classified.

### ***Condensate containing oil [L]***

During the drying of fibres and textiles, condensate is produced which may contain grease from impurities in the fibrous material. As a rule, the condensate is treated in on-site waste water treatment plants.

#### Classification of waste in accordance with EWL:

13 08 02\* other emulsions

#### Notes on recycling, utilization and disposal:

At present there are no known viable treatment processes.

Treatment in CPT plants to separate the water phase. This can then be fed into the sewage system.

### ***Sludges from waste water treatment [M]***

Precipitation sludges arise during precipitation and flocculation of waste water, as a rule, following the biological stage. They are mainly mineral and may contain heavy metals.

With on-site biological waste water treatment, sludges, that are mainly laden with organic matter, are produced.

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Classification of waste in accordance with EWL:

- 04 02 19\* sludges from on-site effluent treatment containing dangerous substances (predominantly precipitation sludge)
- 04 02 20 sludges from on-site effluent treatment other than those mentioned in 04 02 19 (predominantly sludges from the biological stage)

Notes on recycling, utilization and disposal:

At present there are no known viable treatment processes.

Incineration (organic sludges), or disposal to landfill (precipitation sludges). If they do not contain dangerous substances, together with municipal waste.

***Concentrate [N]***

Especially while reprocessing washing water, oil and greasy concentrate from membrane systems may arise.

Classification of waste in accordance with EWL:

- 19 02 07\* oil and concentrates from separation

Notes on recycling, utilization and disposal:

At present there are no known viable treatment processes.

Treatment in CPT plants to separate the water phase. This can then be fed into the sewage system.

***Evaporation residue [O]***

During the evaporation of waste water from washing raw wool, mixed sludges that contain wool grease, salt, soil and other dirt are produced.

Classification of waste in accordance with EWL:

- 04 02 10 organic matter from natural products (for example grease, wax)

Notes on recycling, utilization and disposal:

Can be used in brickworks as swelling agent.

Otherwise incineration, as a rule, together with municipal waste.

### 3 Overview of waste classification – material flow

	<b>Extract from EWL</b>	<b>Material flow</b>	<b>Treatment</b>
<b>04 02</b>	<b>Wastes from the textile industry</b>		
04 02 09	wastes from composite materials (impregnated textile, elastomer, plastomer)	C, D	with municipal waste
04 02 10	organic matter from natural products (for example grease, wax)	F, O	1) recycling (wool grease) 2) with municipal waste
04 02 14*	wastes from finishing containing organic solvents	K	HWI
04 02 15	wastes from finishing other than those mentioned in 04 02 14	K	with municipal waste
04 02 16*	dyesuffs and pigments containing dangerous substances	I, J	recycling, HWI, HWL
04 02 17	dyesuffs and pigments other than those mentioned in 04 02 16	I, J	1) recycling 2) with municipal waste
04 02 19*	sludges from on-site effluent treatment containing dangerous substances	F, M	HWI, HWL
04 02 20	sludges from on-site effluent treatment other than those mentioned in 04 02 19	M	with municipal waste
04 02 21	wastes from unprocessed textile fibres	A, E	1) recycling 2) with municipal waste
04 02 22	wastes from processed textile fibres	B, D	1) recycling 2) with municipal waste

	<b>Wastes from the textile industry to be classified under other waste categories</b>		
13 08 02*	other emulsions	L	CPT
14 06 04*	sludges or solid wastes containing halogenated solvents	G	HWI
14 06 05*	sludges or solid wastes containing other solvents	G	HWI
19 01 10*	spent activated carbon from flue-gas treatment	H	regeneration, HWI
19 02 07*	oil and concentrates from separation	N	CPT

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## 06 01 Wastes from the manufacture, formulation, supply and use (MFSU) of acids

<b>1</b>	<b>Input materials and processes .....</b>	<b>1</b>
1.1	<i>Foreword .....</i>	1
1.2	<i>Sulphuric acid .....</i>	1
1.3	<i>Hydrochloric acid .....</i>	2
1.4	<i>Hydrofluoric acid .....</i>	2
1.5	<i>Phosphoric acid .....</i>	2
1.6	<i>Nitric acid .....</i>	2
1.7	<i>Other acids .....</i>	2
<b>2</b>	<b>Wastes .....</b>	<b>3</b>
2.1	<i>Waste sulphuric acid and sulphuric acid solutions [A] .....</i>	3
2.2	<i>Spent hydrochloric acid and hydrochloric acid solutions [B] .....</i>	4
2.3	<i>Waste hydrofluoric acid and hydrofluoric acid solutions [C] .....</i>	5
2.4	<i>Waste phosphoric acid and phosphoric acid solutions [D] .....</i>	5
2.5	<i>Waste nitric acid and nitric acid solutions [E] .....</i>	6
2.6	<i>Other waste acids [F], [G] and [H] .....</i>	7
<b>3</b>	<b>Overview of waste classification – material flow .....</b>	<b>9</b>

### 1 Input materials and processes

#### 1.1 Foreword

According to the general structure of the EWL, waste is classified in accordance with the industrial process from which it arises (classification rules, point 3.1 to 3.4 in the annex to the commission's decision 2001/118/EG). However, this has not been done in chapter 06 01. Here, due to the wide-ranging sources of waste, the classification is based on constituent substances. Nevertheless some acid wastes, arising from specific industrial processes, such as acid tars, residue gypsum and other processing residue, are listed in the respective branch chapters. Reference will be made to appropriate categories in the following.

#### 1.2 Sulphuric acid

Sulphuric acid is the most important industrial chemical worldwide in terms of quantity and one of the most important chemical raw materials used in a number of applications. The contact process is the most widely used manufacturing process in which catalytic SO<sub>2</sub>-oxidation and SO<sub>3</sub>-absorption result in a 98% acid. As a rule it is used as a raw material, for example as a pickling or stripping chemical or as accumulator

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acid, or it is used in chemical production processes such as in the manufacture of plastics and chemical fibres, in the petrochemical industry or in the production of titanium dioxide. Sulphurous acid is used as a bleaching or reducing agent.

Sulphuric acid either doesn't go into the end product or is present in only small quantities and is removed from the process as waste sulphuric acid (so-called acid residue) together with organic and/or inorganic contaminants.

### **1.3 Hydrochloric acid**

Hydrochloric acid is used as a strong inorganic acid in a wide range of applications, for example, in the breakdown of minerals in the coal and steel industry, in the pickling and etching of metal surfaces, in the regeneration of ion exchangers for water processing, for neutralising alkaline products and wastewater, etc.

### **1.4 Hydrofluoric acid**

Hydrofluoric acid, produced in a technical process from hydrogen fluoride, corrodes mineral compounds, e.g. silicon dioxide. Because of this corrosive characteristic it is used, for example, to etch glass, semiconductors and chips, for facade cleaning, to remove enamel, to descale metal (mainly stainless steel, in combination with nitric acid) and to remove sand from metal castings. In the chemical industry it is a base for the manufacture of fluorochemicals.

### **1.5 Phosphoric acid**

Outside the EU, phosphoric acid is obtained in a thermal process or by breaking down raw phosphate with mineral acid. It is used in the manufacture of feed and fertilizers as well as detergents. In addition, phosphoric acid has a wide range of uses, such as in the manufacture of enamel and ceramic cements, dyes and finishes in the textile industry, as a catalyst in chemical processes, for phosphating metal surfaces, as an etching substance for offset plates and semiconductors, in the manufacture of piezoelectrical crystals and flame-resistant substances. It is also used as a phosphorus carrier in the production of yeasts, enzymes and antibiotics, in the manufacture of drugs and cosmetics and as an acidic additive and carrier for anti-oxidising agents in foodstuffs.

### **1.6 Nitric acid**

Nitric acid is at present manufactured by catalytic oxidation of ammonia. The production of nitric acid is closely connected to the manufacture of fertilizers, explosives, plastics and chemical fibres as well as the production of nitrates for a variety of applications (photographic chemicals, catalysts, preservatives, etc). Other applications include etching and pickling processes in the surface treatment of aluminium and stainless steel, sometimes in combination with hydrofluoric acid (see 1.4).

### **1.7 Other acids**

Other acids include, primarily, acid mixtures **[F]** or spent organic, non-cyanide containing acids (e.g. acetic and citric acid) or acid solutions **[G]** which arise as residue acids or during processes in the chemical and pharmaceutical industry.

Included in organic acids, a special role is given to hydrocyanic acid and cyanide solutions. They are used as base substances for a variety of intermediate products

which are used, for example, in the manufacture of manmade fibres (nylon), dyes, pharmaceutical products, herbicides and fungicides, as well as in the extraction of gold and silver and accumulate as residue hydrocyanic acids and cyanide.

## 2 Wastes

### 2.1 Waste sulphuric acid and sulphuric acid solutions [A]

Depending on their application, waste sulphuric acids arise in different concentrations contaminated with organic and/or inorganic substances

#### Classification of waste in accordance with EWL:

06 01 01\* sulphuric acid and sulphurous acid

Classification according to specific fields of activity is applicable in the following cases:

For sulphuric acid solutions from paint or varnish removal:

08 01 17\* wastes from paint or varnish removal containing organic solvents or other dangerous substances

For residue containing sulphuric acid from flue-gas desulphurisation:

10 01 09\* sulphuric acid

For spent pickling solutions from metal surface treatment:

11 01 05\* pickling acids

For sulphuric acid electrolyte from batteries and accumulators:

16 06 06\* separately collected electrolyte from batteries and accumulators

For small quantities of acids and acid mixtures:

20 01 14\* acids

#### Notes on recycling, utilization and disposal:

By using a number of methods of reprocessing (e.g. distillation and vaporization processes, extraction, adsorption and crystallization processes as well as various cracking processes), organic and/or inorganic contaminants can be removed from the acid or an increased concentration achieved. Residue sulphuric acids and a large part of the waste sulphuric acids or sulphuric acid solutions arising from processes are returned to sulphuric acid recycling as illustrated in **fig. 1**.

Reprocessing may be carried out in-house (e.g. concentration using vaporization technology) or externally (e.g. thermal splitting process in rotary kilns) over sulphur dioxide to fresh acid. The rotary kiln process is also suitable for small quantities of waste acid containing varying amounts of contaminants, for example, from pickling processes for metal surface pre-treatment or paint and varnish removal.

Otherwise, disposal takes place in chemical-physical treatment plants (CPT) using precipitation/flocculation and filtration processes (see sub-chapter 19.08, par. 2.5) to neutralise and separate the water phase which can then be fed into the sewerage system.

**Fig. 1:** Sulphuric acid cycle with partial return of residue and waste acids

Sulphuric acid pickling solutions containing metal can be metallurgically reprocessed (see sub-chapter 11.01, par. 2.1).

Incineration of sulphuric acid solutions with a high organic constituent part, for example, paint and varnish removal chemicals, are in this case classified under EWL 08 01 17\* „wastes from paint and varnish removal ....“ (see also sub--chapter 08 01, par. 5.2)

## **2.2 Spent hydrochloric acid and hydrochloric acid solutions [B]**

Depending on their application, spent hydrochloric acids arise in different concentrations contaminated with organic and/or inorganic substances.

### Classification of waste in accordance with EWL:

06 01 02\* Hydrochloric acid

Classification according to specific fields of activity is applicable in the following cases:

For contact acids from production processes in the chlorine industry:

06 07 04\* solutions and acids, for example contact acid

For hydrochloric acid pickling solutions from metal surface treatment:

11 01 05\* pickling acids

For acid solutions from the regeneration of ion exchangers:

19 08 07\* solutions and sludges from regeneration of ion exchangers

For small quantities of acids and acid mixtures:

20 01 14\* acids

### Notes on recycling, utilization and disposal:

The flow diagram showing partial reprocessing (see fig 1), in principle, also applies to the hydrochloric acid process but with the production of waste hydrochloric acid or hydrochloric acid solutions.

Residue acids from production processes in the chlorine industry are, as a rule, processed to produce hydrogen chloride using electrolytic processing which is em-

ployed before and after further separation processes (e.g. filtration and adsorption processes).

Otherwise, disposal is carried out in chemical-physical treatment plants (CPT) using precipitation/flocculation and filtration processes (see sub-chapter 19 08, par. 2.5) to neutralise and separate out the water phase which can then be fed into the sewerage system.

Hydrochloric acid pickling solutions containing metal can be regenerated and/or metallurgically reprocessed (see chapter 11 01, par. 2.1 and chapter 11 05).

### **2.3 Waste hydrofluoric acid and hydrofluoric acid solutions [C]**

Hydrofluoric acid is toxic and depending on its application, arises in different concentrations contaminated with organic and/or inorganic substances. Stainless steel pickling solutions consist, as a rule, of a hydrofluoric acid/nitric acid mixture and are contaminated with chrome and nickel.

#### Classification of waste in accordance with EWL:

06 01 03\* hydrofluoric acid

Classification according to specific fields of activity is applicable in the following cases:

For glass-polishing and -grinding sludge containing hydrofluoric acid:

10 11 13\* glass-polishing and -grinding sludge containing dangerous substances

For pickling solutions containing hydrofluoric acid from metal surface treatment:

11 01 05\* pickling acids

For small quantities of acids and acid mixtures:

20 01 14\* acids

#### Notes on recycling, utilization and disposal:

As a rule, residue acids from the manufacturing process of base materials containing fluoride are returned to the production process. The flow diagram showing partial re-processing (see fig 1), in principle, also applies to the hydrofluoric acid process but with the production of waste hydrofluoric acid or hydrofluoric acid solutions.

Otherwise, disposal is carried out in chemical-physical treatment plants (CPT) using precipitation/flocculation and filtration processes (see chapter 19 08, par. 2.5) to neutralise, detoxify and separate out the water phase which can then be fed into the sewerage system. In the case of stainless steel pickling solution containing hydrofluoric acid, a limemilk treatment is normally unavoidable in order to achieve the precipitation of chrome and nickel at the same time.

Metal pickling solutions containing hydrofluoric acid can be regenerated and/or metallurgically reprocessed (see chapter 11 01, par. 2.1).

### **2.4 Waste phosphoric acid and phosphoric acid solutions [D]**

Waste phosphoric acid and phosphoric acid solutions originating from, for example, phosphating or etching processes, are contaminated with the alloy of the treated metal surface. Phosphoric acid solutions from combined degreasing/phosphating

processes in metal surface pre-treatment also have a high content of organic contaminants (cleaned-off oil and grease).

Classification of waste in accordance with EWL:

06 01 04\* phosphoric and phosphorous acid

Classification according to specific fields of activity is applicable in the following cases:

For phosphoric acid pickling solutions from metal surface treatment:

11 01 05\* pickling acids

For phosphoric acid pre-treatment solutions from a combined degreasing/phosphating:

11 01 13\* degreasing wastes containing dangerous substances

For small quantities of acid and acid solutions:

20 01 14\* acids

Notes on recycling, utilization and disposal:

Phosphoric acid pickling solutions containing metal can be regenerated and/or metallurgically reprocessed (see sub-chapter 11 01, par. 2.1 and 2.2).

Otherwise, disposal is carried out in chemical-physical treatment plants (CPT) using precipitation/flocculation and filtration processes (see sub-chapter 19 08, par. 2.5) to neutralise and separate out the water phase which can then be fed into the sewerage system.

In some cases incineration is carried out following concentration (e.g. by micro/ultra filtration processes) in metal surface pre-treatment processes such as in combined degreasing/phosphating.

## **2.5 Waste nitric acid and nitric acid solutions [E]**

Depending on its application, waste nitric acid arises in different concentrations contaminated with organic and/or inorganic substances. Stainless steel pickling solutions mainly consist of a mixture of hydrofluoric acid and nitric acid and are contaminated with chrome and nickel.

Classification of waste in accordance with EWL:

06 01 05\* nitric acid and nitrous acid

Classification according to specific fields of activity is applicable in the following cases:

For pickling solutions containing nitric acid from metal surface treatment:

11 01 05\* pickling acids

For small quantities of acids and acid mixtures:

20 01 14\* acids

Notes on recycling, utilization and disposal:

Residue acids from the chemical industry are, as a rule, returned to the production process.

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Metal pickling solutions containing nitric acid can be regenerated and/or metallurgically reprocessed (see sub-chapter 11 01, par. 2.1).

Otherwise, disposal is carried out in chemical-physical treatment plants (CPT) using precipitation/flocculation and filtration processes (see chapter 19 08, par. 2.5) to neutralise, detoxify and separate out the water phase which can then be fed into the sewerage system. Stainless steel pickling solution containing nitric acid usually also contains hydrofluoric acid and must be treated with limemilk because of the chrome and nickel contaminants (see par. 2.3).

## **2.6 Other waste acids [F], [G] and [H]**

### **2.6.1 Acid mixtures [F]**

These include acid mixtures which, for example, result from contamination during certain production processes. As a rule, they are contaminated with organic and/or inorganic contaminants. Acid mixtures which are introduced as such at the beginning of a process are not included here, but classified as pickling acids in the corresponding waste category in sub-chapter 11 01 (see 2.3 and 2.5).

#### Classification of waste in accordance with EWL:

06 01 06\* other acids

Classification according to specific fields of activity is applicable in the following cases:

For small quantities:

20 01 14\* acids

#### Notes on recycling, utilization and disposal:

Provided we are not dealing with clearly defined acid mixtures (see above), there are at present no viable treatment processes known.

Disposal is carried out in chemical-physical treatment plants (CPT) using precipitation/flocculation and filtration processes (see chapter 19 08, par. 2.5) to neutralise and separate out the water phase which can then be fed into the sewerage system.

### **2.6.2 Waste organic acids not containing cyanide [G]**

Depending on their application, organic residue acids from chemical and pharmaceutical production arise in different concentrations contaminated with organic and/or inorganic substances or as contaminated acid mixtures.

#### Classification of waste in accordance with EWL:

06 01 06\* other acids

Classification according to specific fields of activity is applicable in the following cases:

For small quantities:

20 01 14\* acids

#### Notes on recycling, utilization and disposal:

Return to the chemical and pharmaceutical production process.

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Incineration; otherwise, disposal is carried out in chemical-physical treatment plants (CPT) using evaporation, precipitation/flocculation and filtration processes (see sub-chapter 19 08, par. 2.5) to neutralise and separate out the water phase which can then be fed into the sewerage system.

### **2.6.3 Waste hydrocyanic acids and cyanide solutions [H]**

During the manufacture and use of hydrocyanic acids and cyanides, residues containing cyanide in solid and liquid form arise. Because this waste is dangerous, it has to be classified in a specific cyanide category.

#### Classification of waste in accordance with EWL:

06 03 11\* solid salts and solutions containing cyanides

#### Notes on recycling, utilization and disposal:

Residue hydrocyanic acids and cyanide from chemical production processes can be used in the manufacture of acrylonitrile as a base material for plastics and manmade fibres. In Germany, this process is not employed.

Cyanide solutions containing metal from electroplating processes can be metallurgically reprocessed (see sub-chapter 11 01, par. 2.2).

Disposal is carried out in chemical-physical treatment plants (CPT) using precipitation/flocculation and filtration processes (see sub-chapter 19 08, par. 2.5) to detoxify, neutralise and separate out the water phase which can then be fed into the sewerage system. Detoxification is carried out using an oxidation process (treatment with hypochlorite, hydrogen peroxide and/or Ozone ).

### 3 Overview of waste classification – material flow

Extract from EWL	Material flow	Treatment
<b>06 01 Wastes from the manufacture, formulation, supply and use (MFSU) of acids</b>		
06 01 01* sulphuric acid and sulphurous acid	A	1) recycling, 2) CPT
06 01 02* hydrochloric acid	B	1) recycling, 2) CPT
06 01 03* hydrofluoric acid	C	1) recycling, 2) CPT
06 01 04* phosphoric and phosphorous acid	D	1) recycling, 2) CPT
06 01 05* nitric acid and nitrous acid	E	1) recycling, 2) CPT
06 01 06* other acids	F, G	1) recycling, 2) CPT
06 01 99 wastes not otherwise specified	Not normally required	

<b>Wastes from the manufacture, formulation, supply and use (MFSU) of acids, to be classified under other waste categories</b>		
06 03 11* solid salts and solutions containing cyanides	H	CPT
06 07 04* solutions and acids, for example contact acid	B	1) recycling, 2) CPT
08 01 17* wastes from paint or varnish removal containing organic solvents or other dangerous substances	A	1) incineration, 2) CPT
10 01 09* sulphuric acid	A	CPT
10 11 13* glass-polishing and -grinding sludge containing dangerous substances	C	1) recycling, 2) CPT, SWL
11 01 05* pickling acids	A, B, C, D, E	1) recycling, 2) CPT
11 01 13* degreasing wastes containing dangerous substances	D	1) incineration, 2) CPT
16 06 06* separately collected electrolyte from batteries and accumulators	A	1) recycling, 2) CPT
19 08 07* solutions and sludges from regeneration of ion exchangers	B	CPT
20 01 14* acids	A, B, C, D, E, F, G	1) CPT, 2) incineration

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## 06 02 Wastes from the manufacture, formulation, supply and use (MFSU) of bases

<b>1</b>	<b>Input materials and processes .....</b>	<b>1</b>
1.1	<i>Foreword .....</i>	1
1.2	<i>Calcium hydroxide.....</i>	1
1.3	<i>Ammonium hydroxide.....</i>	2
1.4	<i>Sodium and potassium hydroxide .....</i>	2
1.5	<i>Other alkaline compounds.....</i>	3
<b>2</b>	<b>Wastes .....</b>	<b>3</b>
2.1	<i>Waste calcium hydroxide [A].....</i>	3
2.2	<i>Waste ammonia alkaline solution [B] .....</i>	4
2.3	<i>Waste sodium and potassium hydroxide [C] .....</i>	4
2.4	<i>Other waste bases [D] .....</i>	5
<b>3</b>	<b>Overview of waste classification – material flow.....</b>	<b>6</b>

### 1 Input materials and processes

#### 1.1 Foreword

According to the general structure of the EWL, waste is classified in accordance with the industrial process from which it arises (classification rules, point 3.1 to 3.4 in the annex to the commission's decision 2001/118/EG). However, this has not been done in chapter 06 02. Here, due to the wide-ranging sources of waste, the classification is based on constituent substances. Nevertheless some waste bases (e.g. extraction, filtration or evaporation residue), arising from specific industrial processes, are listed in the respective branch chapters. Reference will be made to appropriate categories in the following.

#### 1.2 Calcium hydroxide

Calcium hydroxide is formed from quicklime (calcium oxide) and water. The strong exothermic reaction is described as slaking and the resulting calcium hydroxide as slaked lime. The addition of water produces a white suspension called limemilk. Filtration or sedimentation of this limemilk produces a clear, very weak calcium hydroxide solution (see **fig. 1**).

Calcium hydroxide is mainly used as building material in the manufacture of mortar, and in the form of limemilk as standard precipitation and neutralisation agent in chemical-physical wastewater treatment as well as in the desulphurisation of flue-gas. Aqueous solutions and suspensions are used everywhere in the chemical indus-

try where inexpensive alkalines are required. Calcium hydroxide is also used, for example, as paint pigment, frost-protective coating for fruit trees, in the sugar industry as well as in tanneries.

In these different processes, calcium hydroxide normally arises as paste or liquid waste **[A]** which, depending on the type and degree of contamination, can be reprocessed (e.g. the recovery of metal from CPT sludges in electroplating processes).

## **Fig. 1: Manufacture and use of calcium hydroxide**

### **1.3 Ammonium hydroxide**

Ammonium hydroxide exists in an aqueous solution of ammonia (ammonia solution). Ammonia is manufactured from nitrogen and hydrogen under high pressure and temperature using catalysts.

In the chemical industry, ammonia is the starting product for many chemical synthesis (e.g. manufacture of urea, sulphonamides, fertilizers, chemical fibres, hydrocyanic acid and other cyanide compounds, nitric acid and nitrate, etc). In addition, ammonia is also used in the denitrification and desulphurisation of flue-gas.

As a rule, the whole ammonia solution or a substantial amount ends up in the end product, so that the diagram in 1.2 (see **Fig. 1**), in principle, also applies to the ammonium hydroxide process but with the production of waste ammonia solution **[B]**.

### **1.4 Sodium and potassium hydroxide**

Sodium alkali is mainly manufactured by electrolysis of molten sodium chloride solution producing sodium, chlorine and hydrogen. Solid sodium hydroxide is obtained by evaporation of sodium alkali. The manufacture of potassium alkali is carried out in exactly the same way replacing molten potassium chloride solution.

Potassium alkali is generally used as an agent to neutralise, degrease, strip paint or as a pickling solution as well as in the regeneration of ion exchange resins. In the chemical industry it is used in saponification reactions and in the manufacture of potassium compounds which are further used, for example, in the manufacture of soaps and washing powders, as bleaches in the production of cellulose and to breakdown bauxite in the production of aluminium.

Potassium hydroxide is used as a drying agent in the manufacture of dyes, washing powders and soaps as well as potassium carbonate and potassium compounds and for desulphurisation of oil and as an electrolyte in accumulators.

As a rule, the whole sodium or potassium hydroxide solution or a substantial amount ends up in the end product, so that the diagram in 1.2 (see **Fig. 1**), in principle, also applies to this process but with the production of waste sodium or potassium hydroxide [**C**].

### **1.5 Other alkaline compounds**

A collection position has been created for other metal hydroxide (e.g. barium, ammonium and magnesium hydroxide) and the wide range of organic bases (e.g. amines and alkaloids) as well as for alkaline mixtures. These alkaline compounds arise primarily as residue during manufacture or processing in the chemical and pharmaceutical industry and, because of drag-in and/or in accordance with use, are often contaminated with other components (e.g. other alkalis, complexing agents, organic compounds) [**D**].

## **2 Wastes**

### **2.1 Waste calcium hydroxide [A]**

Depending on where it is used, calcium hydroxide mainly arises as a paste or liquid in varying concentrations, contaminated with organic and/or inorganic substances.

Classification of waste in accordance with EWL:

06 02 01\* calcium hydroxide

Classification according to specific fields of activity is applicable in the following cases:

For residue limemilk from flue-gas cleaning:

10 01 07 calcium-based reaction wastes from flue-gas desulphurisation in sludge form

If dangerous substances are present, e.g. in waste incineration:

10 01 18\* wastes from gas cleaning containing dangerous substances

For residues from limemilk precipitation solutions containing metal which originate from electroplating or other metal surface treatment processes:

11 01 09\* sludges and filter cakes containing dangerous substances

For small quantities of alkalines and alkaline mixtures:

20 01 15\* alkalines

Notes on recycling, utilization and disposal:

As a rule, disposal is carried out in chemical-physical treatment plants (CPT) using precipitation/flocculation and filtration processes (see chapter 19 08, par. 2.5) to neutralise and separate out the water phase which can then be fed into the sewerage system. In some cases, the sludge is concentrated using drying or evaporation technology and the residue then deposited in a underground landfill (UGL). Sludges containing metal from limemilk precipitation can, in some cases, be metallurgically re-processed (see sub-chapter 11 06, par. 2.1).

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## **2.2 Waste ammonia alkaline solution [B]**

Depending on where it is used, waste ammonia alkaline solution arises in varying concentrations, contaminated with organic and/or inorganic substances.

### Classification of waste in accordance with EWL:

06 02 03\* ammonium hydroxide

Classification according to specific fields of activity is applicable in the following cases:

For residue from flue-gas cleaning :

10 01 18\* wastes from gas cleaning containing dangerous substances

For small quantities of alkalis and alkaline mixtures:

20 01 15\* Alkalines

### Notes on recycling, utilization and disposal:

Residue from production processes in the chemical industry are, as a rule, returned to the production process.

Otherwise, disposal is carried out in chemical-physical treatment plants (CPT) using precipitation/flocculation and filtration processes (see sub-chapter 19 08, par. 2.5) to neutralise and separate out the water phase which can then be fed into the sewerage system. In some cases, the sludge is concentrated using drying or evaporation technology and the residue then deposited underground (UGL).

## **2.3 Waste sodium and potassium hydroxide [C]**

Depending on where they are used, sodium and potassium hydroxide mainly arise as a paste or liquid in varying concentrations, contaminated with organic and/or inorganic substances. So, for example, during the production of aluminium using sodium alkali (bauxite breakdown), so-called red mud arises.

### Classification of waste in accordance with EWL:

06 02 04\* sodium and potassium hydroxide

Classification according to specific fields of activity is applicable in the following cases:

For red mud containing sodium alkali from the production of aluminium:

01 03 07\* other wastes containing dangerous substances from physical and chemical processing of metalliferous minerals

For alkaline solutions from paint and varnish removal processes:

08 01 17\* wastes from paint or varnish removal containing organic solvents or other dangerous substances

For waste alkaline pickling solution from metal surface treatment (e.g. aluminium):

11 01 07\* pickling bases

For residue from precipitation and neutralisation of solutions containing metals from electroplating or other metal surface treatment processes:

11 01 09\* sludges and filter cakes containing dangerous substances

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For alkaline solutions from degreasing processes:

11 01 13\* sludges and filter cakes containing dangerous substances.

For alkaline electrolyte from batteries and accumulators:

16 06 06\* separately collected electrolyte from batteries and accumulators

For alkaline solutions from regeneration of ion exchangers::

19 08 07\* solutions and sludges from regeneration of ion exchangers

For small quantities of alkalis and alkaline mixtures:

20 01 15\* alkalines

Notes on recycling, utilization and disposal:

Residue from production processes in the chemical industry, especially sodium hydroxide residue from chlorine chemistry, is, as a rule, returned to the production process.

Alkaline pickling solutions can, in some cases, be metallurgically reprocessed. (see sub-chapter 11 01, par. 2.1).

Alkaline solutions with a high organic content from degreasing or paint/varnish removal processes are incinerated, in some cases following concentration using vaporization (see sub-chapter 11 01, par.2.1 and chapter 08 01, par.5.2).

Otherwise, disposal is carried out in chemical-physical treatment plants (CPT) using precipitation/flocculation and filtration processes (see sub-chapter 19 08, par. 2.5) to neutralise and separate out the water phase which can then be fed into the sewerage system.

## **2.4 Other waste bases [D]**

On the one hand, this section deals with alkaline mixtures which, for example, result from contamination during certain production processes and which are contaminated with organic and/or inorganic substances. On the other hand, this section includes contaminated organic bases from chemical and pharmaceutical production, if no other reprocessing is available.

Classification of waste in accordance with EWL:

06 02 05\* other bases

For small quantities:

20 01 15\* alkalines

Notes on recycling, utilization and disposal:

Residue from production processes in the chemical industry are, as a rule, returned to the production process.

As a rule, disposal is carried out in chemical-physical treatment plants (CPT) using precipitation/flocculation and filtration processes (see sub-chapter 19 08, par. 2.5) to neutralise and separate out the water phase which can then be fed into the sewerage system.

### 3 Overview of waste classification – material flow

Extract from EWL		Material flow	Treatment
<b>06 02</b>	<b>wastes from the manufacture, formulation, supply and use (MFSU) of bases</b>		
06 02 01*	calcium hydroxide	A	1) recycling, 2) CPT
06 02 03*	ammonium hydroxide	B	1) recycling, 2) CPT
06 02 04*	sodium and potassium hydroxide	C	1) recycling, 2) CPT
06 02 05*	other bases	D	1) recycling, 2) CPT
06 02 99	wastes not otherwise specified .	Not normally required	

	<b>wastes from the manufacture, formulation, supply and use (MFSU) of bases to be classified under other waste categories</b>		
01 03 07*	other wastes containing dangerous substances from physical and chemical processing of metalliferous minerals	C	CPT
08 01 17*	wastes from paint or varnish removal containing organic solvents or other dangerous substances	C	1) incineration, 2) CPT
10 01 07	calcium-based reaction wastes from flue-gas desulphurisation in sludge form	A	CPT
10 01 18*	wastes from gas cleaning containing dangerous substances	A, B	CPT, UGL
11 01 07*	pickling bases	C	1) recycling, 2) CPT
11 01 09*	sludges and filter cakes containing dangerous substances	A, C	1) recycling, 2) CPT
11 01 13*	degreasing wastes containing dangerous substances	C	1) incineration, 2) CPT
16 06 06*	separately collected electrolyte from batteries and accumulators	C	1) recycling, 2) CPT
19 08 07*	solutions and sludges from regeneration of ion exchangers	C	1) recycling, 2) CPT
20 01 15*	alkalines	A, B, C, D	1) CPT, 2) incineration

## 08 01 Wastes from MFSU and removal of paint and varnish

<b>1</b>	<b>Storage and on-site transport .....</b>	<b>1</b>
1.1	<i>Raw material storage.....</i>	<i>1</i>
1.2	<i>Other storage areas (finished goods, returned goods, laboratory and waste storage).....</i>	<i>2</i>
<b>2</b>	<b>Cleaning processes .....</b>	<b>3</b>
2.1	<i>Process.....</i>	<i>3</i>
2.2	<i>Waste.....</i>	<i>4</i>
<b>3</b>	<b>Manufacture of paints and varnish .....</b>	<b>5</b>
3.1	<i>Process.....</i>	<i>5</i>
3.2	<i>Waste.....</i>	<i>5</i>
<b>4</b>	<b>Lacquering .....</b>	<b>6</b>
4.1	<i>Process.....</i>	<i>6</i>
4.2	<i>Waste.....</i>	<i>8</i>
<b>5</b>	<b>Lacquer removal.....</b>	<b>10</b>
5.1	<i>Mechanical lacquer removal.....</i>	<i>10</i>
5.2	<i>Chemical lacquer removal .....</i>	<i>11</i>
5.3	<i>Thermal lacquer removal .....</i>	<i>12</i>
<b>6</b>	<b>Overview of waste classification – material flow .....</b>	<b>14</b>

### 1 Storage and on-site transport

#### 1.1 Raw material storage

##### 1.1.1 Process

Materials required for manufacture or lacquer removals are held in a raw material store until required. Materials are stored in the packaging in which they were delivered with the exception of large delivery quantities stored in tanks and silos. Transport from store to the place of use (lacquer manufacture, application, removal) is carried out in the original packaging, in other containers or sometimes through pipes.

##### 1.1.2 Waste

The storage of raw materials or goods for production and on-site transportation leads to discarded packaging material that is often contaminated. This packaging material includes, on the one hand, containers made of metal, plastic, composite material, paper and glass (laboratory) and on the other hand, additional packaging material in

the form of plastics (e.g. cling film, sacks, wrapping material) or paper, cardboard, cartons as well as palettes and crates made of wood.

### ***Discarded packaging [A] [B]***

#### Classification of waste in accordance with EWL:

Dry, scraped-out containers (waste paint dried or cured) as well as packaging material not contaminated with dangerous substances **[A]**:

- 15 01 01 paper and cardboard packaging
- 15 01 02 plastic packaging
- 15 01 03 wooden packaging
- 15 01 04 metallic packaging
- 15 01 05 composite packaging
- 15 01 06 mixed packaging
- 15 01 07 glass packaging

Contaminated containers and other packaging material (e.g. non-cured paint residue or chemical residue) **[B]**:

- 15 01 10\* packaging containing residues or contaminated by dangerous substances

#### Notes on recycling, utilization and disposal:

15 01 01 to 15 01 07: Recycling or utilization under the EU-Directive on Packaging and Packaging Waste, or disposal together with municipal waste.

15 01 10\*: Cleaning, to achieve a quality for 15 01 01 to 15 01 07; incineration or other disposal as hazardous waste.

## **1.2 Other storage areas (finished goods, returned goods, laboratory and waste storage)**

### **1.2.1 Processes**

During the manufacture of lacquer, waste paint arises, resulting, first of all, from raw components where the limited shelf life has expired and from pre-prepared, semi-finished products as a result of failures in production and resulting customer returns. In the laboratories, waste paint and varnish in the form of reserved samples of dispatched goods and contaminated laboratory equipment arises.

In paint shops (lacquer use) there is waste paint resulting especially from spillages during paint changes or as a result of expiry of the stated shelf life of materials.

Paint-stained packaging arises from the use of difficult to empty packages as well as residue in the delivery packages.

### **1.2.2 Waste**

#### ***Packaging with non-cured paint and varnish residue [B]***

Descriptions see 1.1.2

Classification of waste in accordance with EWL:

15 01 10\* packaging containing residues or contaminated by dangerous substances

Notes on recycling, utilization and disposal:

Cleaning, to achieve a quality for 15 01 01 to 15 01 07; incineration or other disposal as hazardous waste.

***Waste paint and varnish [C]***

The composition of waste paint and varnish varies considerably depending on the type of paint or varnish being used (basic organic solvent-based varnish or water-based coating), their level of curing and degree of purity. Solvent-based varnish may contain up to 90% organic solvent in its original composition (e.g. low solids). Water-based varnish has a greatly reduced solvent content (between 1% and 10%). Non-cured paint and varnish contain hazardous components especially these solvent or thinner residues.

Classification of waste in accordance with EWL:

Waste, non-cured, solvent-based lacquer:

08 01 11\* waste paint and varnish containing organic solvents or other dangerous substances

Waste, cured, dried, solvent-based lacquer:

08 01 12 waste paint and varnish other than those mentioned in 08 01 11

Waste, water-based lacquer containing (organic) solvent of  $\geq 3\%$ :

08 01 19\* aqueous suspensions containing paint or varnish containing organic solvents or other dangerous substances

Waste, water-based lacquer containing (organic) solvent of  $< 3\%$ :

08 01 20 aqueous suspensions containing paint or varnish other than those mentioned in 08 01 19

Notes on recycling, utilization and disposal:

Bigger quantities of homogeneous waste paint and varnish can possibly be regrind as recycling varnish, pigment and binder concentrates.

Incineration as hazardous waste. Without dangerous substances disposing together with municipal waste.

## **2 Cleaning processes**

### **2.1 Process**

Because of the need to change colour and in order to maintain quality in both paint and varnish manufacture and paint application in paint shops, a range of paint machines (e.g. pumps), equipment (e.g. spray guns), containers (e.g. delivery containers, contaminated transport containers, weighing equipment) and pipe work has to be cleaned. Depending on the manufactured or applied lacquer, cleaning is carried out using

organic solvents (in the manufacture and use of solvent-based coatings) or water (in the manufacture and use of water-based lacquer). During manual cleaning, cloths and cellulose wipes are used together with organic solvents and thinners (e.g. white spirit, petroleum).

Some paint-contaminated containers and equipment such as spray guns are cleaned in special washing machines or spray gun cleaning equipment, usually with organic solvents and in some cases alkaline solvents.

If there are large quantities of used cleaning solvents, they may be regenerated on-site using distillation.

## 2.2 Waste

The most significant waste arising from on-site cleaning processes are used solvents, washing and rinsing water, cleaning cloths and distillation residue. In addition to the cleaning solvent used, the waste most significantly contains washed off paint and varnish.

### ***Paint contaminated washing and rinsing water [D]***

Paint contaminated washing and rinsing water from cleaning processes with water or watery solvents:

#### Classification of waste in accordance with EWL:

- 08 01 15\* aqueous sludges containing paint or varnish containing organic solvents or other dangerous substances
- 08 01 16 aqueous sludges containing paint or varnish other than those mentioned in 08 01 15

#### Notes on recycling, utilization and disposal:

Disposal is carried out in chemical-physical treatment plants (CPT) using precipitation/flocculation and filtration processes (see chapter 19 08, par. 2.5) to chromate-detoxification, if necessary, to neutralise and separate out the water phase which can then be fed into the sewerage system.

Incineration of the resulting paint or varnish sludges.

### ***Contaminated organic cleaning solvents [E], [F]***

#### Classification of waste in accordance with EWL:

Used organic solvents from the cleaning of machines, equipment, containers, pipe work, etc. [E]:

- 08 01 11\* waste paint and varnish containing organic solvents or other dangerous substances

#### Distillation residue from on-site distillation [F]:

- 07 03 08\* other still bottoms and reaction residues
- 08 01 13\* sludges from paint or varnish containing organic solvents or other dangerous substances

#### Notes on recycling, utilization and disposal:

In-house or externally distillation of solvents and reuse.

Otherwise incineration as hazardous waste.

### ***Contaminated cleaning cloths [G]***

Cleaning cloths are saturated with considerable quantities of cleaning solvents and the paint and varnish, which has been cleaned-off.

#### Classification of waste in accordance with EWL:

15 02 02\*    absorbents, filter material (including oil filters not otherwise specified),  
wiping cloths, protective clothing contaminated by dangerous  
substances

#### Notes on recycling, utilization and disposal:

Contaminated cleaning cloths can be washed by cleaning companies, if necessary.

Otherwise incineration as hazardous waste.

## **3     Manufacture of paints and varnish**

### **3.1    Process**

The manufacture of paints and varnish (see **fig 1**) includes the following process stages:

- varnish production (dissolving binder in solvent)
- weighing (weighing of pigment and varnish according to the recipe)
- Pre-dispersal (Mixing of pigment with the varnish using a solvent)
- Dispersal (Fine mixing using e.g. ball mills)
- Completion (Addition of varnishes, solvents and additives for final mix)
- Toning (Addition of tinting paste, tinting lacquer for the manufacture of coloured lacquers)
- Filtering

**Fig. 1:** Schematic representation of the manufacturing process of paints and varnish

### **3.2    Waste**

#### ***Dust [H]***

When solid raw materials (pigments) are weighed, there is a creation of dusts, which are sucked up and then removed from flue-gas using a dust separator (bag filter, cyclone). Problematic components, which could be found in the filter dusts, are organic compounds and heavy metals (e.g. iron, copper, chrome, lead), which make them similar in composition to the materials used in the manufacture.

#### Classification of waste in accordance with EWL:

08 01 11\* waste paint and varnish containing organic solvents or other dangerous substances

08 01 12 waste paint and varnish other than those mentioned in 08 01 11

Notes on recycling, utilization and disposal:

Incineration, in case of mainly organic contents.

Disposing, in underground-landfills (UGL), if necessary in case of mainly inorganic contents. Without dangerous substances, disposing together with municipal waste.

***Contaminated weighing receptacles [B]***

As a rule, disposed of weighing receptacles are contaminated with hazardous paint residue.

Classification of waste in accordance with EWL:

15 01 10\* packaging containing residues or contaminated by dangerous substances

Notes on recycling, utilization and disposal:

Cleaning, to achieve a quality for 15 01 01 to 15 01 07; incineration or other disposal as hazardous waste.

***Filter residue [J]***

The filters used for filtration (bag, tissue and textile filters) are generally laden with cured paint and other contaminants after use.

Classification of waste in accordance with EWL:

15 02 02\* absorbents, filter material (including oil filters not otherwise specified), wiping cloths, protective clothing contaminated by dangerous substances

15 02 03 absorbents, filter material, wiping cloths and protective clothing other than those mentioned in 15 02 02

Notes on recycling, utilization and disposal:

Incineration as hazardous waste. Without dangerous substances, disposing together with municipal waste.

## **4 Lacquering**

### ***4.1 Process***

Lacquering is a process of surface treatment of metal, wood and plastic parts. The requirements of lacquering are principally mechanical and chemical durability, protection against corrosion or weathering, resistance at high temperatures as well as providing an optical quality to the surface. Depending on the area of application, there is a preference for solvent-based or water-based liquid lacquers or powder lacquers. The application of lacquer can be carried out using brush, roller, spray or dipping processes.

The separation of overspray during spraying is normally carried out in a waterfall (**fig. 2**) or a dry separator (**fig. 3**).

**Fig. 2:** Schematic representation of a spray booth using waterfall separator

**Fig. 3:** Schematic representation of a spray booth using dry separation

## 4.2 Waste

### ***Waste paint and varnish [K]***

As a rule waste paint and varnish arise when lacquer is changed or it drips, as oversprayed lacquer or waste wipes from brush, roller or dipping processes or due to expiry of the shelf-life of the lacquer. The waste should be classified as hazardous in terms of the lacquer content (e.g. in line with the solvent, chromate or heavy metal from the lacquer pigmentation).

#### Classification of waste in accordance with EWL:

- 08 01 11\* waste paint and varnish containing organic solvents or other dangerous substances
- 08 01 12 waste paint and varnish other than those mentioned in 08 01 11
- 15 01 10\* packaging containing residues or contaminated by dangerous substances

#### Notes on recycling, utilization and disposal:

08 01 11\* and 08 01 12: Bigger quantities of homogeneous waste paint and varnish can be regrind as recycling varnish, pigment and binder concentrates.

08 01 11\*: Incineration as hazardous waste.

08 01 12: Incineration as non hazardous waste.

15 01 10\*: Cleaning, to achieve a quality for 15 01 01 to 15 01 07; incineration or other disposal as hazardous waste.

### ***Paint and varnish sludges [L]***

Paint and varnish sludges arise as settlement (coagulant) from spray booth water and during separation of overspray using waterfalls in the spraying process, and as residue in the wastewater treatment plant. The waste should be classified as hazardous in terms of the lacquer content (e.g. in line with the solvent, chromate or heavy metal from the lacquer pigmentation).

#### Classification of waste in accordance with EWL:

Paint and varnish sludges from coagulation or sedimentation containing (organic) solvent  $\geq 3\%$ :

- 08 01 13\* sludges from paint or varnish containing organic solvents or other dangerous substances
- 08 01 15\* aqueous sludges containing paint or varnish containing organic solvents or other dangerous substances

Paint and varnish sludges from coagulation or sedimentation containing (organic) solvent < 3%:

08 01 14 aqueous sludges containing paint or varnish containing organic solvents or other dangerous substances

08 01 16 aqueous sludges containing paint or varnish other than those mentioned in 08 01 15

During complete exchange of spray booth water removed from the system:

08 01 19\* aqueous suspensions containing paint or varnish containing organic solvents or other dangerous substances

08 01 20 aqueous suspensions containing paint or varnish other than those mentioned in 08 01 19

Notes on recycling, utilization and disposal:

Disposal is carried out in chemical-physical treatment plants (CPT) using precipitation/flocculation and filtration processes (see chapter 19 08, par. 2.5) to chromate-detoxification, if necessary, to neutralise and separate out the water phase which can then be fed into the sewerage system.

***Filter material laden with lacquer particles [M]***

Waste filter materials laden with lacquer arise if the spray booth is equipped with a dry separator. The waste should be classified as hazardous in terms of the lacquer content (e.g. in line with the solvent, chromate or heavy metal from the lacquer pigmentation).

Classification of waste in accordance with EWL:

15 02 02\* absorbents, filter material (including oil filters not otherwise specified), wiping cloths, protective clothing contaminated by dangerous substances

15 02 03 absorbents, filter material, wiping cloths and protective clothing other than those mentioned in 15 02 02

Notes on recycling, utilization and disposal:

Incineration as hazardous waste. Without dangerous substances, disposal together with municipal waste.

***Contaminated containers [B]***

Descriptions see 1.1.2

Classification of waste in accordance with EWL:

15 01 10\* packaging containing residues or contaminated by dangerous substances

Notes on recycling, utilization and disposal:

Cleaning, to achieve a quality for 15 01 01 to 15 01 07; incineration or other disposal as hazardous waste.

## ***Contaminated masking paper and adhesive tape [N]***

During the occasionally necessary masking of the work piece being lacquered (e.g. during car repairs), contaminated masking paper and adhesive tape arise. The waste should be classified as hazardous in terms of the lacquer content (e.g. in line with the solvent, chromate or heavy metal from the lacquer pigmentation).

### Classification of waste in accordance with EWL:

- 15 02 02\*    absorbents, filter material (including oil filters not otherwise specified), wiping cloths, protective clothing contaminated by dangerous substances (*exception*)
- 15 02 03    absorbents, filter material, wiping cloths and protective clothing other than those mentioned in 15 02 02 (*rule*)

### Notes on recycling, utilization and disposal:

Incineration as hazardous waste. Without dangerous substances, disposal together with municipal waste.

## ***Contaminated activated carbon or adsorption resins [O]***

During adsorption cleaning of waste air or water containing solvents, spent activated carbon and adsorption resins arise. Because of the adhering solvents, these have to be classified as hazardous.

### Classification of waste in accordance with EWL:

- 14 06 05\*    sludges or solid wastes containing other solvents
- 19 01 10\*    spent activated carbon from flue-gas treatment

### Notes on recycling, utilization and disposal:

Incineration or disposal as hazardous waste.

## **5    Lacquer removal**

### ***5.1    Mechanical lacquer removal***

#### **5.1.1    Process**

Parts of the lacquering equipment, e.g. spray booth racks as well as conveyor systems for the transportation of work pieces, are unavoidably lacquered too. This lacquer must be removed regularly. Also in the case of defect lacquering, the lacquer on the work piece is stripped and the piece re-lacquered.

Physical, lacquer removal processes operate with force from blasting materials (quartz sand, blasting granules) or erosion using water jets (high pressure water jets).

#### **5.1.2    Waste from mechanical lacquer removal [P]**

Waste created during the mechanical removal of lacquer is mainly blasting material contaminated with lacquer particles and filtered waste paint coatings in water. The waste should be classified as hazardous in terms of the stripped lacquer content (e.g. in line with the chromate and heavy metal from the lacquer pigmentation as well as anticorrosion coatings containing zinc, lead and chrome).

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Classification of waste in accordance with EWL:

- 08 01 17\* wastes from paint or varnish removal containing organic solvents or other dangerous substances
- 08 01 18 wastes from paint or varnish removal other than those mentioned in 08 01 17

For blasting materials contaminated with lacquer residue:

- 12 01 16\* waste blasting material containing dangerous substances
- 12 01 17 waste blasting material other than those mentioned in 12 01 16

Notes on recycling, utilization and disposal:

Incineration in case of blasting residues from mainly organic material.

Disposing to landfill in case of blasting residues from mainly inorganic material; without dangerous substances together with municipal waste.

In case of waste from water jet plants, chemical-physical treatment (CPT) using filtrations processes to separate out the water phase.

## **5.2 Chemical lacquer removal**

### **5.2.1 Process**

The stages of chemical lacquer removal are stripping using solvent-based or free chemicals and rinsing with water. As a rule this involves hot stripping in acidic (sulphuric acid), alkaline (sodium leach) or neutral (organic thickening agents) atmosphere or cold stripping using, for example, n-methylpyrrolidone, ethanolamine or dichloromethane, depending on the chemical composition of the lacquer, the work piece and the shape of the piece to be stripped. The removal of coats of lacquer removed from the pieces is carried out by exchanging the stripping baths for fresh ones and returning them to the chemical producers for recycling or by using on-site filtration processes.

### **5.2.2 Waste from chemical lacquer removal [Q]**

Waste from chemical stripping is mainly waste coats of lacquer, acids or leaches containing lacquer sludges, or lacquer sludge containing chlorine from cold stripping using dichloromethane. The waste should be classified as hazardous in terms of the stripper used and/or the lacquer removed (e.g. in line with the chromate and heavy metal from the lacquer pigmentation).

Classification of waste in accordance with EWL:

- 06 01 01\* sulphuric acid and sulphurous acid
- 06 02 04\* sodium and potassium hydroxide
- 08 01 17\* wastes from paint or varnish removal containing organic solvents or other dangerous substances
- 08 01 18 wastes from paint or varnish removal other than those mentioned in 08 01 17
- 08 01 21\* waste paint or varnish remover

Notes on recycling, utilization and disposal:

Wastes containing sulphuric acid are reprocessed to fresh acid via recycling plants by rotary kiln processes.

Incineration in case of mainly organic contents; in case of aqueous lacquer removal after chemical-physical treatment (CPT) using precipitation / flocculation and filtration processes (see chapter 19 08, par. 2.5) to neutralise and separate out the water phase which can then be fed into the sewerage system. Without dangerous substances, disposing together with municipal waste.

### **5.3 Thermal lacquer removal**

#### **5.3.1 Process**

During the thermal stripping of metal pieces, the organic components of the lacquer are carbonised to flammable gases with the exclusion of oxygen (pyrolysis, fluidised bed), while inorganic pigments and ballast material remain as ash. Another stripping process uses molten salts.

Thermal stripping also includes special applications for delicate components using liquid nitrogen or carbon dioxide (lacquer made brittle) as well as laser beams.

#### **5.3.2 Waste from thermal lacquer removal [R]**

From thermal lacquer removal, ash, pyrolysis coke, blasting material from fluidised bed, as well as spent molten salts and carried out salt slag are created depending on the process used (pyrolysis, fluidised bed, molten salts). In addition, there is also waste from flue-gas treatment.

From stripping using liquid nitrogen or carbon dioxide, lacquer residue in its original solid composition arises. From treatment using laser, the resulting solid waste consists mainly of organic pigment from the lacquer, as well as waste from flue-gas treatment.

The waste should be classified as hazardous in terms of the stripping process used and/or the lacquer removed (e.g. in line with the chromate and heavy metals from the lacquer pigmentation).

#### Classification of waste in accordance with EWL:

- 06 03 13\* solid salts and solutions containing heavy metals
- 06 03 14 solid salts and solutions other than those mentioned in 06 03 11 and 06 03 13
- 08 01 17\* wastes from paint or varnish removal containing organic solvents or other dangerous substances
- 08 01 18 wastes from paint or varnish removal other than those mentioned in 08 01 17
- 19 01 07\* solid wastes from gas treatment
- 19 01 10\* spent activated carbon from flue-gas treatment
- 19 01 17\* pyrolysis wastes containing dangerous substances
- 19 01 18 pyrolysis wastes other than those mentioned in 19 01 17

#### Notes on recycling, utilization and disposal:

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Incineration of the varnish residues from the treatment with liquid nitrogen or carbon dioxide and the activated carbon from flue-gas treatment.

As a rule the residual wastes from the above mentioned thermal lacquer removal processes are disposed in hazardous waste landfills (HWL) and underground-landfills (UGL). Without dangerous substances, disposing together with municipal waste.

## 6 Overview of waste classification – material flow

Extract from EWL	Material flow	Treatment
<b>0801 Wastes from MFSU and removal of paint and varnish</b>		
08 01 11* waste paint and varnish containing organic solvents or other dangerous substances	C, E, K	1) Recycling, distillation, incineration, 2) HWI
	H	2) HWL, UGL
08 01 12 waste paint and varnish other than those mentioned in 08 01 11	C, H, K	1) Recycling, 2) incineration, 3) with municipal wastes
08 01 13* sludges from paint or varnish containing organic solvents or other dangerous substances	F, L	1) Incineration, 2) HWI
08 01 14 sludges from paint or varnish other than those mentioned in 08 01 13	L	1) Incineration, 2) with municipal wastes
08 01 15* aqueous sludges containing paint or varnish containing organic solvents or other dangerous substances	D, L	CPT
08 01 16 aqueous sludges containing paint or varnish other than those mentioned in 08 01 15	D, L	CPT
08 01 17* wastes from paint or varnish removal containing organic solvents or other dangerous substances	P, Q, R	1) Recycling, incineration, 2) CPT, HWI
08 01 18 wastes from paint or varnish removal other than those mentioned in 08 01 17	P, Q, R	1) Incineration, 2) CPT, 3) with municipal wastes
08 01 19* aqueous suspensions containing paint or varnish containing organic solvents or other dangerous substances	C, L	1) Recycling, 2) HWI
08 01 20 aqueous suspensions containing paint or varnish other than those mentioned in 08 01 19	C, L	Recycling
08 01 21* waste paint or varnish remover	Q	1) Incineration, 2) HWI
08 01 99 wastes not otherwise specified	Not normally required	

<b>Wastes from MFSU and removal of paint and varnish, to be classified under other waste categories</b>		
06 01 01* sulphuric acid and sulphurous acid	Q	1) Recycling,

			2) CPT
06 02 04*	sodium and potassium hydroxide	Q	CPT
06 03 13*	solid salts and solutions containing heavy metals	R	UGL
07 03 08*	other still bottoms and reaction residues	F	1) Incineration, 2) HWI
12 01 16*	waste blasting material containing dangerous substances	P	1) Incineration, 2) HWL, HWI
12 01 17	waste blasting material other than those mentioned in 12 01 16	P	1) Incineration, 2) with municipal wastes
14 06 05*	sludges or solid wastes containing other solvents	O	1) Incineration, 2) HWI, HWL
15 01 01	paper and cardboard packaging	A	1) Recycling, 2) incineration, 3) with municipal wastes
15 01 02	plastic packaging	A	1) Recycling, 2) incineration, 3) with municipal wastes
15 01 03	wooden packaging	A	1) Recycling, 2) incineration, 3) with municipal wastes
15 01 04	metallic packaging	A	1) Recycling, 2) with municipal wastes
15 01 05	composite packaging	A	1) Incineration, 2) with municipal wastes
15 01 06	mixed packaging	A	1) Incineration, 2) with municipal wastes
15 01 07	glass packaging	A	1) Recycling, 2) with municipal wastes
15 01 10*	packaging containing residues of or contaminated by dangerous substances	B	1) Cleaning, 2) HWI, HWL
15 02 02*	absorbents, filter materials (including oil filters not otherwise specified), wiping cloths, protective clothing contaminated by dangerous substances	J, M, N	1) Incineration, 2) HWI
		G	2) Washing
15 02 03	absorbents, filter materials, wiping cloths and protective clothing other than those mentioned in 15 02 02	J, M, N	1) Incineration, 2) with municipal wastes
19 01 07*	solid wastes from gas treatment	R	HWL, UGL

19 01 10*	spent activated carbon from flue-gas treatment	O, R	1) Incineration, 2) HWI
19 01 17*	pyrolysis wastes containing dangerous substances	R	HWL
19 01 18	pyrolysis wastes other than those mentioned in 19 01 17	R	With municipal wastes

## 08 02 Wastes from MFSU of other coatings (including ceramic materials)

<b>1</b>	<b>Foreword</b> .....	<b>1</b>
<b>2</b>	<b>Process</b> .....	<b>1</b>
<b>3</b>	<b>Wastes</b> .....	<b>3</b>
<b>4</b>	<b>Overview of waste classification - material flow</b> .....	<b>6</b>

### 1 Foreword

Coatings serve, firstly, to protect materials and improve optical appearance. Coating involves applying inorganic (e.g. enamel) or organic (e.g. paint and lacquer) materials to wood, plastic, metal or mineral (e.g. ceramic) surfaces using spray, dipping, spinning processes, etc. or using electrostatic (e.g. powder coatings), electrolytic (e.g. galvanising processes or electrolytic oxidation processes) or metallurgical (e.g. galvanising) precipitation. Other processes include, for example, the vacuum evaporation of metals on ceramic components as well as flame and plasma spraying.

This paper concentrates on the process of enamelling. For other coating processes producing waste of significance, please refer to the appropriate EWL-sub-chapters:

For painting and powder coating:

08 01 wastes from MFSU and removal of paint and varnish

For galvanic coating, phosphating, etc:

11 01 wastes from chemical surface treatment and coating of metals and other materials (for example galvanic processes, zinc coating processes, pickling processes, etching, phosphating, alkaline degreasing, anodising)

For metallurgical coatings with zinc (galvanising):

11 05 wastes from hot galvanising processes

For ceramic coating (glazing):

10 12 wastes from manufacture of ceramic goods, bricks, tiles and construction products

Because of the similarity in materials, some wastes which are produced during the enamelling process (e.g. pigment materials containing heavy metal) are not classified in sub-chapter 08 02 but rather under sub-chapter 10 12.

### 2 Process

The principal raw materials used in enamel production (see **fig. 1**) are quartz, feldspar, soda, calcium carbonate, borax, sodium nitrate, fluorspar, aluminium hydroxide,

and other metal oxides (e.g. cobalt and nickel oxide to bring about improved adhesion of enamel to sheet metal). These raw materials are smelted at a temperature of approx. 1.200°C and then solidified in water or in cooling rollers whereby the so-called enamel frits, granular or scale, are produced. The frits are ground with pigments and other additives, with or without water, and then suspended in water as enamel slip. The suspension is applied to the surface of mainly metal pieces (base material) such as steel, stainless steel, cast iron or aluminium. The fine enamel powder and the base material are bound tightly together during firing at a temperature of approx. 600 - 800°C.

Vapour, gas and particle emissions	Dust <b>[A]</b>	Waste to flue-gas treatment <b>[C]</b>	In some cases H <sub>2</sub> O steam	Dust <b>[A]</b>		Waste to flue-gas treatment <b>[C]</b>
Raw material	Preparation	Smelting	Cooling	Grinding	Suspension and application	Firing
Pigments						
Base material (steel, cast, aluminium pieces, etc.)						
Liquid and solid wastes	Failures <b>[B]</b>	Spent refractory materials from maintenance <b>[D]</b>	Frit-rejects <b>[E]</b>	Rejects from the grinding process <b>[F]</b>	Slip waste <b>[G]</b>	Rejects from the firing process <b>[H]</b> , spent refractory material from maintenance <b>[D]</b>

**Fig.1:** An example of an enamelling process with resulting wastes or emissions

## 3 Wastes

### 3.1.1 Dusts from raw material preparation as well as dry grinding of enamel frits [A]

Dusts resulting from raw material preparation and from dry grinding of so-called enamel frits are collected in filter plants (as a rule dry). In some cases they may contain dangerous substances (e.g. nickel oxide).

Classification of waste in accordance with EWL:

- 08 02 01 waste coating powders
- 10 12 11\* wastes from glazing containing heavy metals

Notes on recycling, utilization and disposal:

As a rule, recycling of the dusts to the preparation or grinding processes.

Disposal to landfill, enamel and pigment materials containing heavy metals which have not been fired, in UGL.

If they do not contain dangerous substances, disposal to landfill together with municipal waste.

### 3.1.2 Failures and rejects before the smelting process [B]

Failures from raw material preparation before smelting contain, as a rule, the raw materials of the enamel products in powder or solid form. In some cases they may contain dangerous substances (e.g. nickel oxide).

Classification of waste in accordance with EWL:

- 08 02 01 waste coating powders
- 10 12 11\* wastes from glazing containing heavy metals

Notes on recycling, utilization and disposal:

As a rule, recycling to the preparation process.

Disposal to landfill; enamel raw materials containing heavy metals which have not been fired may, in some cases, be deposited in UGL.

If it does not contain dangerous substances, disposal together with municipal waste.

### 3.1.3 Wastes from flue-gas treatment [C]

Waste from flue-gas treatment normally arises as solid filter dust, which, in addition to dangerous substances from the smelting process, may also contain particles of enamelling raw materials (e.g. nickel oxide).

Classification of waste in accordance with EWL:

- 10 12 09\* solid wastes from gas treatment containing dangerous substances
- 10 12 10 solid wastes from gas treatment other than those mentioned in 10 12 09

Notes on recycling, utilization and disposal:

At present there are no known viable treatment processes.

Disposal to landfill; if it does not contain dangerous substances, disposal together with municipal waste.

### **3.1.4 Wastes from maintenance of smelting furnaces and kilns [D]**

Waste refractory materials from smelting furnaces and kilns can arise during maintenance and repair. They may contain dangerous substances such as asbestos.

#### Classification of waste in accordance with EWL:

- 16 11 05\* linings and refractories from non-metallurgical processes containing dangerous substances
- 16 11 06 linings and refractories from non-metallurgical processes others than those mentioned in 16 11 05

#### Notes on recycling, utilization and disposal:

Wastes free of asbestos from the maintenance of smelting furnaces and kilns is currently utilized in the manufacture of refractory materials.

Otherwise, disposal to landfill; for the contact with asbestos containing material on landfills additional regulations have to be followed.

If it does not contain dangerous substances, disposal to landfill together with municipal waste.

### **3.1.5 Frit-rejects from the smelting process [E]**

Rejects from the manufacture of so-called enamel frits are glazed materials that are inert.

#### Classification of waste in accordance with EWL:

- 10 12 08 waste ceramics, bricks, tiles and construction products (after thermal processing)

#### Notes on recycling, utilization and disposal:

As a rule, crushing and recycling to the preparation process.

Otherwise, disposal to landfill, as a rule together with municipal waste.

### **3.1.6 Rejects following the grinding process [F] and slip waste [G]**

Rejects arising after either a dry or under water grinding process are unglazed frit material that is normally inert.

Slip waste is a very similar material but in suspension and to which pigment material has been added, and which may therefore contain heavy metals. Pigments are a particularly expensive raw material for the enamel industry. As a result measures are taken to avoid waste in this area.

#### Classification of waste in accordance with EWL:

- 08 02 02 aqueous sludges containing ceramic materials
- 08 02 03 aqueous suspensions containing ceramic materials
- 10 12 11\* wastes from glazing containing heavy metals

#### Notes on recycling, utilization and disposal:

As a rule, recycling of sludges to the preparation process.

08 02 02 and 10 12 11\*: Disposal to landfill; in some cases glazing raw materials containing heavy metals which have not been fired may be disposed in

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UGL after being dried. Without dangerous substances together with municipal waste.

08 02 03: Chemical physical treatment (CPT) using filtration processes (see subchapter 19 08, par. 2.5) to separate and recycle the water phase or in some cases for feeding the water phase into the sewerage system.

### **3.1.7 Rejects from the firing process [H]**

Rejects from the firing process are metal carrier materials (steel, cast and aluminium) and fired enamel. Enamel and pigment materials containing dangerous substances are glazed and inert after firing.

#### Classification of waste in accordance with EWL:

- 10 12 08 waste ceramics, bricks, tiles and construction products (after thermal processing)
- 19 12 02 ferrous metal
- 19 12 03 non-ferrous metal

#### Notes on recycling, utilization and disposal:

Depending on the metal used as carrier material, utilization in secondary metallurgy. Otherwise, disposal to landfill, as a rule together with municipal waste.

## 4 Overview of waste classification - material flow

Extract from EWL		Material flow	Treatment
<b>08 02</b>	<b>wastes from MFSU of other coatings (including ceramic materials)</b>		
08 02 01	waste coating powders	A, B	1) recycling, 2) with municipal waste
08 02 02	aqueous sludges containing ceramic materials	F, G	1) recycling, 2) with municipal waste
08 02 03	aqueous suspensions containing ceramic materials	F, G	CPT
08 02 99	wastes not otherwise specified	not normally required	

<b>wastes from MFSU of other coatings (including ceramic materials) to be classified under other waste categories</b>			
10 12 08	waste ceramics, bricks, tiles and construction products (after thermal processing)	E, H	1) recycling, 2) with municipal waste
10 12 09*	solid wastes from gas treatment containing dangerous substances	C	HWL
10 12 10	solid wastes from gas treatment other than those mentioned in 10 12 09	C	with municipal waste
10 12 11*	wastes from glazing containing heavy metals	A, B, F, G	1) recycling, 2) HWL, UGL
16 11 05*	linings and refractories from non-metallurgical processes containing dangerous substances	D	HWL
16 11 06	linings and refractories from non-metallurgical processes others than those mentioned in 16 11 05	D	1) recycling, 2) with municipal waste
19 12 02	ferrous metal	H	recycling
19 12 03	non-ferrous metal	H	recycling

## 08 03 Wastes from MFSU of printing inks

<b>1</b>	<b>Storage and internal company transport .....</b>	<b>1</b>
1.1	<i>Raw material storage.....</i>	<i>1</i>
1.2	<i>Other storage (finished goods, goods for return, laboratory and waste storage) .....</i>	<i>2</i>
<b>2</b>	<b>Cleaning procedures.....</b>	<b>3</b>
<b>3</b>	<b>Manufacture of printing inks .....</b>	<b>5</b>
<b>4</b>	<b>Printing works .....</b>	<b>6</b>
4.1	<i>Type setting.....</i>	<i>6</i>
4.2	<i>Production of printing plates.....</i>	<i>7</i>
<b>5</b>	<b>Overview of waste classification - material flow .....</b>	<b>14</b>

### 1 Storage and internal company transport

#### 1.1 Raw material storage

##### Process

In raw material storage, the materials required for production are stored ready for use. Apart from large quantities stored in tanks and silos, materials are stored in the form in which they are supplied. Materials are transported from store to the place of use in their original packaging, in some other form of transport containers or, in some cases, in pipes.

##### Wastes

Used packaging material, at times dirty, arises in connection with storage or raw materials and supplies and internal company transport. On the one hand, this includes containers made of metal, plastic, composite material, cardboard, and glass (from laboratories), and on the other hand, other packaging material in the form of plastic (e.g. cling film, sacks, ties), paper, cardboard, cartons and wooden palettes and cases.

##### ***Used packaging [A] [B]***

##### Classification of waste in accordance with EWL:

Drip-free, scraped-out containers and packaging material with no dangerous contamination **[A]**:

- 15 01 01 paper and cardboard packaging
- 15 01 02 plastic packaging

- 15 01 03 wooden packaging
- 15 01 04 metallic packaging
- 15 01 05 composite packaging
- 15 01 06 mixed packaging
- 15 01 07 glass packaging

Containers and other packaging material with dangerous contaminants (e.g. residues of non-hardened ink, residues of chemicals) **[B]**:

- 15 01 10\* packaging containing residues of or contaminated by dangerous substances

Notes on recycling, utilization and disposal:

15 01 01 to 15 01 07: Recycling or utilization under the EU-Directive on Packaging and Packaging Waste, or disposal together with municipal waste.

15 01 10\*: Cleaning, to achieve a quality for 15 01 01 to 15 01 07; incineration or other disposal as hazardous waste.

**1.2 Other storage (finished goods, goods for return, laboratory and waste storage)**

**Process**

During the manufacture of printing inks, residues ink and ink-stained packaging arise, resulting from, first of all, raw components where the limited shelf-life has expired and from pre-prepared, semi-finished products from failures in production and resulting customer returns, and secondly, from samples of dispatched goods and contaminated laboratory equipment from the laboratories. In printing works, residues ink and contaminated packaging material arise especially from ink supply to the various printing presses (ink overspill from the ink containers, difficult to empty packages) as well as from printing inks where the limited shelf life has expired.

**Waste**

***Packaging with non-hardened residues printing ink [B]***

Description see 1.1.2

Notes on recycling, utilization and disposal:

Cleaning, to achieve a quality for 15 01 01 to 15 01 07; incineration or other disposal as hazardous waste.

***Residues of printing ink [C]***

The composition of residues printing ink varies considerably according to the source, the type of printing ink (mineral oil or solvent-based inks, water-based inks, UV inks) as well as the grade of hardening and contamination. In their original form, all printing inks, even water-based printing inks, contain solvents or thinners in the form of volatile organic solvents (hydrocarbon, ketone, ester, alcohol) or inert mineral oils. Residues, non-hardened printing inks contain dangerous components especially remains of these solvents and thinners.

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### Classification of waste in accordance with EWL:

Non-hardened printing ink remains:

08 03 12\* waste ink containing dangerous substances

Hardened, dried printing ink remains:

08 03 13 waste ink other than those mentioned in 08 03 12

### Notes on recycling, utilization and disposal:

Bigger quantities of homogeneous residues of printing ink can possibly be regrind as recycling gravure printing inks.

Incineration as hazardous waste. Without dangerous substances disposal together with municipal waste.

## **2 Cleaning procedures**

### **2.1 Process**

In order to ensure quality during the manufacture of printing inks as well as in the printing works, various machines, machine parts, containers and tubes that carry ink have to be cleaned. Cleaning of small parts and inking equipment is mainly carried out by hand using cleaning cloths. Mineral-oil-based cleaning solutions (white spirits, petroleum) are predominantly used but plant-oil-based cleaning materials are also used but to a lesser degree. During the manufacture and use of water-based printing inks, cleaning is normally carried out using water or watery alkaline solvents. Containers, packaging and machine parts are cleaned in special washing machines using organic solvents or watery alkaline solvents. Dirty volatile cleaning solvents are partly regenerated by distillation on-site. Cleaning of rubber blankets in offset printing is carried out by hand or in automatic washing plants using water-free or water-containing solvent mixtures. In offset plants, the wetting system is periodically changed and rinsed out with water.

### **2.2 Wastes**

From cleaning procedures, the majority of waste arises from contaminated solvents, washing and rinsing water, cleaning cloths as well as distillation residue from internal processes. Depending on the type of cleaning carried out as well as cleaning solutions used, the waste can contain residues printing ink, grease, oil and paper fibres. In addition, from offset printing, wetting solutions containing small quantities of 2-propanol arise.

#### ***Washing and rinsing water [D] [E]***

Dirty washing and rinsing water arises:

- during cleaning of containers and parts using water or watery alkaline solvents in areas where water-based printing inks are being used **[D]**,
- during rinsing of wetting system in offset printing **[E]**.

The contents (residues printing inks, 2-propanol) are present in very dilute concentrations.

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Classification of waste in accordance with EWL:

- 08 03 07 aqueous sludges containing ink  
08 03 08 aqueous liquid waste containing ink

Notes on recycling, utilization and disposal:

- 08 03 07: Disposing of the concentrated sludges of printing inks together with municipal waste.
- 08 03 08: Disposal is carried out in chemical-physical treatment plants (CPT) using precipitation/flocculation and filtration processes (see chapter 19 08, par. 2.5) to neutralise and separate out the water phase which can then be fed into the sewerage system.

***Dirty cleaning solvents [F] [G] [H]***

Dirty mineral-oil-based cleaning solvents and plant-oil-based cleaning solutions should be collected and disposed of separately as mixing the two systems prevents possible external recycling. The solid content generally lies below 5%, while distillation residue may be more. The water content in the residue from rubber blanket cleaning can be as high as 80%.

Classification of waste in accordance with EWL:

Dirty mineral-oil-based cleaning solvents **[F]**:

- 08 01 11\* waste paint and varnish containing organic solvents or other dangerous substances

Dirty plant-oil-based cleaning solutions **[G]**:

- 08 03 12\* waste ink containing dangerous substances

Distillation residue **[H]**:

- 08 03 14\* ink sludges containing dangerous substances

Notes on recycling, utilization and disposal:

In-house or externally regeneration by distillation, filtration or hydrogenation of organic cleaning solutions or solvents and reuse. As distillation residues resulting sludges of printing ink can possibly be regrind as recycling gravure printing inks.

Otherwise incineration as hazardous waste.

***Dirty wiping cloths [I]***

Wiping cloths are heavily laden with cleaning solvents and cleaned-off printing ink. Oil filters don't arise in the process here described.

Classification of waste in accordance with EWL:

- 15 02 02\* absorbents, filter materials (including oil filters not otherwise specified), wiping cloths, protective clothing contaminated by dangerous substances.

Notes on recycling, utilization and disposal:

Contaminated wiping cloths can be washed by cleaning companies, if necessary.

Otherwise incineration as hazardous waste.

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## 3 Manufacture of printing inks

### 3.1 Process

The manufacture of printing inks includes the following steps:

- Varnish production (dissolving of binders in solvent)
- Weighing (weighing the pigment and varnish in accordance with the recipe)
- Pre-dispersal (mixing of the pigment with the varnish using dissolver)
- Dispersal (fine mixing using e. g. ball mills)
- Completion (addition of varnishes; solvents and additives for final production)
- Filtration

### 3.2 Wastes

#### ***Dusts [J]***

While weighing solid raw materials (pigments), dusts are created which are sucked up and then separated from the extracted air in a dust separator (bag filter, cyclonic filter). Problematic components in the filter dusts could be organic binders containing chlorine (present in most coloured ink pigments) and heavy metals (e.g. iron, copper, chrome, lead).

#### Classification of waste in accordance with EWL:

08 03 12\* waste ink containing dangerous substances

#### Notes on recycling, utilization and disposal:

Incineration, in case of mainly organic contents.

Disposing in case of mainly inorganic contents; in case of residues of pigments, which content water-soluble heavy metals, in underground-landfills (UGL). Without dangerous substances disposing together with municipal waste.

#### ***Contaminated weighing equipment [B]***

As a rule, weighing equipment is contaminated with dangerous residues inks.

#### Classification of waste in accordance with EWL:

15 01 10\* packaging containing residues of or contaminated by dangerous substances

#### Notes on recycling, utilization and disposal:

Cleaning, to achieve a quality for 15 01 01 to 15 01 07.

Otherwise incineration as hazardous waste.

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### ***Filter residues [K]***

The filters used during filtration (bag, tissue, textile filters) are normally laden with non-hardened printing inks and other contaminants after use. Oil filters don't arise in the process here described.

#### Classification of waste in accordance with EWL:

15 02 02\*     absorbents, filter materials (including oil filters not otherwise specified), wiping cloths, protective clothing contaminated by dangerous substances.

#### Notes on recycling, utilization and disposal:

Incineration as hazardous waste. Without dangerous substances, disposing together with municipal waste.

## **4     Printing works**

The manufacture of printed material, whatever printing technique is used, comprises four stages: typesetting, the production of printing plates, printing process and follow-up processes. In the following, the processes and the waste produced during typesetting and the production of printing plates are described. During the printing process, only waste from cleaning procedures and ink supply (printing ink residues, packaging material) arise, and these are described in chapters 1 and 2 above. The follow-up processes of printed products (cutting, stamping, folding, stapling and gluing) will not be considered further here.

### ***4.1   Type setting***

#### **Process**

For the production of type copy, digitalised data (text and pictures to be printed) is projected onto film and then used to make a plate. The next step involves the production of a proof and in some cases the layout of several films on a polyester-assembly foil (film editing) as model for typesetting.

#### **Wastes**

In addition to the typical wastes from photographic black and white processing (black and white developer, bleach bath, rinsing bath, fixing bath, intensifier bath, washing bath) which are described in detail under 0901 (wastes from the photographic industry), spent toner from the production of proofs as well as assembly foils which are no longer required for film editing arise.

### ***Spent toner [L]***

In the production of proofs only dry toner is used which does not generally contain dangerous substances. Spent toner cartridges (containing residual contents) can simply be returned to suppliers for refilling.

#### Classification of waste in accordance with EWL:

08 03 18     waste printing toner other than those mentioned in 08 03 17

#### Notes on recycling, utilization and disposal:

Spent dry toner cartouches (including residue contents) can often be given back to the manufacturer for refilling.

Otherwise disposing together with municipal waste.

### ***Spent assembly foils [M]***

The bases of assembly foils are polyester resins.

Classification of waste in accordance with EWL:

20 01 39 plastics

Notes on recycling, utilization and disposal:

Assembly foils can be supplied to the plastic recycling.

Incineration, possibly together with municipal waste.

## **4.2 Production of printing plates**

The production of printing plates varies according to the printing process (offset (planography) printing, letterpress/relief printing, gravure and screen printing) and type of plate.

### **4.2.1 Offset printing plates**

#### **4.2.1.1 Monometal plates (positive, negative plates)**

##### **Process**

With monometal plates, the exposed (positive plates) and the unexposed (negative plates) components of each layer of the printing plate (carrier material: aluminium) are dissolved and washed with water-based offset plate developer solutions. Following any necessary proof corrections, gelatine is applied to the plates.

##### **Wastes**

#### ***Used plate developer solutions [N]***

Spent plate developer solutions contain components from the printing plate surface (polyvinyl alcohol, diazo resin) as well as components from the developer solutions (e.g. phosphate, silicate, wetting agents, tenside, alcohol).

Classification of waste in accordance with EWL:

09 01 02\* water-based offset plate developer solutions

Notes on recycling, utilization and disposal:

There are at present no viable treatment processes known.

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As a rule chemical-physical treatment (CPT) using precipitation/flocculation and filtration processes (see chapter 19 08, par. 2.5) separate out the water phase which can then be fed into the sewerage system.

***Proof correction liquid bottles containing residues [B]***

Correction liquids contain acids, alcohol, glycol, fluoride and hydrocarbon. Correction liquid bottles containing residues should be disposed of under the following listed EWL categories.

Classification of waste in accordance with EWL:

15 01 10\* packaging containing residues of or contaminated by dangerous substances

Notes on recycling, utilization and disposal:

Proof correction liquid bottles containing residues can often be given back to the manufacturer for reusing or utilization.

After emptying of the residues the bottles can possibly be recycled, or disposed together with municipal waste.

Otherwise incineration as hazardous waste.

#### 4.2.1.2 Electro-photographic plate

##### Process

Electro-photographic plates (aluminium carrier, covered with an organic photo semiconductor coating) are first of all evenly loaded in the dark. Exposure above the object leads to a discharge of the semi-conductor coating exposed to the light. On the exposed plate, toner is applied which adheres to the remaining charged areas. The toner is fixed by heating. Then, the discharged areas without fixed toner are dissolved using either developer solutions (OPC – layers) or etching agents (zinc oxide layers).

##### Wastes

###### ***Spent toner [L]***

When electro-photographic offset plates are developed, both dry toner (main components: soot, polyacrylate) and liquid toner (soot suspension in aliphatic solvents) are used.

###### Classification of waste in accordance with EWL:

Liquid toner containing organic solvents (isoparaffins)

08 03 17\* waste printing toner containing dangerous substances

Dry toner:

08 03 18 waste printing toner other than those mentioned in 08 03 17.

###### Notes on recycling, utilization and disposal:

Liquid toner: Incineration as hazardous waste.

Dry toner cartouches (including residue contents) can often be given back to the manufacturer for refilling. Otherwise disposal together with municipal waste.

###### ***Spent developing solutions or etching agents [O]***

Developer (OPC-layers) used is watery alkaline solvent containing 10 – 20% organic components (tenside, monoethanolamine, alcohol). For etching (zinc oxide layers), calcium hexacyanoferrate or other metal compounds are used. These developing and etching liquids reappear in the wastes.

###### Classification of waste in accordance with EWL:

Spent developing solutions (OPC-layers):

09 01 03\* solvent-based developer solutions

Spent etching agents (zinc oxide layers)

06 03 11\* solid salts and solutions containing cyanides

###### Notes on recycling, utilization and disposal:

For spent developing solutions or etching agents are at present no viable treatment processes known.

Incineration of the developing solutions, as a rule as hazardous waste.

Spent etching agents: As a rule chemical-physical treatment (CPT) using precipitation/flocculation and filtration processes (see chapter 19 08, par. 2.5) to detoxify, neutralise and separate out the water phase which can then be fed into the sewerage system.

## 4.2.2 Letterpress/relief printing plates

### Process

With letterpress/relief printing plates, the non-polymerised components (e.g. unexposed areas) on the exposed plate (photopolymer plate) are washed with a developer solution. Following that, the washed plates are dried in a drying cabinet and then exposed to UV light for full polymerisation. The washing solution depends on the photopolymer system being used. With letterpress/newspaper printing, either water solutions (or perhaps very dilute alkaline solvents) or alcohol-water solutions (water content below 20%) are used. With relief printing, solvent solutions (80% aliphatic/alicyclic hydrocarbons, 20% pentanols) are used for washing.

### Wastes

#### *Spent developer solutions [P]*

As well as ethanol, the alcohol-containing washing solvents for letterpress printing plates contain up to 1.5% photopolymers (acrylics, polymer binder) from the coatings. As well as solvent, the solvent-containing washing solvents for relief plates contain up to 6% components from the coatings. With letterpress plates that are developed with watery (or weak alkaline solvents), the watery washing solvents contain only the dissolved coating (approx. 1.5%) and are otherwise free of contaminants.

#### Classification of waste in accordance with EWL:

Spent alcohol or solvent containing washing solutions

09 01 03\* solvent-based developer solutions

Spent aqueous (alkaline) washing solutions

08 03 08 aqueous liquid waste containing ink

#### Notes on recycling, utilization and disposal:

In-house or externally distillation of mainly alcohol or solvent containing washing solutions and reuse; otherwise incineration as hazardous waste.

For spent mainly aqueous washing solutions are presently no viable treatment processes known.

As a rule chemical-physical treatment (CPT) using precipitation/flocculation and filtration processes (see chapter 19 08, par. 2.5) to neutralise and separate out the water phase which can then be fed into the sewerage system.

## 4.2.3 Gravure printing plates

### Process

Production of copper-plated cylinders (cylinder preparation):

The cylinders pass through the following galvanic procedures during copper plating: Degreasing (watery-alkaline), pickling (pickling agent: dilute sulphuric or hydrochloric

acid), nickel plating (electrolyte: nickel sulphate, nickel chloride), copper plating (electrolyte: copper sulphate, sulphuric acid).

Transfer of the printing image onto copper-plated cylinders:

The creation of an indented surface for ink (little bowls) in the cylinder surface is carried out by electro-mechanical engraving and subsequent chromium plating (electrolyte: chromo-sulphuric acid) or by etching. Etching involves the use of iron chlorides solvent to etch the indentations in the copper layer.

Cylinder correction:

Faults in the printing plates necessitate a cylinder correction. If the indentations have to be increased in volume (plus correction), they are re-etched with ferric (III) chloride solvent after first being cleaned, degreased, and uncovered. If the indentations have to be reduced in volume (minus correction) they are partially copper-plated, covered and then etched after first having been cleaned, and degreased.

## Wastes

As well as typical wastes from galvanic treatment (degreasing baths, pickling solutions, acids, sludges containing heavy metals, watery rinsing solutions) which are described in detail under 11 01 (Wastes from chemical surface treatment and coating of metals and other materials), etching solvents arise especially during the etching process and cylinder correction.

### ***Spent etching solvents [Q]***

The etching material used is iron chloride which collects dissolved copper during the etching process.

Classification of waste in accordance with EWL:

08 03 16\* wastes etching solutions

Notes on recycling, utilization and disposal:

There are at present no viable treatment processes known.

As a rule chemical-physical treatment (CPT) using precipitation/flocculation and filtration processes (see chapter 19 08, par. 2.5) to neutralise and separate out the water phase which can then be fed into the sewerage system.

## 4.2.4 Screen printing screens

### Process

To produce screens for screen printing, fabric is stuck to a frame, cured, covered in a protective lacquer, cleaned with a watery washing fluid and covered with a copy coating. After exposure, the non-cured template components (e.g. unexposed template areas) are washed out and touched up if necessary.

Used screen printing templates can be reused after being cleaned and stripped. As a rule, cleaning is carried out in automatic screen washing plants (sometimes with integrated regeneration/distillation) using solvents. The mainly manual stripping uses watery periodate containing solvents and, then, high-pressure cleaner sprays off the loosened copy material.

## Wastes

### ***Residues of template adhesive and lacquer [R]***

Usually, the template adhesive used is a two-part adhesive with a polyurethane base. The lacquer overcoat for the template adhesive is usually either two-part marking lacquer or one-part protective lacquer. When not activated, both the adhesive and the template lacquer contain dangerous components in the form of solvents and activator (isocyanides).

#### Classification of waste in accordance with EWL:

Non-cured template adhesive:

08 04 09\* waste adhesives and sealants containing organic solvents or other dangerous substances

Cured template adhesive:

08 04 10 waste adhesives and sealants other than those mentioned in 08 04 09

Non-cured template lacquer:

08 01 11\* waste paint and varnish containing organic solvents or other dangerous substances

Cured template lacquer:

08 01 12 waste paint and varnish other than those mentioned in 08 01 11

#### Notes on recycling, utilization and disposal:

Non-cured residues of template lacquer can possibly be given back to the manufacturer for reusing in new lacquer.

Otherwise incineration; without dangerous substances, disposing together with municipal waste.

### ***Spent cleaning solvents [S]***

To clean and degrease the fabric, watery (weak acidic or alkaline) degreasing solvents are used, which, once exhausted, most importantly contain organic components (e.g. tenside, oils and grease).

#### Classification of waste in accordance with EWL:

11 01 13\* wastes from degreasing containing dangerous substances

#### Notes on recycling, utilization and disposal:

There are at present no viable treatment processes known.

As a rule chemical-physical treatment (CPT) using flocculation and filtration or vapourisation processes (see chapter 19 08, par. 2.5) to neutralise and separate out the water phase which can then be fed into the sewerage system.

### ***Washed out copy layers [T]***

The copy coating is a light-sensitive colloid coating (components: polyvinyl alcohol or polyvinyl acetate, diazo compounds, artificial resins). When the copy coating is developed with water, on average, about 30% non-cured (unexposed) coating materials land in the waste or wastewater.

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Classification of waste in accordance with EWL:

Non-cured, fluid copy coating residue:

08 03 14\* ink sludges containing dangerous substances

Cured copy coating residue:

08 03 15 ink sludges other than those mentioned in 08 03 14

Notes on recycling, utilization and disposal:

There are at present no viable treatment processes known.

As a rule chemical-physical treatment (CPT) using flocculation and filtration processes (see chapter 19 08, par. 2.5) to separate out the water phase which can then be fed into the sewerage system.

***Cleaning solvents and distillation residues***

An emulsified solvent mixture (mineral oil base) or alcohol water mixture is used to clean used, ink-stained screens.

Classification of waste in accordance with EWL:

Dirty mineral-oil-based cleaning solvents **[F]**:

08 01 11\* waste paint and varnish containing organic solvents or other dangerous substances

Distillation residues **[H]**:

08 03 14\* ink sludges containing dangerous substances

Notes on recycling, utilization and disposal:

In-house or externally distillation of cleaning solvents and reuse.

Otherwise incineration as hazardous waste.

***Stripper containing copy materials [U]***

As stripping material, periodates containing compounds with nitric acid and tenside elements or very corrosive alkaline solvents are used, which gather dissolved copy coating during their use.

Classification of waste in accordance with EWL:

08 03 14\* ink sludges containing dangerous substances

Notes on recycling, utilization and disposal:

There are at present no viable treatment processes known.

As a rule chemical-physical treatment (CPT) using precipitation/flocculation and filtration processes (see chapter 19 08, par. 2.5) to detoxify, neutralise and separate out the water phase which can then be fed into the sewerage system.

## 5 Overview of waste classification - material flow

Extract from EWL	Material flow	Treatment
<b>0803 Wastes from MFSU of printing inks</b>		
08 03 07 aqueous sludges containing ink	D, E	With Municipal waste
08 03 08 aqueous liquid waste containing ink	D, E, P	CPT
08 03 12* waste ink containing dangerous substances	C	Recycling
	C, G, J	Incineration
	J	HWL, UGL
08 03 13 waste ink other than those mentioned in 08 03 12	C	Recycling
	C, J	1) Incineration, 2) with municipal waste
08 03 14* ink sludges containing dangerous substances	H	Incineration
	T, U	CPT
08 03 15 ink sludges other than those mentioned in 08 03 14	T	CPT
08 03 16* waste etching solutions	Q	CPT
08 03 17* waste printing toner containing dangerous substances	L	Incineration
08 03 18 waste printing toner other than those mentioned in 08 03 17	L	1) Recycling, 2) with municipal waste
08 03 19* disperse oil	Not normally required	1) Incineration, 2) HWI
08 03 99 Wastes not otherwise specified	Not normally required	
<b>Wastes from MFSU of printing inks, which should be classified under other categories</b>	O	CPT
06 03 11* solid salts and solutions containing cyanides	O	CPT
08 01 11* waste paint and varnish containing organic solvents or other dangerous substances	F	Distillation
	F, R	Recycling, incineration
08 01 12 waste paint and varnish other than those mentioned in 08 01 11	R	1) Incineration, 2) with municipal waste
08 04 09* waste adhesives and sealants containing organic solvents or other dangerous substances	R	Incineration

08 04 10	waste adhesives and sealants other than those mentioned in 08 04 09	R	1) Incineration, 2) with municipal waste
09 01 02*	water-based offset plate developer solutions	N	CPT
09 01 03*	solvent-based developer solutions	O, P	1) Distillation, 2) incineration
11 01 13*	degreasing wastes containing dangerous substances	S	CPT
15 01 01	paper and cardboard packaging	A	1) Recycling, 2) incineration, 3) with municipal waste
15 01 02	plastic packaging	A	1) Recycling, 2) incineration, 3) municipal waste
15 01 03	wooden packaging	A	1) Recycling, 2) incineration, 3) with municipal waste
15 01 04	metallic packaging	A	1) Recycling, 2) with municipal waste
15 01 05	composite packaging	A	1) Incineration, 2) with municipal waste
15 01 06	mixed packaging	A	1) Incineration, 2) with municipal waste
15 01 07	glass packaging	A	1) Recycling, 2) with municipal waste
15 01 10*	packaging containing residues of or contaminated by dangerous substances	B	Cleaning, incineration
15 02 02*	absorbents, filter materials (including oil filters not otherwise specified), wiping cloths, protective clothing contaminated by dangerous substances	I, K	Incineration
		I	Washing
15 02 03	absorbents, filter materials, wiping cloths, protective clothing other than those mentioned in 15 02 02	K	1) Incineration, 2) with municipal waste
20 01 39	plastics	M	1) Recycling, 2) incineration, 3) with municipal waste

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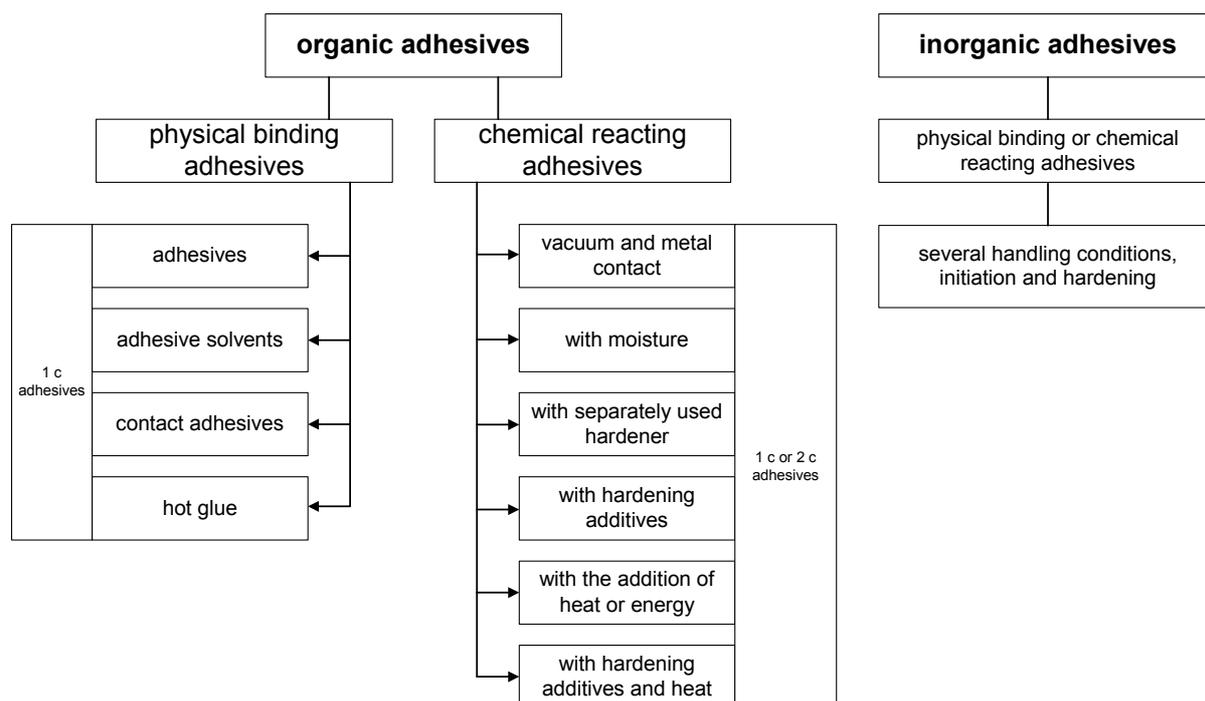
## 08 04 Wastes from MFSU of adhesives and sealants (including wa- terproofing products)

FOREWORD .....	1
1. MANUFACTURE OF ADHESIVES AND SEALANTS .....	2
1.1 Process .....	2
1.2 Waste .....	3
2. STORAGE AND INTERNAL COMPANY TRANSPORT .....	4
2.1 Process .....	4
2.2 Waste .....	4
3. CLEANING PROCESSES .....	5
3.1 Processes .....	5
3.2 Waste .....	6
4. UTILIZATION: ADHESIVES AND SEALANTS .....	7
4.1 Process .....	7
4.2 Waste .....	8
5. OVERVIEW OF WASTE CLASSIFICATION – MATERIAL FLOW .....	9

### Foreword

**Adhesives** are defined as „non-metallic working materials“, which can join bodies and inner solidity by surface adhesion without changing the body structure. The term adhesive is a generic term which encompasses other terms such as glue, paste, contact adhesive, putty and binder. **Fig. 1** shows the various adhesives. An adhesive comprises a basic raw material (determines its adhesive properties and its strength) and the many necessary additives required to provide special applications and process characteristics.

A **sealant** is defined as a mass which remains ductile or elastic and which is used to seal holes and cracks. As a rule, sealants comprise elastomers with additives.



**Fig. 1:** Categories of adhesives  
(Source: following Römpp, Chemie Lexikon)

## 1. Manufacture of adhesives and sealants

### 1.1 Process

The manufacture of adhesives and sealants is normally carried out in agitators, often in association with polymerisation, polyaddition or polycondensation processes.

In polymerisation processes, high molecular compounds are produced from low molecular base materials to form adhesive components such as so-called „Latices“. As a rule, these are further processed in agitators to form adhesives and sealants and mixed with additives. The composition of adhesives and sealants varies greatly and is explained below.

#### **Base materials and auxiliary materials in adhesives**

The base materials used in adhesives are mainly organic substances such as starch, cellulose ether, natural rubber, synthetic rubber, polyethylene, polypropylene, polyvinylester, polyvinylchloride, polyvinylalcohol, polyamide, polyester, polyurethane, epoxy resin, phenol resin and many more. Inorganic adhesives consist mainly of mineral materials, are seldom used, and therefore play a minor role.

Additives used include softeners (e.g. phthalate, phenolsulphonic acid amide), solvents (e.g. benzine, toluol, xylol, methylene chloride, trichloroethylene), filling materials (e.g. pyrogenic and precipitated silicic acids, chalks, light and heavy spar) or other additives such as preservatives, anti-ageing materials, light protectors, and foam depressants.

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## **Base materials and auxiliary materials in sealants**

As a rule, sealants are built on a base of polysulphides, silicones, polyacrylates, polyurethane, butyl compounds and PVC.

Additives used include softeners, filling materials as well as adhesive agents (e.g. phenol resins, epoxy resins), retarders (e.g. stearic acid, dimer and trimer fatty acids), or oxidation agents (e.g. lead dioxide, manganese dioxide, calcium peroxide).

Because of relatively high viscosity, the pastes have to be manufactured in a type of kneading, mechanical mixer with a high energy input.

Once manufactured, adhesives and sealants are packed in retail packaging, for example, plastic buckets, tubes, spray canisters, cartridges, glass bottles, etc.

### **1.2 Waste**

Waste which arises during manufacture results in **adhesive and sealant remains [A]** and **rosin oils [B]** from production failures and laboratory remains (e.g. samples).

#### ***Adhesive and sealant remains [A]***

Contact adhesives, applied to carrier materials, mainly removable adhesive layers, do not contain solvent and as a rule do not contain dangerous substances.

Adhesive solvents contain either organic solvent or water (water-based dispersion/emulsion adhesive). If there are organic solvents or other dangerous substances present, adhesives have to be classified as hazardous waste.

Contact adhesives contain organic solvents. If these solvents are not fully evaporated, waste must be classified as hazardous.

Hot glues are solvent-free adhesives which become pasty or liquid when heated, and when solidified, stick to the work piece. As a rule, hot glues do not contain dangerous substances.

Chemical reaction adhesives do not contain organic solvents, with the exception of adhesive systems which are combined with resin additives and heat treatment (see fig 1). Chemical reaction adhesives do not normally contain dangerous substances.

As a rule, inorganic adhesives are made of mineral components and in some cases should be checked for solvents or any other dangerous components.

Polyurethane and polyacrylate-based sealants normally contain organic solvents and if evaporation is not complete, they should be classified as hazardous waste. Further dangerous substances may be present as additives making it necessary to check each one.

#### Classification of waste in accordance with EWL:

08 04 09\* waste adhesives and sealants containing organic solvents or other dangerous substances

08 04 10 waste adhesives and sealants other than those mentioned in 08 04 09

#### Notes on recycling, utilization and disposal:

On-site or external regeneration by distillation, filtration or hydration of organic solvents and recycling.

Otherwise, disposal in hazardous waste incineration (HWI); if it does not contain dangerous material, in some cases together with municipal waste.

### ***Rosin oil [B]***

Rosin oils are dark viscous oils on a mineral oil base (hydro-carbon) which makes them hazardous.

#### Classification of waste in accordance with EWL:

08 04 17\*    rosin oil

#### Notes on recycling, utilization and disposal:

Oil recycling.

Incineration for use as a fuel.

Otherwise hazardous waste incineration (HWI) .

## **2. Storage and internal company transport**

### **2.1 Process**

Raw materials needed for production are stored in the raw material store until required. They are stored in the packaging in which they are received with the exception of large quantities which are held in tanks and silos. Raw material being transported from store to production area is either in its original packaging, in some other transport container or transported through a pipe system.

In the store, **used packaging [C]** arises in the form of paper, cardboard, carton, plastic (e.g. cling-film, bags, ties), as well as wooden pallets and crates. In some cases these contain adhesive or sealant residue.

**Adhesive or sealant residue and rosin oil [D]** arise, first of all from storing beyond the recommended life of the raw material and semi-manufactured components, as well as from production failures or customer returns. In order to avoid wastage, adhesives and sealants should be stored in clean, airtight containers in cool, dry rooms. In laboratory areas, adhesive and sealant remains from samples and contaminated laboratory equipment arises.

### **2.2 Waste**

#### ***Contaminated packaging [C]***

The storage of raw and process materials and internal company transport lead to used packaging which is sometimes contaminated. This packaging includes metal plastic, composite material, glass (from the laboratories), paper and carton containers as well as wooden pallets and crates.

#### Classification of waste in accordance with EWL:

If it does not contain dangerous substances:

15 01 01    paper and cardboard packaging

15 01 02    plastic packaging

- 
- 15 01 03 wooden packaging
  - 15 01 04 metallic packaging
  - 15 01 05 composite packaging
  - 15 01 06 mixed packaging
  - 15 01 07 glass packaging

If it contains dangerous substances such as unhardened adhesive and sealant, chemical remains or cambric cases contaminated with dangerous substances,:

- 15 01 10\* packaging containing residues of or contaminated by dangerous substances

Notes on recycling, utilization and disposal:

- 15 01 01 to 15 01 07: Recycling or utilization in accordance with packaging regulations or EU packaging directive or disposal together with municipal waste.
- 15 01 10\*: Cleaning or drying in order to achieve the quality 15 01 01 to 15 01 07. Otherwise, incineration (HWI) or disposal to HWL.

***Adhesive and sealant remains and rosin oil [D]***

The composition of adhesive and sealant remains varies according to the type of raw materials used and the product that has been manufactured. Adhesives or sealants which have not hardened may contain dangerous substances especially remainder organic solvents or thinners (see paragraph 1.2).

Classification of waste in accordance with EWL:

- 08 04 09\* waste adhesives and sealants containing organic solvents or other dangerous substances
- 08 04 10 waste adhesives and sealants other than those mentioned in 08 04 09
- 08 04 17\* rosin oil

Notes on recycling, utilization and disposal:

- 08 04 09\*, 08 04 10: Regeneration, either on-site or externally using distillation, filtration or hydration of organic solvents and then recycling. Otherwise, disposal in hazardous waste landfill (HWI); if it does not contain dangerous substances, in some cases, together with municipal waste.
- 08 04 17\*: Oil recycling.  
Incineration as a fuel.  
Otherwise, disposal in hazardous waste incinerators (HWI).

### **3. Cleaning processes**

#### **3.1 Processes**

In order to maintain quality, aggregate, machine parts, containers and pipes used in the manufacture or utilization (e.g. in construction or car manufacture) of adhesives or sealants have to be cleaned. The cleaning of small parts is normally carried out by

hand using cloths. Mineral oil based cleaners (testbenzine, petroleum) are used for this. During the manufacture and utilization of water-based dispersion/emulsion adhesives, cleaning is carried out using water or aqueous alkali solvents. Containers and machine parts are washed in washing machines using organic solvents or aqueous alkali solvents.

### 3.2 Waste

Waste arising from cleaning processes are mainly **spent washing and rinsing media [E], sludges from cleaning processes [F]** as well as **contaminated cleaning cloths. [G]**. In addition to the cleaning materials used, this waste contains adhesive and sealant residue. As a rule, the cleaning material which is used has the same basis as the solvent used in the adhesive, i.e. water in the case of water-soluble adhesives and organic solvents in the case of organic solvent-based adhesives.

#### ***Spent washing and rinsing media [E]***

As a rule, contaminated (normally alkali) washing and rinsing media contain dissolved or solid adhesive and sealant residue.

#### Classification of waste in accordance with EWL:

Washing and rinsing media containing organic solvents or other dangerous substances:

08 04 15\* aqueous liquid waste containing adhesives or sealants containing organic solvents or other dangerous substances

aqueous washing and rinsing media:

08 04 16 aqueous liquid waste containing adhesives or sealants other than those mentioned in 08 04 15

#### Notes on recycling, utilization and disposal:

At present there are no known viable treatment processes.

As a rule, chemical physical treatment (CPT) to neutralise and separate the water phase so it can be fed into the sewerage system.

Otherwise, disposal in hazardous waste incinerators (HWI).

#### ***Sludges from cleaning processes [F]***

Sludges from cleaning processes may contain organic solvents or other dangerous substances, which means they must be classified as hazardous waste.

#### Classification of waste in accordance with EWL:

Sludges containing organic or other dangerous substances:

08 04 11\* adhesive and sealant sludges containing organic solvents or other dangerous substances

08 04 13\* aqueous sludges containing adhesives or sealants containing organic solvents or other dangerous substances

aqueous sludges:

- 08 04 12 adhesive and sealant sludges other than those mentioned in 08 04 11  
08 04 14 aqueous sludges containing adhesives or sealants other than those mentioned in 08 04 13

Notes on recycling, utilization and disposal:

At present there are no known viable treatment processes.

As a rule, incineration in hazardous waste incinerators (HWI); if they do not contain dangerous substances, together with municipal waste.

***Contaminated cleaning cloths [G]***

Cleaning cloths are contaminated with the cleaning material used and with adhesive and sealant. As a rule, water-soluble adhesives do not contain dangerous substances.

Classification of waste in accordance with EWL:

- 15 02 02\* absorbents, filter materials (including oil filters not otherwise specified), wiping cloths, protective clothing contaminated by dangerous substances.  
15 02 03 absorbents, filter materials, wiping cloths and protective clothing other than those mentioned in 15 02 02

Notes on recycling, utilization and disposal:

In some cases, contaminated cleaning cloths can be washed by cleaning companies and then used again.

Otherwise, incineration (HWI); if they do not contain dangerous substances, together with municipal waste.

## **4. Utilization: adhesives and sealants**

### **4.1 Process**

Adhesion is a widely used process in connecting technology in which the shape and structure of the parts being connected are not changed. As a result, adhesives are widely used, for example in the plastics, furniture and car industry, in shoe manufacture, in the building and construction industry and many more. The demands made of the glued joint are mainly mechanical but also chemical (surface adhesion and internal solidity). Depending on the field of use, the adhesives used are either solvent-based or water-based (see organic adhesives). Adhesives can be applied manually, using a brush, spatula, spreader, or can be applied by machine using spray guns, rollers or similar equipment.

Sealing joints or cracks with liquid or pasty sealant or flexible profiles is used for sealing, for example, buildings, furniture, cars, gear housing, pipes and containers against water, oil, atmospheric effects or aggressive media. The demands made of the sealant are mechanical and chemical properties as well as a wide range of applications. Depending on the type of application, bitumin (asphalt), putty, silicon-sealants, man-made resins and polysulphide are used. Sealants are generally seen as building

materials. Sealants can be applied manually using spatulas or cartridges or by machine using spray guns and other equipment.

## 4.2 Waste

The application of adhesives and sealants results in waste comprising **adhesive and sealant remains [H]**, **contaminated packaging [I]** as well as **contaminated cleaning cloths [J]** used to remove excess adhesive or sealant.

### ***Adhesive and sealant remains [H]***

(Description see paragraph 1.2)

#### Classification of waste in accordance with EWL:

- 08 04 09\* waste adhesives and sealants containing organic solvents or other dangerous substances
- 08 04 10 waste adhesives and sealants other than those mentioned in 08 04 09

#### Notes on recycling, utilization and disposal:

Regeneration either on-site or externally using distillation, filtration or hydration of solvents and then re-use.

Otherwise, treatment in hazardous waste incinerators (HWI); if they do not contain dangerous substances, in some cases together with municipal waste.

### ***Contaminated packaging [I]***

Packaging which has not been completely emptied or cleaned contains adhesive or sealant. Waste which is contaminated with organic solvents or other dangerous substances has to be classified as hazardous.

#### Classification of waste in accordance with EWL:

- 15 01 01 paper and cardboard packaging
- 15 01 02 plastic packaging
- 15 01 03 wooden packaging
- 15 01 04 metallic packaging
- 15 01 05 composite packaging
- 15 01 06 mixed packaging
- 15 01 07 glass packaging
- 15 01 10\* packaging containing residue of or contaminated by dangerous substances

#### Notes on recycling, utilization and disposal:

15 01 01 to 15 01 07: Recycling or utilization in accordance with packaging regulations or EU packaging directive or disposal together with municipal waste

15 01 10\*: Cleaning or drying in order to reach the quality required of 15 01 01 to 15 01 07, Otherwise, incineration (HWI) or disposal (HWL).

## Contaminated cleaning cloths [J]

(Description see paragraph 3.2)

### Classification of waste in accordance with EWL:

15 02 02\*    absorbents, filter materials (including oil filters not otherwise specified), wiping cloths, protective clothing contaminated by dangerous substances

15 02 03    absorbents, filter materials, wiping cloths and protective clothing other than those mentioned in 15 02 02

### Notes on recycling, utilization and disposal:

Contaminated cleaning cloths can in some cases be washed by cleaning companies and then re-used.

Otherwise, incineration (HWI); if they do not contain dangerous substances, together with municipal waste.

## 5. Overview of waste classification – material flow

Extract from EWL		Material flow	Treatment
<b>08 04</b>	<b>wastes from MFSU of adhesives and sealants (including waterproofing products)</b>		
08 04 09*	waste adhesives and sealants containing organic solvents or other dangerous substances	A, D, H	1) recycling, 2) HWI
08 04 10	waste adhesives and sealants other than those mentioned in 08 04 09	A, D, H	with municipal waste
08 04 11*	adhesive and sealant sludges containing organic solvents or other dangerous substances	F	1) CPT, 2) HWI
08 04 12	adhesive and sealant sludges other than those mentioned in 08 04 11	F	1) CPT, 2) with municipal waste
08 04 13*	aqueous sludges containing adhesives or sealants containing organic solvents or other dangerous substances	F	1) CPT, 2) HWI
08 04 14	aqueous sludges containing adhesives or sealants other than those mentioned in 08 04 13	F	1) CPT, 2) with municipal waste
08 04 15*	aqueous liquid waste containing adhesives or sealants containing organic solvents or other dangerous substances	E	1) CPT, 2) HWI
08 04 16	aqueous liquid waste containing adhesives or sealants other than those mentioned in 08 04 15	E	1) CPT, 2) with municipal waste

08 04 17*	rosin oil	B, D	1) recycling, 2) use as a fuel, 3) HWI
08 04 99	wastes not otherwise specified	not normally required	-

<b>wastes from MFSU of adhesives and sealants (including waterproofing products), to be classified under other waste categories</b>			
15 01 01	paper and cardboard packaging	C, I	1) recycling, 2 with municipal waste
15 01 02	plastic packaging	C, I	1) recycling, 2) with municipal waste
15 01 03	wooden packaging	C, I	1) recycling, 2 with municipal waste
15 01 04	metallic packaging	C, I	1) recycling, 2) with municipal waste
15 01 05	composite packaging	C, I	1) recycling, 2) with municipal waste
15 01 06	mixed packaging	C, I	1) sorting, 2 with municipal waste
15 01 07	glass packaging	C, I	1) recycling, 2) with municipal waste
15 01 10*	packaging containing residues of or contaminated by dangerous substances	C, I	1) cleaning, 2) HWL, HWI
15 02 02*	absorbents, filter materials (including oil filters not otherwise specified), wiping cloths, protective clothing contaminated by dangerous substances	G, J	1) cleaning, 2) HWI, HWL
15 02 03	absorbents, filter materials, wiping cloths and protective clothing other than those mentioned in 15 02 02	G, J	1) cleaning, 2) with municipal waste

## 0901 Wastes from the photographic industry

<b>1</b>	<b>Processes .....</b>	<b>1</b>
1.1	<i>Black and white process .....</i>	1
1.2	<i>Black and white reversal process .....</i>	2
1.3	<i>Colour negative process .....</i>	2
1.4	<i>Colour print process .....</i>	2
1.5	<i>Colour reversal process.....</i>	3
1.6	<i>Intensifying, toning down, toning .....</i>	3
1.7	<i>On-site or external silver recovery [O].....</i>	4
1.8	<i>Used film recycling and paper cutting [P] .....</i>	4
1.9	<i>Single-use cameras [Q].....</i>	4
<b>2</b>	<b>Wastes .....</b>	<b>4</b>
<b>3</b>	<b>Overview of waste classification – material flow .....</b>	<b>11</b>

### 1 Processes

#### 1.1 *Black and white process*

During the black and white process, exposed film material passes through the following baths: developing bath, fixing bath as well as in-between and final rinsing baths. In the developing bath, the silver halide particles, which during exposure hold the composed potential picture, are reduced to silver. In the fixing bath, the unexposed and therefore undeveloped silver compounds are bonded and removed from the emulsion coating. The in-between rinsing prevents undesirable contamination, which mainly occurs during repro and X-ray processing. In the final rinse, developed film is cleaned of materials from the baths. This includes substantial quantities of silver in addition to fixing bath components.

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## **1.2 Black and white reversal process**

During the black and white reversal process, exposed film passes through two developing baths. There, a slide is produced. The silver picture produced in the first developer is again oxidised to soluble silver in a bleaching bath. In a treatment bath, bleach substance remains are removed from the emulsion coating. In the second developer, the unexposed silver bromide is reduced to silver metal.

## **1.3 Colour negative process**

In colour negative film processing the film passes through colour developing, bleaching bath, fixing bath, and final bath. Before the fixing and final baths there are also rinses. The purpose of developing baths is to reduce the silver halide particles, which during exposure hold the composed potential picture, to silver. In addition to the reaction between the developer and the exposed silver halide there is a colour producing reaction: the oxidised developer reacts with the stored compounds in the film, known as couplers, to produce colour. When the photographic material is developed, there is a silver picture as well as a colour picture. This has to be removed. Bleach, which oxidises the silver metal back to silver ion, is used. This is subsequently removed in the fixing bath.

## **1.4 Colour print process**

Prints are made from negative film during colour print processing. The steps involved are colour developing bath, bleaching bath, fixing bath and rinsing. The bleaching and fixing baths are normally combined into a bleach-fixer bath. To increase the speed of the process, a stop bath with in-between rinsing can be operated between the developing and bleaching baths.

### **1.5 Colour reversal process**

For the first stage in processing colour reversal film (developing a negative), black and white developer is also used as the first developer. With colour reversal processing, a positive (slide or print) is obtained immediately, for which some additional baths are required. There are several steps involved in developing slides: first developing bath (black and white developer), reversal bath, colour developing bath, conditioning bath, bleaching bath, fixing bath, and, if necessary, stabiliser or final bath. Reversal baths are necessary for developing reversal film. In the reversal bath, veiling makes it possible to develop the undeveloped silver halide, from which the positive comes. Conditioning baths are used during the processing of colour reversal films in order to speed up the bleaching process. Another term is pre-bleach bath. Rinsing takes place before the reversal and final baths. There is no reversal bath during reversal print processing, but instead, there is a surface secondary exposure. Instead of a conditioning bath, a bleach accelerator is added to the bleaching bath.

### **1.6 Intensifying, toning down, toning**

**Intensifying:** Intensifying baths [L] are used to subsequently correct insufficient blackening, e.g. negatives which have been exposed or developed insufficiently. Intensifying baths contain potassium hexacyanoferrate or potassium dichromate.

**Toning-down:** Negatives that are too heavily blackened (e.g. due to too long development) can be corrected in toning-down baths **[M]**. There, some of the silver picture is dissolved or transferred into a compound of lower optical density. Contents of a toning-down bath are, for example, potassium hexacyanoferrate, per sulphate, dichromate or permanganate.

**Toning:** In a toning bath **[N]**, a slide can be given a specific tone. Toner contains components such as potassium hexacyanoferrate (III), sodium selenite, sodium sulphide, potassium thiocyanate as well as copper, lead and antimony salts.

### **1.7 On-site or external silver recovery [O]**

Fixing baths, bleach-fixer baths as well as subsequent rinses contain significant quantities of silver. This is normally recovered using electrolysis, but also, depending on suitability, by sedimentation, ion exchangers or precipitation. The de-silvered baths are then regenerated or discarded.

### **1.8 Used film recycling and paper cutting [P]**

Discarded film material is usually burned, whereby any silver present can be recovered from the ash.

### **1.9 Single-use cameras [Q]**

Single-use cameras are given back to the photographic shops. From there the cameras are passed to the developer, who is required to remove the batteries from the cameras.

## **2 Wastes**

All the baths become unusable after a certain period of time and have to be discarded and replaced in order to maintain product quality.

### **Spent black and white developer [A]**

The components of developing baths of most concern are reducing agents (hydroquinone, phenidone, metol), which exist oxidised in the spent solution. In addition, there is the developer and also a range of additives (antioxidants, complexing agents, antiveiling agents). During the lifetime of the developing solution, there is a build up of chloride and bromide as well as leftover emulsion from the photographic material.

#### Classification of waste in accordance with EWL -classification:

09 01 01\* water-based developer and activator solutions

#### Notes on recycling, utilization and disposal:

There are at present no viable treatment processes known.

Chemical-physical treatment (CPT) using vaporisation or precipitation/flocculation processes (see chapter 19 08, par. 2.5) to neutralise and separate out the water phase which can then be fed into the sewerage system.

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### ***Spent fixing baths [B]***

Ammonium thiosulphate or sodium thiosulphate are used as fixing materials. As well as ammonium and sodium thiosulphate, spent fixing baths contain a significant amount of silver, which is present as dissolved thiosulphate compound.

Classification of waste in accordance with EWL -classification:

09 01 04\* fixer solutions

Notes on recycling, utilization and disposal:

Reclamation of silver over on-site or external electrolysis installations and possibly regeneration by adding refreshing solutions.

Chemical-physical treatment (CPT) using vaporisation or precipitation/flocculation processes (see chapter 19 08, par. 2.5) to neutralise and separate out the water phase which can then be fed into the sewerage system. Possibly recovering of ammonia by stripping.

### ***Final rinse water [B]***

The water from the final rinses is very dilute fixing bath so that it is sensible to treat it together with spent fixing baths.

Classification of waste in accordance with EWL -classification:

09 01 04\* fixer solutions

Notes on recycling, utilization and disposal:

If the treatment does not take place together with the spent fixing baths (reclamation of silver), as a rule the reclamation of silver takes place by ion exchangers (see chapter 19 08, par. 2.2) and the cleaned water phase can be fed into the sewerage system.

### ***Spent bleaching baths from black and white processing [C]***

Bleaching baths contain bleaching substances, which oxidise silver metal back to dissolved silver ion. The main components used in bleaching baths in the black and white reversal process are oxidising agents such as dichromate or permanganate.

Classification of waste in accordance with EWL -classification:

09 01 05\* bleach solutions and bleach fixer solutions

Notes on recycling, utilization and disposal:

Regeneration by injecting atmospheric oxygen (re-oxidation) and by adding refreshing solutions.

Chemical-physical treatment (CPT) using vaporisation or precipitation/flocculation processes (see chapter 19 08, par. 2.5) to detoxify, if necessary, neutralise and separate out the water phase which can then be fed into the sewerage system.

### ***Spent treatment baths [D]***

The purpose of treatment baths is to remove bleaching substance remains from the emulsion. They mainly contain sodium sulphate.

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Classification of waste in accordance with EWL -classification:

06 03 14 solid salts and solutions other than those mentioned in 06 03 11 and 06 03 13

Notes on recycling, utilization and disposal:

There are at present no viable treatment processes known.

Chemical-physical treatment (CPT) using vaporisation or precipitation/flocculation processes (see chapter 19 08, par. 2.5) to neutralise and separate out the water phase which can then be fed into the sewerage system.

***Spent colour developer [E]***

The main components of colour developing baths are reducing agents (phenylen-diaminoderivatives), which are present in an oxidised state in the spent solution. In addition, there is developer and a range of additives (antioxidants, complexing agents, antiveiling agents). There is a build up of chloride or bromide as well as emulsion leftover from the photographic material over the period of use of the developing solution.

Classification of waste in accordance with EWL -classification:

09 01 01\* water-based developer and activator solutions

Notes on recycling, utilization and disposal:

Spent colour developer (specially RA-4 print process) can be regenerated externally by ion exchangers (see chapter 19 08, par. 2.2) to remove chlorides out of the photo material and by adding refreshing solutions.

Chemical-physical treatment (CPT) using vaporisation or precipitation/flocculation processes (see chapter 19 08, par. 2.5) to neutralise and separate out the water phase which can then be fed into the sewerage system.

***Spent bleaching baths from colour processing [F]***

The main components of bleaching baths from colour processing are trivalent ferrous compounds (ammonium-iron-EDTA; potassium hexacyanoferrate), which are present as bivalent compounds in the spent bath.

Classification of waste in accordance with EWL -classification:

09 01 05\* bleach solutions and bleach fixer solutions

Notes on recycling, utilization and disposal:

Regeneration by injecting atmospheric oxygen (re-oxidation) and by adding refreshing solutions.

Chemical-physical treatment (CPT) using vaporisation or precipitation/flocculation processes (see chapter 19 08, par. 2.5) to detoxify, if necessary, neutralise and separate out the water phase which can then be fed into the sewerage system.

***Spent stop baths [G]***

Once a film has left the developing bath, developing may continue for some time due to the presence of developer left sticking on. Stop baths should prevent this. They

are generally comprised of acetic acid. Due to the drag out of developing solution, it is normal practice to have a combined disposal with developing baths.

Classification of waste in accordance with EWL -classification:

09 01 01\* water-based developer and activator solutions

Notes on recycling, utilization and disposal:

There are at present no viable treatment processes known.

Chemical-physical treatment (CPT) using vaporisation or precipitation/flocculation processes (see chapter 19 08, par. 2.5) to neutralise and separate out the water phase which can then be fed into the sewerage system.

***Spent bleach-fixer baths [H]***

The bleach-fixer baths combine the properties of bleaching and fixing baths e.g. oxidise silver to silver ion and then remove it by binding it in a silver thiosulphate compound. The advantage is the shorter processing time. The main constituents in bleach-fixer baths are ammonium iron EDTA (bleaching substance) and ammonium thiosulphate (fixing substance).

Classification of waste in accordance with EWL -classification:

09 01 05\* bleach solutions and bleach fixer solutions

Notes on recycling, utilization and disposal:

Reclamation of silver by cementation or electrolysis installations and regeneration and possibly regeneration by injecting atmospheric oxygen (re-oxidation) and by adding refreshing solutions.

Chemical-physical treatment (CPT) using vaporisation or precipitation/flocculation processes (see chapter 19 08, par. 2.5) to detoxify, if necessary, neutralise and separate out the water phase which can then be fed into the sewerage system.

***Spent reversal baths [J]***

Reversal baths contain, for example, propionic acid and its sodium salt, tin (II) chloride and sodium phosphate. Tin (IV) compounds are produced in the reaction. Due to the drag out of developing solution, it is normal practice to have a combined disposal with developing baths.

Classification of waste in accordance with EWL -classification:

09 01 01\* water-based developer and activator solutions

Notes on recycling, utilization and disposal:

There are at present no viable treatment processes known.

Chemical-physical treatment (CPT) using vaporisation or precipitation/flocculation processes (see chapter 19 08, par. 2.5) to neutralise and separate out the water phase which can then be fed into the sewerage system.

***Spent conditioning baths [K]***

Components are, for example, EDTA, potassium sulphate and 1-thioglycerol. Due to the drag out of developing solution, its normal practice to have a combined disposal with developing baths.

Classification of waste in accordance with EWL -classification:

09 01 01\* water-based developer and activator solutions

Notes on recycling, utilization and disposal:

There are at present no viable treatment processes known.

Chemical-physical treatment (CPT) using vaporisation or precipitation/flocculation processes (see chapter 19 08, par. 2.5) to neutralise and separate out the water phase which can then be fed into the sewerage system.

***Spent intensifying baths [L]***

The significant waste components of spent intensifying baths are potassium hexacyanoferrate (III) or dichromate as well as 2-pyrrolidone.

Classification of waste in accordance with EWL -classification:

06 03 11\* solid salts and solutions containing cyanides

06 03 13\* solid salts and solutions containing heavy metals

Notes on recycling, utilization and disposal:

There are at present no viable treatment processes known.

Chemical-physical treatment (CPT) using vaporisation or precipitation/flocculation processes (see chapter 19 08, par. 2.5) to neutralise and separate out the water phase which can then be fed into the sewerage system.

***Spent toning-down baths [M]***

In addition to potassium hexacyanoferrate (III), iron (III) chloride, dichromate and ammonium persulphate or sodium thiosulphate, spent toning-down baths also contain complex dissolved silver from the photographic material.

Classification of waste in accordance with EWL -classification:

06 03 11\* solid salts and solutions containing cyanides

06 03 13\* solid salts and solutions containing heavy metals

06 03 14 solid salts and solutions other than those mentioned in 06 03 11 and 06 03 13

Notes on recycling, utilization and disposal:

Reclamation of silver, as a rule together with fixing and bleach-fixers baths, because not volume relevant.

Otherwise chemical-physical treatment (CPT) using vaporisation or precipitation/flocculation processes (see chapter 19 08, par. 2.5) to detoxify, if necessary, neutralise and separate out the water phase which can then be fed into the sewerage system.

***Spent toning baths [N]***

The significant waste components in spent toning baths are toner components such as potassium hexacyanoferrate (III), sodium selenite, sodium sulphide and potassium thiocyanate.

Classification of waste in accordance with EWL -classification:

- 06 03 11\* solid salts and solutions containing cyanides
- 06 03 13\* solid salts and solutions containing heavy metals
- 06 03 14 solid salts and solutions other than those mentioned in 06 03 11 and 06 03 13

Notes on recycling, utilization and disposal:

There are at present no viable treatment processes known.

Chemical-physical treatment (CPT) using vaporisation or precipitation/flocculation processes (see chapter 19 08, par. 2.5) to detoxify, if necessary, neutralise and separate out the water phase which can then be fed into the sewerage system.

***Spent final baths***

A final or stabiliser bath allows film to dry more quickly and smoothly, hardens the emulsion coating and neutralises leftover chemical substances. Contents are normally formaldehyde and wetting agents. Only small quantities of final or stabilising baths arise so they can be disposed of as wastewater in accordance with regional wastewater policy.

***Waste from on-site or external silver recovery [O]***

Depending on the silver recovery process used for spent fixing, bleach-fixer or rinsing baths, silver exists initially bound to electrolytic cells, base materials in ion exchangers, steel wool (cementation) or as silver sulphide (precipitation). A further appropriate treatment of this silver-containing waste (separation of silver from electrolytic cells in separation plants, smelting of silver impregnated steel wool, incineration of coated exchanger resins and removal of silver from ash, etc) is required in order to recover suitably purified silver.

Fixing and bleach-fixer baths and their treatment baths from which silver has been removed, are disposed of under 09 01 13\* if they cannot be regenerated.

Classification of waste in accordance with EWL -classification:

- 09 01 06\* wastes containing silver from on-site treatment of photographic wastes
- 09 01 13\* aqueous liquid waste from on-site reclamation of silver other than those mentioned in 09 01 06

Notes on recycling, utilization and disposal:

In hydro-metallurgical processes corresponding the composition, chemical-physical treatment (CPT) using precipitation/flocculation processes (see chapter 19 08, par. 2.5) to separate out the water phase which can then be fed into the sewerage system.

Incineration, smelting or disposing, corresponding the carrier materials (e.g. exchanger resins, steel wool, graphite).

***Used film recycling and paper cutting [P]***

Discarded films are normally burned, and any silver present can be recovered from the ash.

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Classification of waste in accordance with EWL -classification:

09 01 07 photographic film and paper containing silver or silver compounds

09 01 08 photographic film and paper free of silver or silver compounds

Notes on recycling, utilization and disposal:

Incineration; specially for X-ray films a following reclamation of silver is economic.

Otherwise disposing together with municipal waste.

***Single-use cameras [Q]***

Single-use cameras can contain contaminated (e.g. mercury, cadmium, nickel) batteries.

Classification of waste in accordance with EWL -classification:

09 01 10 single-use cameras without batteries

09 01 11\* single-use cameras containing batteries included 16 06 01, 16 06 02 or 16 06 03

09 01 12 single-use cameras containing batteries other than mentioned in 09 01 11

Notes on recycling, utilization and disposal:

Disposing of the batteries under the Batteries Ordinance.

The empty housings can disposed together with municipal waste.

### 3 Overview of waste classification – material flow

Extract from EWL	Material flow	Treatment
<b>09 01 Wastes from the photographic industry</b>		
09 01 01* water-based developer and activator solutions	E ----- A, G, J, K	Regeneration ----- CPT
09 01 02* water-based offset plate developer solutions	see comment under 08 03	Regeneration, CPT
09 01 03* solvent-based developer solutions	see comment under 08 03	Regeneration, CPT
09 01 04* fixer solutions	B	Reclaiming of silver, regeneration, CPT
09 01 05* bleach solutions and bleach fixer solutions	C, F ----- H	Regeneration ----- Reclaiming of silver, CPT
09 01 06* wastes containing silver from on-site treatment of photographic wastes	O	Recycling
09 01 07 photographic film and paper containing silver or silver compounds	P	1) Incineration with recycling, 2) with municipal waste
09 01 08 photographic film and paper free of silver or silver compounds	P	With Municipal waste
09 01 10 single-use cameras without batteries	Q	1) Returning, 2) with municipal waste
09 01 11* single-use cameras containing batteries included in 16 06 01, 16 06 02 or 16 06 03	Q	Returning
09 01 12 single-use cameras containing batteries other than those mentioned in 09 01 11	Q	Returning
09 01 13* aqueous liquid waste from on-site reclamation of silver other than those mentioned in 09 01 06	O	CPT
09 01 99 wastes not otherwise specified	Not normally required	

<b>Wastes of the photographic industry to be classified under other waste categories</b>		
06 03 11* solid salts and solutions containing cyanides	L, M, N	CPT

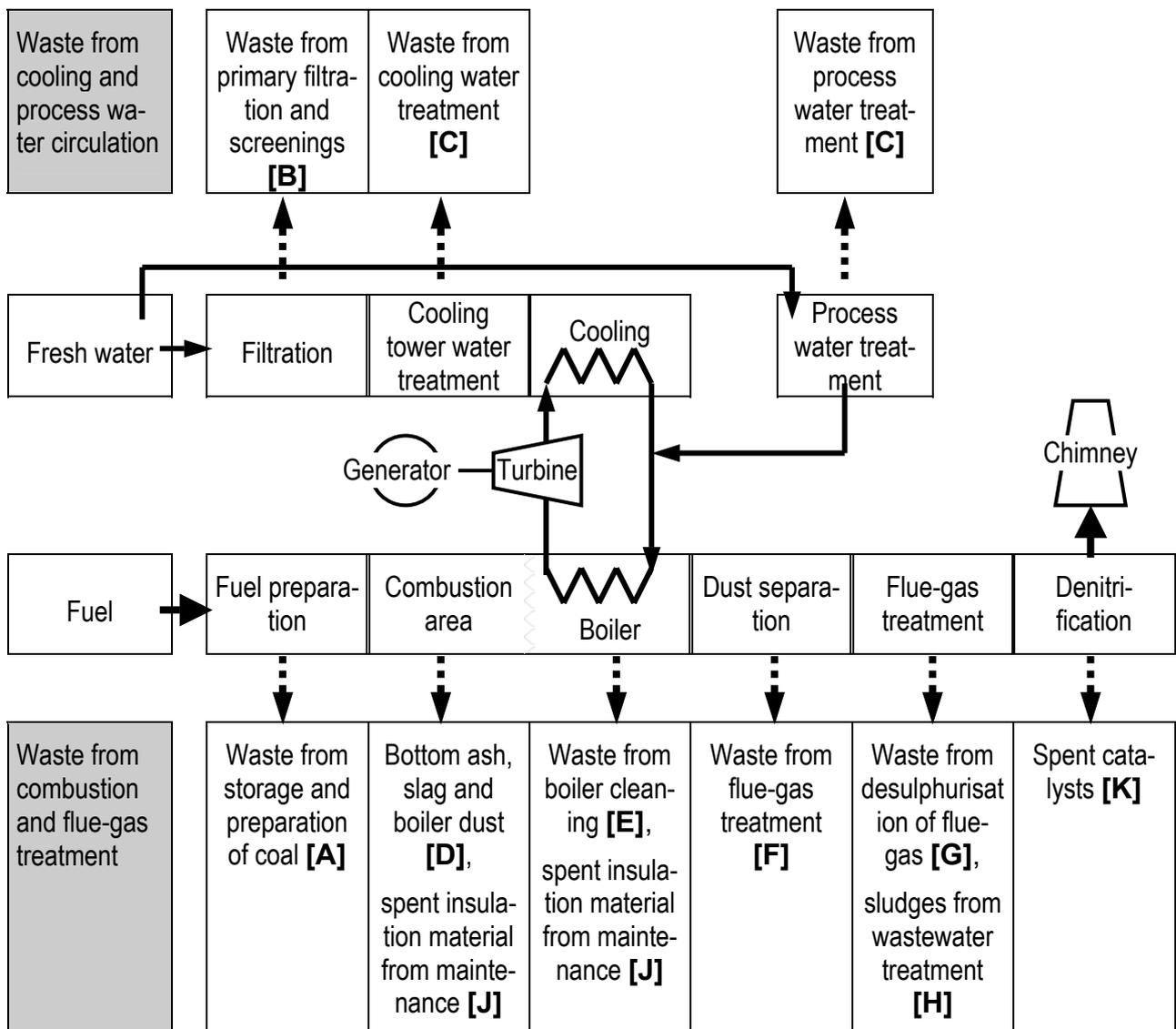
06 03 13*	solid salts and solutions containing heavy metals	L, M, N	CPT
06 03 14	solid salts and solutions other than those mentioned in 06 03 11 and 06 03 13	D, M, N	CPT

## 10 01 Wastes from power stations and other combustion plants (except 19)

<b>1</b>	<b>Process</b> .....	<b>1</b>
<b>2</b>	<b>Waste</b> .....	<b>2</b>
<b>3</b>	<b>Overview of waste classification – material flow</b> .....	<b>7</b>

### 1 Process

The main part of the power station process (**fig 1**) is the steam boiler in which the heat from coal dust-, oil-, gas-, grate- or fluidised bed combustion plants is used to produce steam. The steam is passed through a turbine, which drives the power generator.



**Fig 1:** Material flow in fossil-fuel-powered power stations and possible waste

The expanded steam has to be condensed. The resulting heat is transferred to the circulating cooling water. Evaporated water lost to the atmosphere from the cooling tower is replaced with fresh water, which is treated to meet the cooling tower water quality.

As a rule, a dust removal plant in the form of an electro or textile filter is installed after the boiler. There, most of the fly ash and heavy metal is separated.

Flue-gas treatment can be carried out dry (using materials containing calcium such as activated carbon or coke to separate organic substances and mercury), semi-dry (using a calcium hydrate wash or activated carbon), or as flue-gas wash (single-stage acid or multiple-stage acid to alkaline). Treatment of the washing water is carried out by evaporation or suitable water treatment.

Catalytic denitrification normally takes place after flue-gas treatment.

## 2 Waste

### ***Waste from storage and preparation of coal [A]***

Here, in the case of coal dust thermal processing as well as the utilisation of coal in fluidised bed thermal processing, we are concerned with the portion, which cannot be used due to particle size.

#### Classification of waste in accordance with EWL:

10 01 25 wastes from fuel storage and preparation of coal-fired power plants

#### Notes on recycling, utilization and disposal:

Incineration.

### ***Waste from the filtration of fresh water as well as screenings [B]***

During water treatment for cooling water and process water, filtration and screening residue arises from the primary (physical) stage of fresh water treatment.

#### Classification of waste in accordance with EWL:

19 09 01 solid waste from primary filtration and screenings

10 01 26 wastes from cooling water treatment

#### Notes on recycling, utilization and disposal:

There are at present no viable treatment processes known.

Disposing together with municipal waste or in mono-landfills.

### ***Wastes from cooling and boiler process water treatment [C]***

Following the physical treatment (filtration – see above) and during the treatment of fresh water for cooling or boiler process water, sludges from decarbonation, saturated or spent ion exchange resins as well as solutions and sludges from their regeneration normally arise.

#### Classification of waste in accordance with EWL:

10 01 26 wastes from cooling water treatment

- 
- 19 09 03 sludges from decarbonation
  - 19 09 05 saturated or spent ion exchange resins
  - 19 09 06 solutions and sludges from regeneration of ion exchangers

Notes on recycling, utilization and disposal:

Ion exchanger resins can possibly be regenerated and reused. Otherwise are at present no viable treatment processes known .

Incineration of the exchanger resins; otherwise disposing together with municipal waste.

***Bottom ash, slag and boiler dust [D]***

During dust thermal processing, the main portion of inert fuel parts is removed in the bottom of the combustion area either dry as ash or granulated by using a water bath for molten fluid.

During grate combustion, ash and slag arise as grate cinders as well as ash, which fall through the grate. Fall through material from the first combustion zone is often returned to fuel preparation because it is often combusted incompletely.

During fluidised bed combustion or gasification, a mixture of predominantly fluidised bed sands as well as the inert portion of fuel arises. The residue arises not in the boiler combustion area but in the process area of the fluidised bed. Non-separated particles are carried into the flue-gas section of the steam boiler.

Whatever the incineration process, waste may be processed together with fuel (co-incineration), and could therefore lead to the production of additional dangerous substances.

Classification of waste in accordance with EWL:

- 10 01 01 bottom ash, slag and boiler dust (excluding boiler dust mentioned in 10 01 04)
- 10 01 14\* bottom ash, slag and boiler dust from co-incineration containing dangerous substances
- 10 01 15 bottom ash, slag and boiler dust from co-incineration other than those mentioned in 10 01 14
- 10 01 24 sands from fluidised beds

Notes on recycling, utilization and disposal:

Slag and sands can be utilized in the building and construction industry.

Disposing, without dangerous substances together with municipal waste or in mono-landfills.

14 01 14\*: HWL.

***Waste from cleaning the flue-gas section of the boiler [E]***

Aqueous sludges, which may contain dangerous substances such as reaction products from fuel, arise during cleaning of the flue-gas section of the boiler.

Classification of waste in accordance with EWL:

- 10 01 22\* aqueous sludges from boiler cleansing containing dangerous substances
- 10 01 23 aqueous sludges from boiler cleansing other than those mentioned in 10 01 22

Notes on recycling, utilization and disposal:

There are at present no viable treatment processes known.

Chemical-physical treatment (CPT) using precipitation/flocculation and filtration processes (see chapter 19 08, par. 2.5) to neutralise and separate out the water phase which can then be fed into the sewerage system or in a stretch of water.

***Waste from flue-gas treatment [F]***

As a rule, waste from flue-gas treatment exists as solid filter dusts, which could contain not only dangerous substances from the incineration process (salts, sulphur, heavy metals etc.) but also dangerous residues or reaction products from waste which has also been co-incinerated.

Classification of waste in accordance with EWL:

- 10 01 02 coal fly dust
- 10 01 03 fly ash from peat and untreated wood
- 10 01 04\* oil fly ash and boiler dust
- 10 01 13\* fly ash from emulsified hydrocarbons used as fuel
- 10 01 16\* fly ash from co-incineration containing dangerous substances
- 10 01 17 fly ash from co-incineration other than those mentioned in 10 01 16

Notes on recycling, utilization and disposal:

There are at present no viable treatment processes known.

Disposing, without dangerous substances together with municipal waste or in mono-landfills.

10 01 04\*, 10 01 13\* and 10 01 16\*: Depending on elution of the dangerous substances HWL or UGL.

***Waste from flue-gas desulphurisation [G]***

For some fuels (e.g. hard coal), desulphurisation through the addition of alkaline adsorbents is sufficient and results in solid residues containing calcium, which can also be processed to produce valuable end-products (e.g. REA gypsum). In the case of a wet wash, part of the flow is removed and treated as wastewater, whereby sludges arise containing constituents similar to the residues from dry processes. The residue from flue-gas desulphurisation may contain small amounts of dangerous substances in the form of heavy metals and, if material containing carbon has been added to the fuels, organic components, or may consist of sulphuric acid.

Classification of waste in accordance with EWL:

- 10 01 05 calcium-based reaction wastes from flue-gas desulphurisation in solid form (as a rule)

- 
- 10 01 07 calcium-based reaction wastes from flue-gas desulphurisation in sludge form (as a rule)
  - 10 01 09\* sulphuric acid
  - 10 01 18\* wastes from gas cleaning containing dangerous substances
  - 10 01 19 wastes from gas cleaning other than those mentioned in 10 01 05, 10 01 07 and 10 01 18

Notes on recycling, utilization and disposal:

Calcium containing residues from the flue-gas desulphurisation can possibly be used as gypsum in the building and construction industry.

Wastes containing sulphuric acid are possibly reprocessed by thermal splitting processes (e.g. rotary kiln processes) for sulphuric acid production.

Otherwise chemical-physical treatment (CPT) using precipitation/flocculation and filtration processes (see chapter 19 08, par. 2.5) to neutralise and separate out the water phase which can then be fed into the sewerage system or into waters.

Disposing, without dangerous substances together with municipal waste or in mono-landfills.

10 01 18\*: UGL

***Waste from on-site wastewater treatment [H]***

The above mentioned part flow removed during flue-gas wet wash also can be processed in an central on-site wastewater treatment plant. The residue from flue-gas desulphurisation may contain dangerous substances in the form of heavy metals and, if material containing carbon has been added to the fuels, small amounts of organic components.

Classification of waste in accordance with EWL:

- 10 01 20\* sludges from on-site effluent treatment containing dangerous substances (exception)
- 10 01 21 sludges from on-site effluent treatment other than those mentioned in 10 01 20 (as a rule)

Notes on recycling, utilization and disposal:

There are at present no viable treatment processes known.

Disposing, without dangerous substances together with municipal waste or in mono-landfills.

10 01 20\*: HWL

***Waste from maintenance of boiler firing area and steam boiler [J]***

Periodic maintenance and repair to the boiler results in waste fireproof linings and caked material known as broken furnace linings as well as insulation material. These may contain dangerous substances such as asbestos or deposits from the combustion process containing dangerous substances.

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Classification of waste in accordance with EWL:

- 16 11 05\* linings and refractories from non-metallurgical processes containing dangerous substances
- 16 11 06 linings and refractories from non-metallurgical processes other than those mentioned in 16 11 05

Notes on recycling, utilization and disposal:

Asbestos free wastes from maintenance of boiler firing area and steam boiler are normally used by recycling companies for production of fireproof materials.

Disposing; for the contact with asbestos containing material on landfills additional regulations have to be followed. Without dangerous substances together with municipal waste.

***Spent catalysts [K]***

As a rule, a selective catalytic denitrification process (SCR) is incorporated after the flue-gas treatment. The main components of SCR catalysts are titanium dioxide in addition to tungsten, and up until now also molybdenum compounds, and, therefore, need to be classified as hazardous waste.

Classification of waste in accordance with EWL:

- 16 08 02\* spent catalysts containing dangerous transition metals (<sup>3</sup>) or dangerous transition metal compounds
- 16 08 03 spent catalysts containing transition metals or transition metal compounds not otherwise specified

Notes on recycling, utilization and disposal:

Spent catalysts can possibly be used by recycling companies for reclaiming of metals or for production of fireproof materials.

Otherwise disposing, without dangerous substances together with municipal waste.

### 3 Overview of waste classification – material flow

Extract from EWL	Material flow	Treatment
<b>10 01 Wastes from power stations and other combustion plants (except 19)</b>		
10 01 01 bottom ash, slag and boiler dust (excluding boiler dust mentioned in 10 01 04)	D	1) Recycling, 2) with municipal waste
10 01 02 coal fly dust	F	1) With municipal waste, 2) mono-landfill
10 01 03 fly ash from peat and untreated wood	F	1) with municipal waste, 2) mono-landfill
10 01 04* oil fly ash and boiler dust	F	HWL, UGL
10 01 05 calcium-based reaction wastes from flue-gas desulphurisation in solid form	G	1) Recycling, 2) with municipal waste, 3) Mono-landfill
10 01 07 calcium-based reaction wastes from flue-gas desulphurisation in sludge form	G	1) Recycling, 2) with municipal waste, 3) mono-landfill
10 01 09* sulphuric acid	G	Recycling, CPT
10 01 13* fly ash from emulsified hydrocarbons used as fuel	F	HWL, UGL
10 01 14* bottom ash, slag and boiler dust from co-incineration containing dangerous substances	D	HWL
10 01 15 bottom ash, slag and boiler dust from co-incineration other than those mentioned in 10 01 14	D	1) Recycling, 2) with municipal waste, 3) mono-landfill
10 01 16* fly ash from co-incineration containing dangerous substances	F	HWL, UGL
10 01 17 fly ash from co-incineration other than those mentioned in 10 01 16	F	1) With municipal waste, 2) mono-landfill
10 01 18* wastes from gas cleaning containing dangerous substances	G	HWL, UGL
10 01 19 wastes from gas cleaning other than those mentioned in 10 01 05, 10 01 07 and 10 01 18	G	1) With municipal waste, 2) mono-landfill
10 01 20* sludges from on-site effluent treatment containing dangerous substances	H	HWL

10 01 21	sludges from on-site effluent treatment other than those mentioned in 10 01 20	H	1) With municipal waste, 2) mono-landfill
10 01 22*	aqueous sludges from boiler cleansing containing dangerous substances	E	CPT
10 01 23	aqueous sludges from boiler cleansing other than those mentioned in 10 01 22	E	CPT
10 01 24	sands from fluidised beds	D	1) Recycling, 2) with municipal waste, 3) mono-landfill
10 01 25	wastes from fuel storage and preparation of coal-fired power plants	A	Incineration
10 01 26	wastes from cooling water treatment	B, C	1) With municipal waste, 2) mono-landfill
10 01 99	wastes not otherwise specified	Not normally required	

<b>Wastes from power stations and other combustion plants to be classified under other waste categories</b>			
16 08 02*	spent catalysts containing dangerous transition metals ( <sup>3</sup> ) or dangerous transition metal compounds	K	Recycling, HWL, UGL
16 08 03	spent catalysts containing transition metals or transition metal compounds not otherwise specified	K	1) Recycling, 2) with municipal waste
16 11 05*	linings and refractories from non-metallurgical processes containing dangerous substances	J	HWL
16 11 06	linings and refractories from non-metallurgical processes other than those mentioned in 16 11 05	J	1) Recycling, 2) with municipal waste
19 09 01	solid waste from primary filtration and screenings	B	Municipal waste
19 09 03	sludges from decarbonation	C	Municipal waste
19 09 05	saturated or spent ion exchange resins	C	1) Recycling, 2) incineration, 3) with municipal waste
19 09 06	solutions and sludges from regeneration of ion exchangers	C	1) CPT, 2) with municipal waste

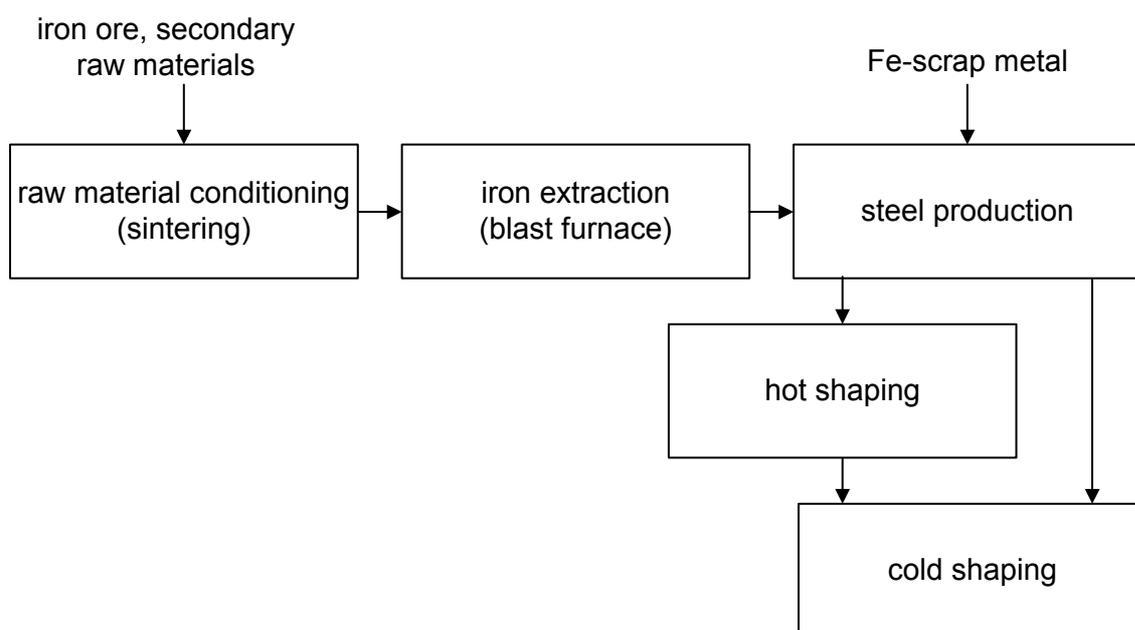
## 10 02 Wastes from the iron and steel industry

<b>1</b>	<b>Processes .....</b>	<b>1</b>
1.1	Conditioning of raw materials .....	2
1.2	Iron production .....	3
1.3	Steel production .....	5
1.4	Shaping processes (warm and cold rolling) .....	6
<b>2</b>	<b>Wastes .....</b>	<b>7</b>
2.1	Slag from smelting processes [A].....	7
2.2	Waste from flue-gas treatment [B].....	7
2.3	Spent furnace and ladle linings [C].....	8
2.4	Sludges from cooling water treatment [D] .....	9
2.5	Scales from warm shaping [E] .....	9
<b>3</b>	<b>Overview of waste classification - material flow.....</b>	<b>10</b>

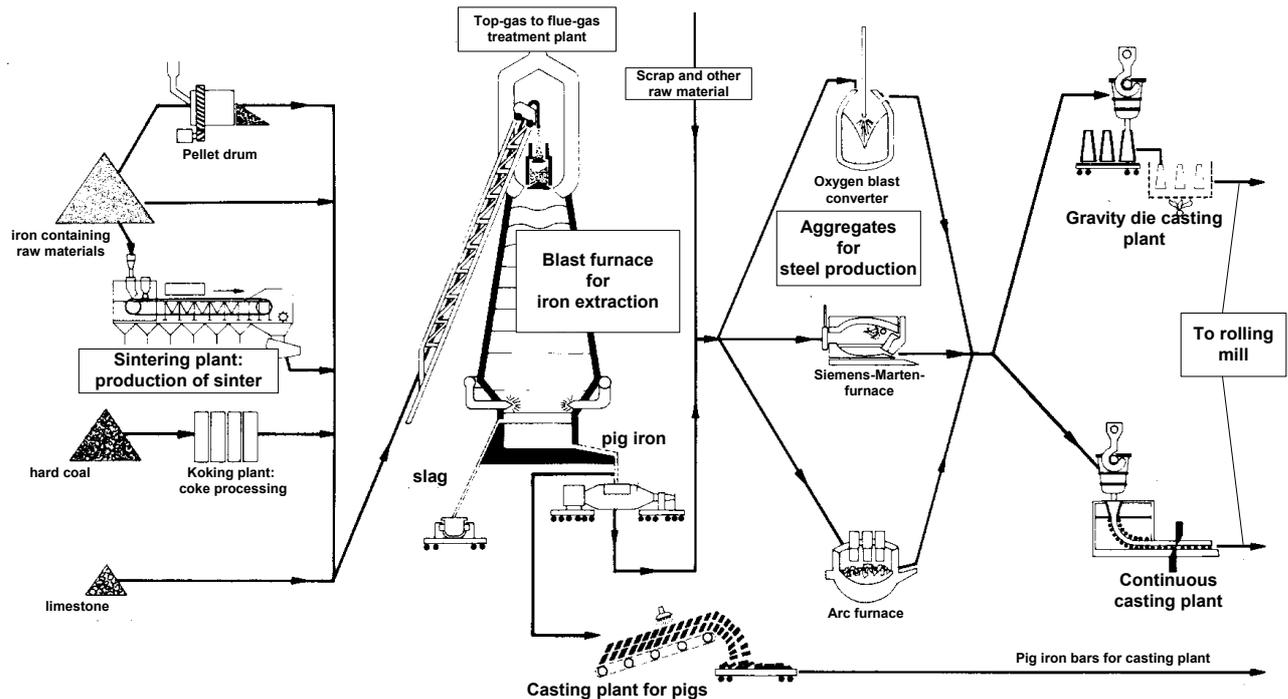
### 1 Processes

In Europe the iron and steel industry is largely confined to secondary metallurgical processes as well as further processing to produce industrial intermediary products.

The following steps (see **fig. 1** and **fig. 2**) summarise iron and steel making processes.



**Fig. 1:** Some iron and steel making processes



**Fig. 2:** Iron and steel production

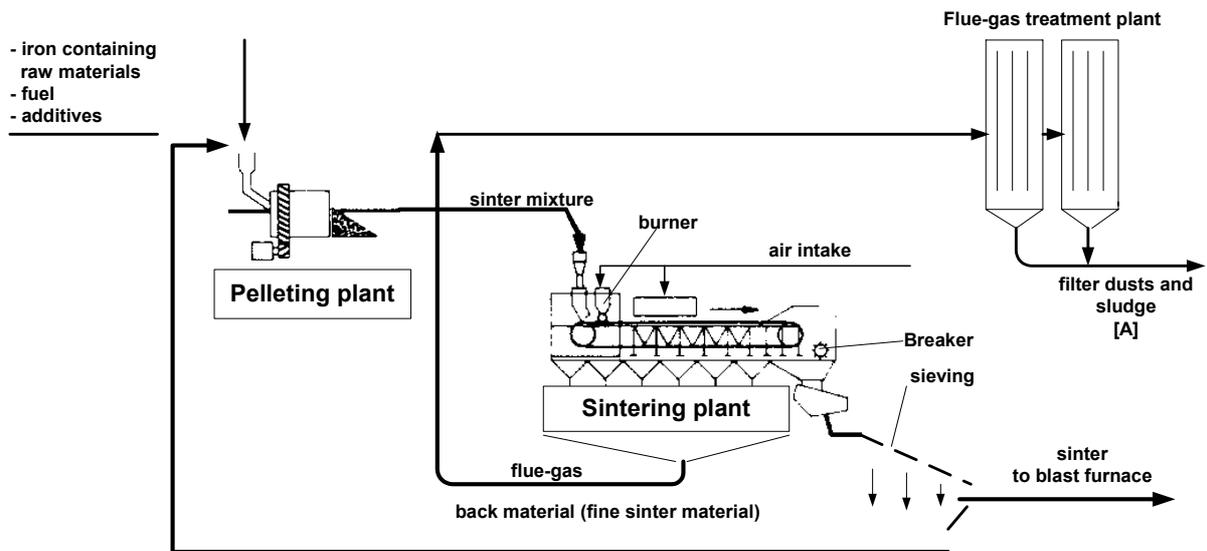
### 1.1 Conditioning of raw materials

The raw material used in the production of iron and steel in Europe includes scrap of varying quality and filings as well as finely-grained, ferrous waste material. This finely-grained input material, for example fine-grained ores, top-gas dust, mill scale, etc., cannot be smelted in its original form but has to be first conditioned, i.e. converted into pieces which can be charged.

The finely-grained material is agglomerated to form green pellets with a diameter of 10 to 20 mm in a pellet machine (usually a pellet plate or drum) and then together with back material (fine particles in sinter), water and solid fuel (as a rule coke, coal) placed on the sinter grate in the sintering plant. (see **fig. 3**).

Additional materials optimise the pelleting process (e.g. back material), enable the sintering process to take place (solid fuel) and optimise the later formation of slag (e.g. lime, dolomite or other base carriers) in the blast furnace.

During the sintering process fuel is ignited by flames on the surface of the charge. Air is fed into the sintering plant from top to bottom so that the combustion and sintering processes progress from top to bottom. Flue-gas is drawn off from the bottom and then treated. The solid components are sintered (baked) to form a porous mass, the so-called 'sinter'.

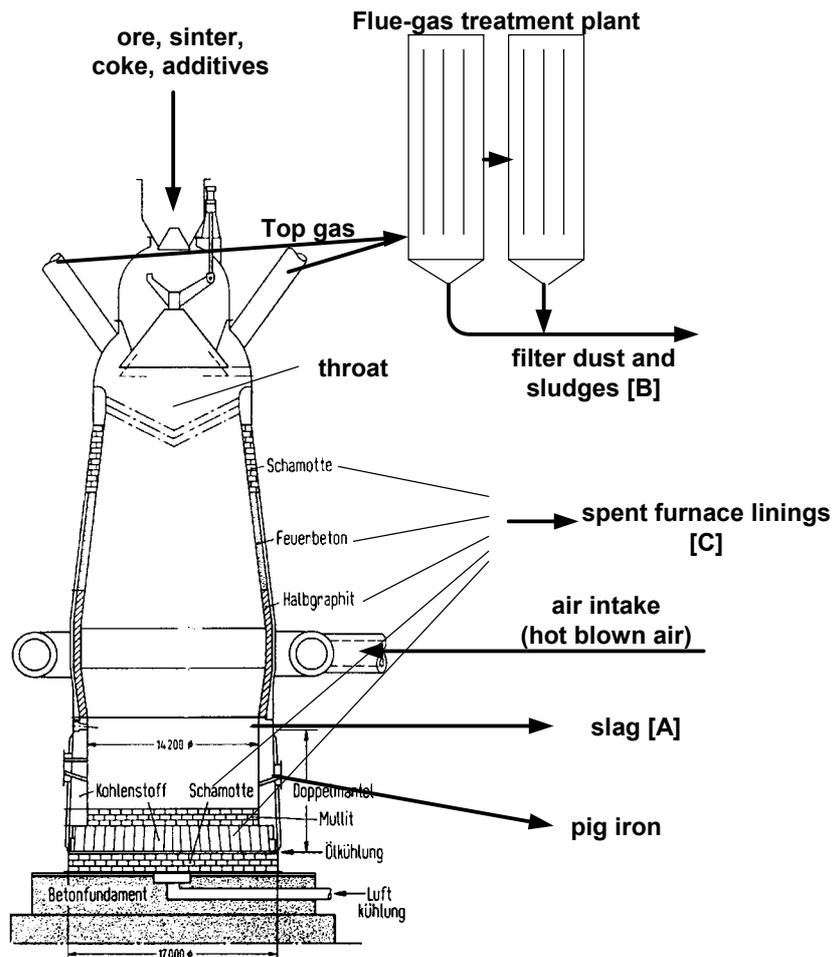


**Fig. 3:** Diagram of a sintering plant with initial pelleting

As the input materials are heated to a temperature of 1200 °C during the sintering process, the flue-gas is heavily contaminated with substances with a low boiling point (e.g. organics, sulphur, heavy metals) and with reaction and cracking products, especially dioxins/ furanes. As a result, the **filter dusts [B]** produced in the subsequent flue-gas treatment plant are heavily contaminated with dangerous substances.

## 1.2 Iron production

The production of iron from different raw materials containing iron (iron ore, flue-gas dusts, mill scales, etc) normally takes place as a reduction process in a blast furnace, resulting in molten pig iron, but in some exceptional cases using other processes, pig iron equivalent products such as iron sponge are produced. Because of the quantity and pollution significance, only the blast furnace process is represented here (**fig. 4**).



**Fig. 4:** Cross-section of a blast furnace

There are three technical, process aggregates combined in a blast furnace; reduction reactor, coke combustion reactor and molten metal aggregate for iron and slag. The furnace is continuously and alternately charged with coke, iron ore and additional materials to a level at the top of the furnace over the throat dust hood. Alternate layers of iron ore and coke build up in the furnace. Hot air is blasted in through nozzles from a pipe that encircles the furnace. Immediately beside the nozzles the coke first of all burns at temperatures of approx. 2,200 °C to produce CO<sub>2</sub>. The rising hot CO<sub>2</sub> reacts with the coke lying above to produce carbon monoxide which reduces iron oxide to iron. The gases cool to approx. 1,000 °C. The gas (flue-gas) leaves the furnace via the flue at a temperature of approx. 150 °C to 400 °C and is then treated. **Filter dusts and sludges [B]** are separated in filter plants.

In the lower third of the furnace, a ball of coke forms and molten iron and slag trickles down. The outer area is considerably hotter due to the blast of oxygen so that slag and iron form a liquid ring at the bottom. Due to its lower specific weight, the slag [A] floats to the surface and is periodically tapped off. The molten pig iron, saturated with carbon, is periodically tapped off at a lower level and, as a rule, is poured into iron bars, so-called 'pigs'.

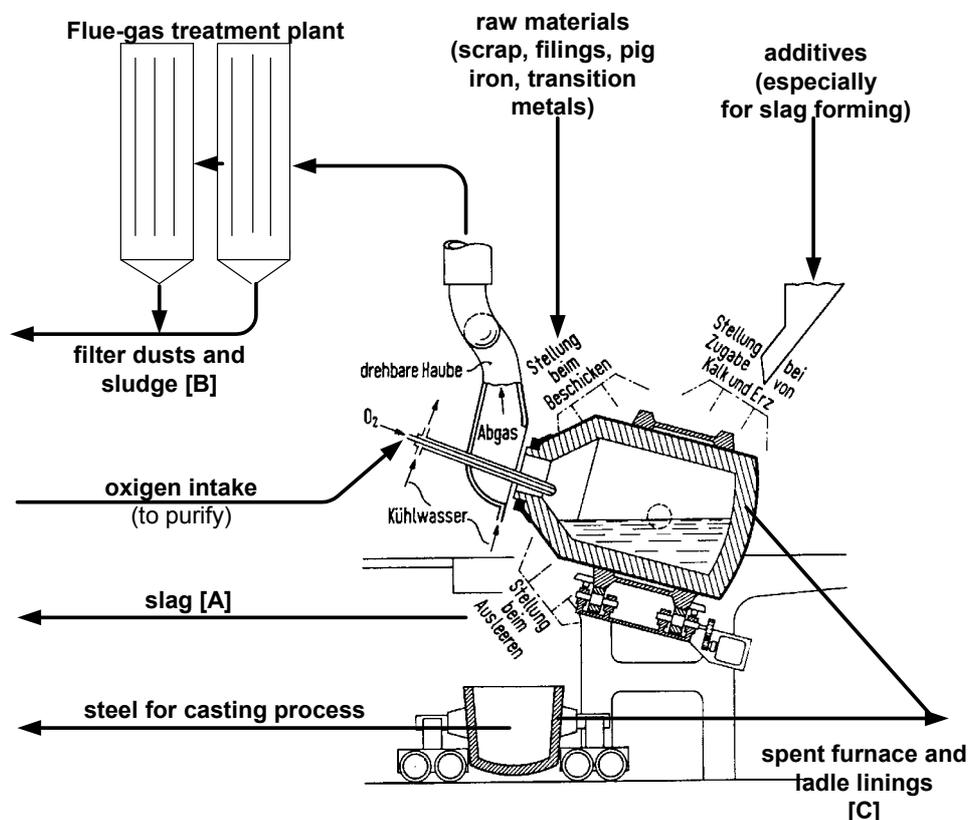
The outer steel cover on the furnace, the nozzles, and the equipment for tapping off slag and iron must be continually cooled in cold water canals. The cooling water is normally circulated. In order that the water is suitable for circulation and to keep it so, (pre) treatment (e.g. limescale removal) is necessary. Thereby **sludges from cooling water treatment [D]** arise.

The inner surfaces of the furnace are fortified with refractory materials, i.e. brick lined. These are subject to mechanical, chemical and thermal wear and tear and therefore have to be replenished or replaced during the statutory annual inspection. **Spent furnace linings and refractories arise [C]**.

### 1.3 Steel production

Compared to iron production, steel production is a pure smelting process with subsequent adjustment of the alloy composition so that the input materials must mainly be in metallic form. Raw material conditioning is restricted to the production of material which can be easily charged. Large pieces of scrap have to be cut or shredded and scrap that is too small (e.g. fine shavings) is pressed to form briquettes.

To produce steel, raw material such as scrap, filings or pig iron is first of all smelted and then refined in a converter by blasting oxygen. In this refining process, the carbon content is reduced to between 0.02 and 0.2% by oxidation, as are sulphur and phosphorous which are undesirable in steel. Depending on the application, and also independent of the raw materials used, various smelting aggregates are used, for example arc furnace, induction furnace, Siemens-Martin furnace as well as various types of converters, for example the Kaldo converter (see **fig. 5**)



**Fig. 5: Cross section of a steel converter (Kaldo converter)**

Flue-gas created in large quantities during purification as well as during smelting is heavily contaminated with dust and is treated in a flue-gas treatment plant. Thereby, **filter dusts and sludges [B]** arise.

In order to achieve the required steel composition and quality, additional materials, e.g. chalk, fluorspar and aluminium oxide are added to assist the production of slag and, for example, Cr, Ni, Mn, etc. are added as alloy elements. The purpose of slag is to absorb and bind elements such as silicon, manganese and phosphorus which are transferred in oxide during the steel production process and removed from the steel bath. Before pouring, **slag [A]** is removed from the metal bath.

The finished steel from the furnace or converter is poured into ladles and then into casting equipment. The principal processes used today for pouring are the discontinuous block casting process to produce blocks or slabs and the continuous casting process.

The furnace coverings and the additional aggregate close to the furnace has to be continually cooled in cold water canals. The water is normally circulated. In order to make the water suitable for circulating and to maintain it, pre-treatment (e.g. decalcification) is required. Thereby, **sludges from cooling water treatment [D]** arise.

The inside of smelters, converters and ladles are completely protected with a variety of refractory materials, i.e. brick lined. These are subject to mechanical, chemical and thermal wear and therefore have to be replenished or replaced at regular intervals. Thereby, **spent furnace and ladle linings [C]** arise.

#### **1.4 Shaping processes (warm and cold rolling)**

Today it is usually the case that further processes to shape intermediary steel products such as bars, profiles, sheet or pipes follows directly after the pouring of steel. As a rule, the steel blocks or billets (from continuous casting processes) go through several stages of rolling, or in rare cases forging, until the desired measurements are achieved. Ideally this takes place when the steel is still warm, 800 to 1,200 °C (warm shaping or rolling). Because of the high temperatures, the rolling and transport equipment has to be cooled and at the same time lubricated. At the same time, the fresh metal surface from the shaping process becomes covered with scale which cracks during transportation and falls off in subsequent shaping processes. The cracked scale is washed away from the oily cooling water and separated in cold water containers. This usually leads to **scale from warm shaping [E]**.

Cold shaping does not result in scale. As a rule, cold shaping processes are no longer used in steel works but rather in metal processing industries. The distinction between mechanical metal working and metal processing (see chapter 12 01) is not clearly defined.

## 2 Wastes

### 2.1 Slag from smelting processes [A]

Slag which is liquid when taken from the metal bath from blast furnaces and from steel works is processed into building and additive material by influencing the solidification process. Blast furnace wool (fibrous insulation material), blast furnace pellets (additives in cement production), blast furnace foamed slag (light material additive for the building industry), material for road building and slag lime as fertilizer (converter chalk) are obtained from blast furnace slag.

During these processes, mainly breaking/cutting, grinding and screening processes, residue which does not meet the required quality criteria arises and so, over and above the utilisation processes named above, have to be disposed of. The main components of slag are oxides of calcium, silicon, aluminium, manganese and iron. In addition, there may be pieces of metallic iron, i.e. smelted alloy.

Slag conditioning is to some extent carried out by spraying with water. During treatment of the water, sludges or filtercake, whose composition reflects that of the slag, arise.

#### Classification of waste in accordance with EWL:

- 10 02 01 wastes from the processing of slag
- 10 02 02 unprocessed slag
- 10 02 15 other sludges and filter cakes

#### Notes on recycling, utilization and disposal:

If there is a high metal content, recycling to the smelting process. Unprocessed slag can in some cases be used in the building material industry.

Otherwise, disposal to landfill, as a rule inert material landfill, or together with municipal waste.

### 2.2 Waste from flue-gas treatment [B]

Flue-gas treatment from sinter and smelting processes in the iron and steel industry is mainly carried out using textile filters, electro-filters and to some extent wet washers. As well as fuel ash, the dusts and sludges contain, especially, residue of contaminants present in the input material, non-combusted additive materials as well as iron oxide and other metal oxides, especially zinc oxide in steel works. In addition, other volatile heavy metals such as lead and cadmium could be present if they have been introduced in the input materials.

There is a strong possibility of dioxins/furanes being present in the residue from flue-gas treatment from sintering processes.

As a rule, dust from steel works shows a high level of zinc oxide and dusts from blast furnaces a high level of iron oxide.

### Classification of waste in accordance with EWL:

- 10 02 07\* solid wastes from gas treatment containing dangerous substances  
(*rule*)
- 10 02 08 solid wastes from gas treatment other than those mentioned in 10 02 07  
(*exception*)
- 10 02 13\* sludges and filter cakes from gas treatment containing dangerous substances  
(*rule*)
- 10 02 14 sludges and filter cakes from gas treatment other than those mentioned  
in 10 02 13 (*exception*)

### Notes on recycling, utilization and disposal:

If there is a high metal content (especially zinc and iron), it can be used in secondary metallurgy, or recycled in the smelting process.

Otherwise, disposal to UGL or HWL, if it does not contain dangerous substances, together with municipal waste.

## **2.3 Spent furnace and ladle linings [C]**

Spent linings from furnaces and ladles arise during regular maintenance to renew refractory linings and the removal of burned on material. Refractory linings are either acid, basic or neutral. As well as other materials, basic linings contain basic metal oxides such as manganese, chrome manganese, chrome, dolomite or limestone. Acid linings contain mainly quartz. Neutral linings contain mainly aluminium oxide with silicon oxide. Refractory materials are mineral or ceramic materials, resistant at high temperatures. Other components of the refractory products are carbon, graphite and silicon carbide.

Metal sticking to the broken furnace and ladle linings can be used as scrap once it has been separated.

### Classification of waste in accordance with EWL:

- 16 11 01\* carbon-based linings and refractories from metallurgical processes containing dangerous substances (*exception*)
- 16 11 02 carbon-based linings and refractories from metallurgical processes other than those mentioned in 16 11 01
- 16 11 03\* other linings and refractories from metallurgical processes containing dangerous substances (*exception*)
- 16 11 04 other linings and refractories from metallurgical processes other than those mentioned in 16 11 03 (*rule*)

### Notes on recycling, utilization and disposal:

At present there are no known viable treatment processes.

- 16 11 01\*: Thermal treatment in HWI.
- 16 11 02: Incineration, in some cases together with municipal waste.
- 10 11 03\*/ Material utilization in the building material industry.

10 11 04: Otherwise, disposal to HWL, if it does not contain dangerous substances together with municipal waste.

#### **2.4 Sludges from cooling water treatment [D]**

Cooling water used to cool smelting aggregate and related aggregate is as a rule circulated. The processing of raw water (e.g. separation of solids, decalcification) as well as the treatment of circulating water (removal of contaminants) results in filter residue and sludge. If cooling water is exposed to surface cooling, it is often contaminated with oil and other lubricants which are separated in oil separators.

##### Classification of waste in accordance with EWL:

- 10 02 11\* wastes from cooling-water treatment containing oil
- 10 02 12 wastes from cooling-water treatment other than those mentioned in 10 02 11

##### Notes on recycling, utilization and disposal:

At present there are no known viable treatment processes.

If there is a high organic content, incineration, otherwise, disposal to landfill; if it does not contain dangerous substances, together with municipal waste.

#### **2.5 Scales from warm shaping [E]**

The friable layer of scale of metal oxide crumbles during further processing in the rolling or shaping mills and is carried away in the cooling water. In sedimentation containers mill scales are separated from cooling water. The cooling water is also often contaminated with oil (lubricants). This settles readily on the porous surface of the scale. The oil content may be as high as 15%.

##### Classification of waste in accordance with EWL:

- 10 02 10 mill scales

##### Notes on recycling, utilization and disposal:

As a rule, processing in secondary metallurgical processes (blast furnace); in some cases, if there is a high oil content, following the removal of oil (e.g. in rotary kiln).

Otherwise disposal to landfill, if it does not contain dangerous substances, together with municipal waste.

### 3 Overview of waste classification - material flow

Extract from EWL		Material flow	Treatment
<b>10 02</b>	<b>wastes from the iron and steel industry</b>		
10 02 01	wastes from the processing of slag	A	1) material use 2) inert waste landfill 3) with municipal waste
10 02 02	unprocessed slag	A	1) material use 2) inert waste landfill 3) with municipal waste
10 02 07*	solid wastes from gas treatment containing dangerous substances	B	1) recycling, 2) UGL, HWI
10 02 08	solid wastes from gas treatment other than those mentioned in 10 02 07	B	1) recycling, 2) with municipal waste
10 02 10	mill scales	E	1) recycling, 2) with municipal waste
10 02 11*	wastes from cooling-water treatment containing oil	D	1) incineration, 2) HWI
10 02 12	wastes from cooling-water treatment other than those mentioned in 10 02 11	D	With municipal waste
10 02 13*	sludges and filter cakes from gas treatment containing dangerous substances	B	1) recycling, 2) UGL, HWI
10 02 14	sludges and filter cakes from gas treatment other than those mentioned in 10 02 13	B	1) recycling, 2) with municipal waste
10 02 15	other sludges and filter cakes	A	1) material use 2) inert waste landfill 3) with municipal waste
10 02 99	wastes not otherwise specified	not normally required	

	<b>wastes from the iron and steel industry to be classified under other waste categories</b>		
16 11 01*	carbon-based linings and refractories from metallurgical processes containing dangerous substances	C	HWI
16 11 02	carbon-based linings and refractories from metallurgical processes other than those mentioned in 16 11 01	C	1) incineration 2) with municipal waste
16 11 03*	other linings and refractories from metallurgical processes containing dangerous substances	C	1) material use, 2) HWI
16 11 04	other linings and refractories from metallurgical processes other than those mentioned in 16 11 03	C	1) material use, 2) with municipal waste

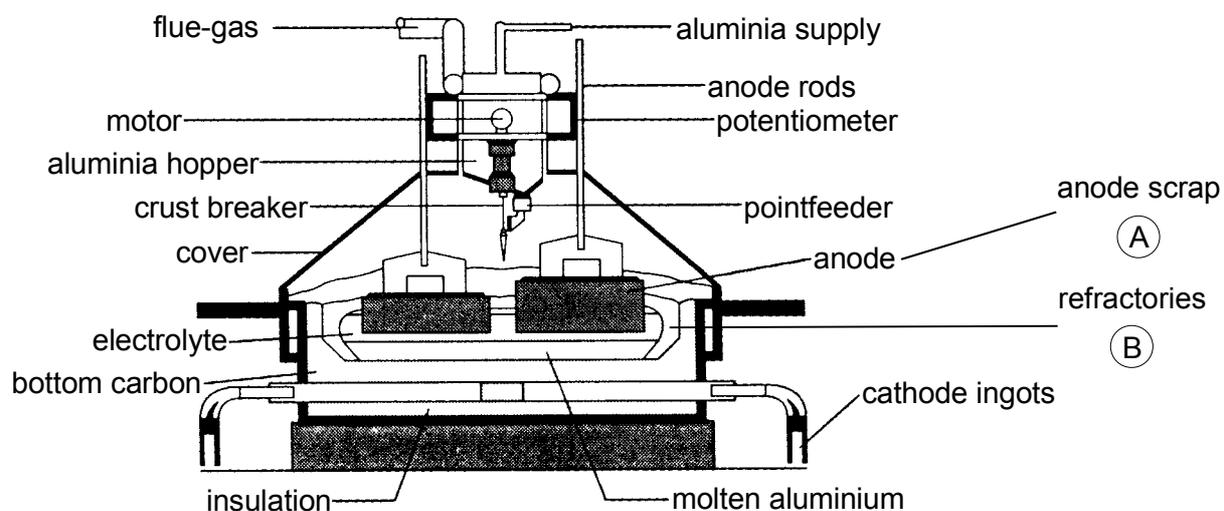
## 10 03 Wastes from aluminium thermal metallurgy

<b>1</b>	<b>Process .....</b>	<b>1</b>
1.1	<i>Primary aluminium production .....</i>	<i>1</i>
1.2	<i>Secondary aluminium production .....</i>	<i>3</i>
<b>2</b>	<b>Waste .....</b>	<b>3</b>
2.1	<i>Waste from anode production and use [A] .....</i>	<i>3</i>
2.2	<i>Waste alumina [F] .....</i>	<i>4</i>
2.3	<i>Waste from first smelting [B], [C] .....</i>	<i>4</i>
2.4	<i>Waste from secondary smelting [C], [D] .....</i>	<i>5</i>
2.5	<i>Dusts, filter cake and sludges from flue-gas treatment [E] .....</i>	<i>6</i>
2.6	<i>Waste from cooling-water treatment [G] .....</i>	<i>6</i>
2.7	<i>Waste from the processing of drosses and salt slags [H] .....</i>	<i>7</i>
<b>3</b>	<b>Overview of waste classification – material flow .....</b>	<b>8</b>

### 1 Process

#### 1.1 Primary aluminium production

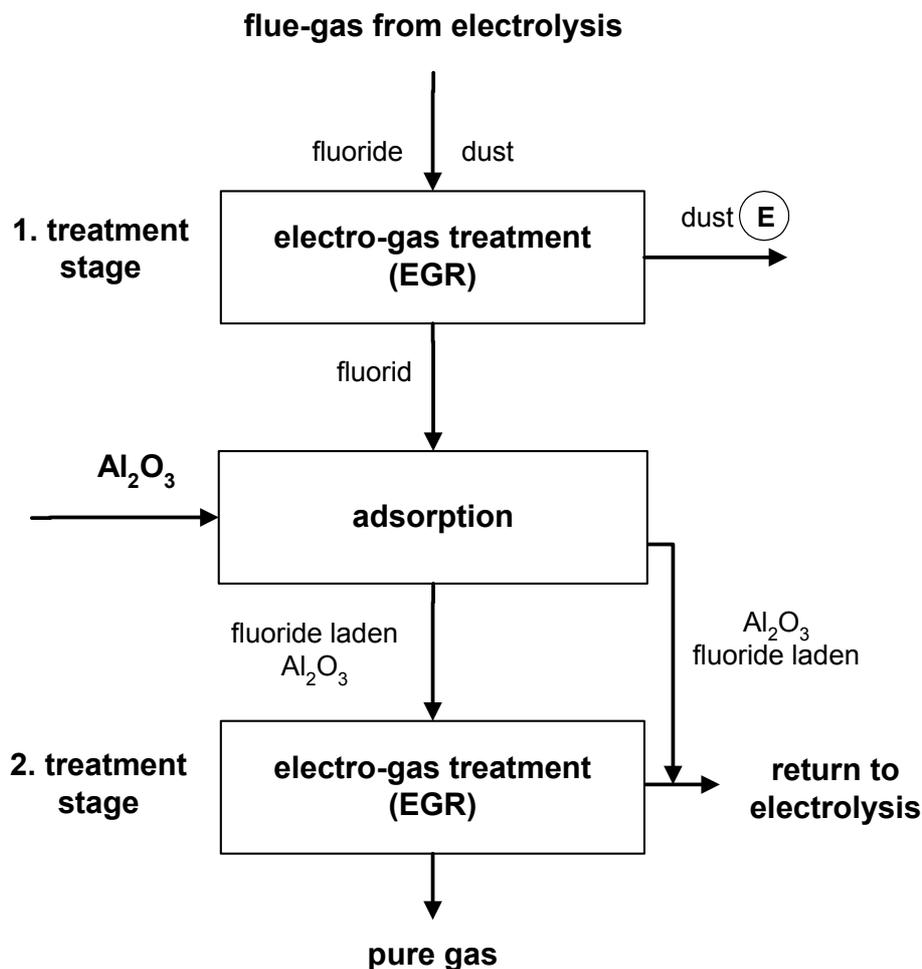
Aluminium oxide in the form of  $Al_2O_3$  is obtained in several steps from the raw material bauxite using the Bayer process. Metallic aluminium is obtained from this in a smelter electrolytic process by means of reduction and refining. Most is produced as commercial aluminium with a purity of 99.4 to 99.9%.



**Fig. 1:** Sketch showing the principle of a closed electrolytic smelter with point feeder

During smelter electrolysis, aluminium oxide dissolved in cryolite forms the electrolyte. The electrolytic bath is lined with carbon and forms the cathode. Pre-kilned rods made of pure carbon and of various forms are used for the anode. The metal is drawn off from the bottom of the bath and then further processed in batches in hearth furnaces or poured into transportable 500kg ingots known as sows.

During large scale aluminium production several electrolytic cells are connected in series and the concentrated flue-gas is collectively treated, first of all in a mechanical dust separator, then washed in wash towers and then discharged through a chimney. The acidic washing water is passed for water-treatment where it is regenerated by precipitating out the fluoride ions before being returned to the process again.

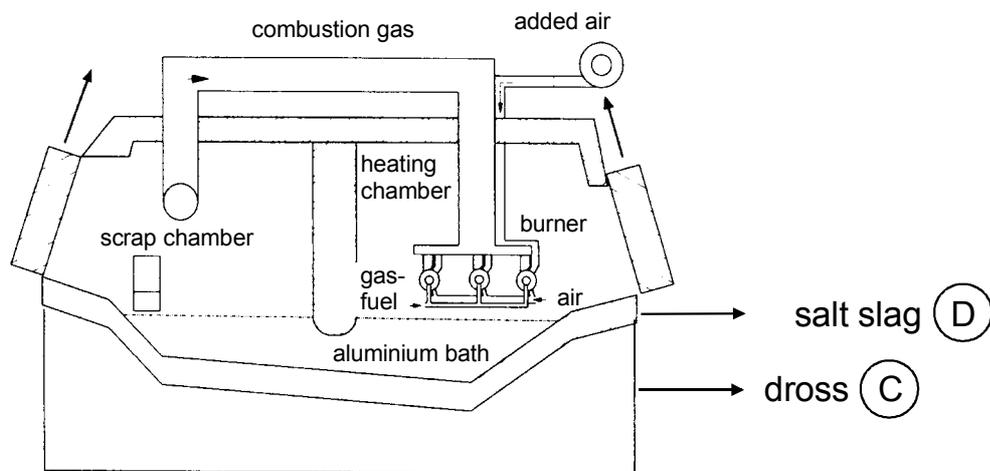


**Fig. 2:** Diagram of dry flue-gas treatment for aluminium electrolysis

Flue-gas treatment today is increasingly carried out using the dry process (see **fig.2**). In the first stage most of the dust particles are separated in an electro-filter (EGR). In the second stage aluminium oxide is blown into the flue-gas stream which is carrying gaseous fluorocarbons. The oxide with adsorbed fluorocarbon and sometimes dust is separated in cloth filters or electro-filters and after temporary storage returned to the electrolytic cell.

## 1.2 Secondary aluminium production

During secondary aluminium production both new scrap, which is waste from production such as stamping remains, and old scrap, which comprises used products from various sources, are used. Initially they are sorted according to alloy, cleaned of bits sticking to them and if necessary shredded. The smelting of heavily soiled scrap is often carried out in rotary kilns using covering salt. The salt cover reduces the oxidation loss and takes contaminants from the smelt. For less contaminated scrap, hearth-type melting furnaces of various designs are used. **Fig 3** shows a twin-chambered hearth furnace of modern design („closed well“) which is suitable for smelting contaminated or very thin scrap such as aluminium foil.



**Fig. 3:** Twin-chamber hearth furnace (closed-well)

Next, the smelt undergoes further treatment in holding and refining furnaces in order to obtain alloys of required quality.

Flue-gas treatment is normally carried out using textile filters and dry adsorption processes. In the latter, a powdery adsorbent is blown into the flue-gas and then the laden adsorbent and the fly-dust are separated in the pipes of a textile filter. Calcium hydrate, sometimes with activated carbon or activated coke added, is used as adsorbent.

## 2 Waste

### 2.1 Waste from anode production and use [A]

The production of anodes is carried out using petroleum coke and pitch in electrode factories which are normally connected to the smelting works. For Söderberg plants (self-firing anodes) a fluid mass comprising a high proportion of pitch is produced. For electrolytic systems with pre-fired anodes, blocks are made and heated to 1200°C in furnaces which are airtight. The waste which arises during this manufacturing process contains carbon and, in some cases, tar.

With continuous oxidation taking place during electrolysis, the carbon anodes wear out. The worn out anodes become **anode scrap [A]** and are replaced with new anode rods.

Classification of waste in accordance with EWL:

- 10 03 02 anode scraps
- 10 03 17\* tar-containing wastes from anode manufacture
- 10 03 18 carbon-containing wastes from anode manufacture other than those mentioned in 10 03 17

Notes on recycling, utilization and disposal:

- 10 03 02 As a rule, recycled to the anode production process
- 10 03 17\* Thermal treatment in HWI
- 10 03 18 Incineration, if applicable together with municipal waste

## 2.2 Waste alumina [F]

During certain process stages or during repair, waste alumina in the form of dust or solid bits arises.

Classification of waste in accordance with EWL:

- 10 03 05 waste alumina

Notes on recycling, utilization and disposal:

As a rule, recycled to secondary aluminium works, otherwise, disposal, if applicable together with municipal waste.

## 2.3 Waste from first smelting [B], [C]

During regular maintenance of the electrolytic cell, **linings and refractories [B]** arise which contain cathode graphite and bits of fire-proof material. In addition, they contain metallic aluminium, aluminium oxide, fluoride as well as quantities of nitrides and cyanides.

The difference between slag and dross is not clear. As a rule, during primary smelting only dross, not slag, is produced. **Dross [C]** arises in the associated casting works during the purification of aluminium. As the liquid metal cannot be completely protected from air getting in, an aluminium oxide crust forms on the surface and has to be skimmed off from time to time. The main components of the dross are aluminium with a content of up to 60% as well as aluminium oxide  $\text{Al}_2\text{O}_3$ . In addition there are also traces of nitride, carbide, and phosphide, which in contact with water could produce flammable gases. During the cooling down stage, part of the metallic aluminium burns to form aluminium oxide  $\text{Al}_2\text{O}_3$  so that, depending on the cooling conditions, the aluminium oxide content can increase.

Classification of waste in accordance with EWL:

- 10 03 04\* primary production slags
- 10 03 15\* skimmings that are flammable or emit upon contact with water, flammable gases in dangerous quantities

- 
- 10 03 16 skimmings other than those mentioned in 10 03 15
  - 16 11 01\* carbon-based linings and refractories from metallurgical processes containing dangerous substances (*rule*)
  - 16 11 02 carbon-based linings and refractories from metallurgical processes other than those mentioned in 16 11 01 (*exception*)

Notes on recycling, utilization and disposal:

If there is sufficient aluminium content, recycling to secondary aluminium works.

Otherwise:

- 10 02 04\* Disposal to landfill, HWL.
- 10 03 15\* Treatment for gas evolutioning. If it is sufficiently disreacted, disposal to landfill, as a rule HWL.
- 10 03 16 Disposal to landfill, if applicable together with municipal waste.
- 16 11 01\* Thermal treatment in HWI.
- 16 11 02 Incineration, if applicable together with municipal waste.

## **2.4 Waste from secondary smelting [C], [D]**

It is not always possible to protect the liquid metal from air getting in so that an aluminium oxide crust forms on the surface and has to be skimmed off from time to time. The resulting product, known as **dross** or **skimmings [C]**, consists mainly of  $Al_2O_3$  with varying quantities of dragged out Al metal. Sometimes a difference is made between white and black dross. White dross is created with the addition of pure Al metal and contains no carbon contamination. On the other hand, the addition of scrap which is contaminated with, for example, oil, fat, paint or plastic results in a coloured, black dross due to the carbon content.

The addition of smelt salt in rotary kilns results in approx. 250 – 300 kg/t Al – **salt slag [D]**. As well as water soluble components, it contains aluminium oxide, metallic aluminium and other contaminants from the scrap.

Classification of waste in accordance with EWL:

- 10 03 15\* skimmings that are flammable or emit upon contact with water, flammable gases in dangerous quantities
- 10 03 16 skimmings other than those mentioned in 10 03 15
- 10 03 08\* salt slags from secondary production
- 10 03 09\* black drosses from secondary production

Notes on recycling, utilization and disposal:

If there is sufficient aluminium content, recycling to secondary aluminium works.

Otherwise:

- 10 03 15\* Treatment for gas evolutioning. If it is sufficiently disreacted, disposal to landfill, as a rule HWL.
- 10 03 16 Disposal to landfill, if applicable together with municipal waste.

- 
- 10 03 09\* Disposal to landfill, if applicable together with municipal waste.
- 10 03 08\* As a rule reprocessing in recycling plants, otherwise disposal to landfill UGL, HWL.

## **2.5 Dusts, filter cake and sludges from flue-gas treatment [E]**

The gas-dust mix produced during electrolysis may consist of fluorides, metal and carbon containing dusts, CO<sub>2</sub>, CO, SO<sub>2</sub> and nitric oxide emissions. In addition, a low concentration of heavy metals may be present as accompanying elements from the ore. With furnace and foundry flue-gas treatment from electrolysis, a difference is made between wet wash and dry flue-gas treatment. **Filter sludges** are produced during the now more rarely-used alkaline or acidic wet wash. For dry separation of **filter dust [E]**, adsorption processes and electro-filters are used.

Due to the flue-gas flow carrying fine components from the raw materials, filter dust from secondary production consists of evaporated and/or hydrolyzed salt, of CaO in the case of furnaces with added salt, and of organic components from the raw materials. The composition of the dusts varies considerably depending on the raw materials used and the kind of flue-gas treatment employed. In secondary smelting works, flue-gas treatment is often carried out using textile filters supported by a dry adsorption process or airborne current procedure.

### Classification of waste in accordance with EWL:

- 10 03 19\* flue-gas dust containing dangerous substances
- 10 03 20 flue-gas dust other than those mentioned in 10 03 19
- 10 03 23\* solid wastes from gas treatment containing dangerous substances
- 10 03 24 solid wastes from gas treatment other than those mentioned in 10 03 23
- 10 03 25\* sludges and filter cakes from gas treatment containing dangerous substances
- 10 03 26 solid wastes from gas treatment other than those mentioned in 10 03 25

### Notes on recycling, utilization and disposal:

At present there are no known viable treatment processes.

Disposal to landfill, as a rule HWL. If there are no dangerous substances present, together with municipal waste.

## **2.6 Waste from cooling-water treatment [G]**

During primary and secondary aluminium production, cooling water has a restricted use, eg. for fuel processing, quenching poured metal or salt slag treatment. During filtration or periodic desludging of the circulating coolant, sludges, with a composition which depends on the medium used, arise.

### Classification of waste in accordance with EWL:

- 10 03 27\* wastes from cooling-water treatment containing oil

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10 03 28 wastes from cooling-water treatment other than those mentioned in  
10 03 27

Notes on recycling, utilization and disposal:

At present there are no known viable treatment processes.

10 03 27\* Thermal treatment in HWI

10 03 28 As a rule, disposal to landfill, if applicable together with municipal waste.

## **2.7 Waste from the processing of drosses and salt slags [H]**

In the foundries and secondary production works, dross is treated in various ways in order to recover the aluminium contained in it. This is carried out by squeezing, stirring and/or pulverizing, whereby a dusty waste is created which contains aluminium oxide, metallic aluminium, salt, nitride and accompanying elements from the dross. Because of this, there is a possibility of ammonia being formed in the presence of moisture.

The processing of salt slag is often carried out using the loose crystallisation process in which also the dross dust mentioned above is processed. As well as the recovered aluminium and mixed salt, aluminium oxide also arises.

Classification of waste in accordance with EWL:

10 03 21\* other particulates and dust (including ball-mill dust) containing dangerous substances

10 03 22 other particulates and dust (including ball-mill dust) other than those mentioned in 10 03 21

10 03 29\* wastes from treatment of salt slags and black drosses containing dangerous substances

10 03 30 wastes from treatment of salt slags and black drosses other than those mentioned in 10 03 29

Notes on recycling, utilization and disposal:

10 03 21\*/

10 03 29\* At present there are no known viable treatment processes. Otherwise disposal to UGL or HWL.

10 03 22/

10 03 30 Used in the cement industry as Al<sub>2</sub>O<sub>3</sub> carriers.

Otherwise, disposal to landfill, if applicable together with municipal waste.

### 3 Overview of waste classification – material flow

Extract from EWL	Material flow	Treatment
<b>10 03 wastes from aluminium thermal metallurgy</b>		
10 03 02 anode scraps	A	1) Recycling, 2) with municipal waste
10 03 04* primary production slags	C	HWL
10 03 05 waste alumina	F	1) Recycling, 2) with municipal waste
10 03 08* salt slags from secondary production	D	1) Recycling, 2) UGL, HWL
10 03 09* black drosses from secondary production	C	HWL
10 03 15* skimmings that are flammable or emit, upon contact with water, flammable gases in dangerous quantities	C	1) degasing, 2) HWL
10 03 16 skimming other than those mentioned in 10 03 15	C	with municipal waste
10 03 17* tar-containing wastes from anode manufacture	A	HWI
10 03 18 carbon-containing waste from anode manufacture other than those mentioned in 10 03 17	A	1) Incineration, 2) with municipal waste
10 03 19* flue-gas dust containing dangerous substances	E	HWL
10 03 20 flue-gas dust other than those mentioned in 10 03 19	E	with municipal waste
10 03 21* other particulates and dust (including ball-mill dust) containing dangerous substances	H	1) UGL, 2) HWL
10 03 22 other particulates and dust (including ball-mill dust) other than those mentioned in 10 03 21	H	1) material use, 2) with municipal waste
10 03 23* solid wastes from gas treatment containing dangerous substances	E	HWL
10 03 24 solid wastes from gas treatment other than those mentioned in 10 03 23	E	with municipal waste
10 03 25* sludges and filter cakes from gas treatment containing dangerous substances	E	HWL
10 03 26 sludges and filter cakes from gas treatment	E	with municipi-

	other than those mentioned in 10 03 25		pal waste
10 03 27*	wastes from cooling-water treatment containing oil	G	HWI
10 03 28	wastes from cooling-water treatment other than those mentioned in 10 03 27	G	with municipal waste
10 03 29*	waste from treatment of salt slags and black drosses containing dangerous substances	H	1) UGL, 2) HWL
10 03 30	wastes from treatment of salt slags and black drosses other than those mentioned in 10 03 29	H	1) material use, 2) with municipal waste
10 03 99	wastes not otherwise specified	Normally not required	

<b>wastes from aluminium thermal metallurgy, to be classified under other waste categories</b>		<b>Material flow</b>	<b>Treatment</b>
16 11 01*	carbon-based linings and refractories from metallurgical processes containing dangerous substances	B	HWI
16 11 02	carbon-based linings and refractories from metallurgical processes other than those mentioned in 16 11 01	B	1) Incineration, 2) with municipal waste

## 10 04 / 05 / 06 / 07 / 08 Wastes from lead, zinc, copper, silver, gold and platinum thermal metallurgy and wastes from other non-ferrous thermal metallurgy

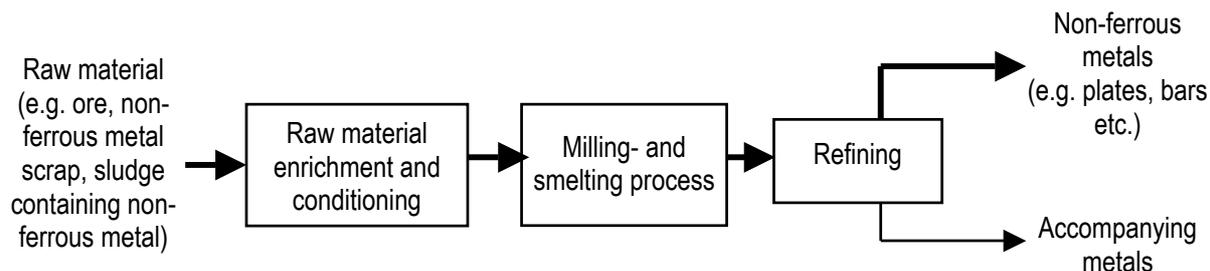
<b>1</b>	<b>Process</b> .....	<b>1</b>
1.1	<i>General</i> .....	1
1.2	<i>Conditioning of raw material</i> .....	2
1.3	<i>Smelting process</i> .....	3
1.4	<i>Lead production</i> .....	6
1.5	<i>Zinc production</i> .....	6
1.6	<i>Copper production</i> .....	7
1.7	<i>Silver, gold and platinum production</i> .....	8
1.8	<i>Nickel-, Magnesium- and tin production</i> .....	8
<b>2</b>	<b>Waste</b> .....	<b>9</b>
2.1	<i>Slag and dross from smelting and refining processes [A]</i> .....	9
2.2	<i>Waste from flue-gas treatment [B]</i> .....	10
2.3	<i>Spent furnace linings [C]</i> .....	11
2.4	<i>Dusts [D]</i> .....	12
2.5	<i>Sludges from cooling water treatment [E]</i> .....	12
2.6	<i>Waste from pyro-metallurgical electrolysis [F]</i> .....	13
2.7	<i>Calcium arsenate [G]</i> .....	14
<b>3</b>	<b>Overview of waste classification - material flow</b> .....	<b>14</b>

### 1 Process

#### 1.1 General

In terms of world production, the most important non-ferrous metals are aluminium (Al), copper (Cu), zinc (Zn), lead (Pb), nickel (Ni), magnesium (Mg) and tin (Sn). In addition, precious metals such as silver (Ag), gold (Au) and platinum (Pt) are of economic importance. The production of heavy metals and steel refining products such as cadmium, cobalt, chrome, manganese, molybdenum, niobium, tantalum, titanium, vanadium and wolfram as well as rare earth metals will not be dealt with in this paper because they arise either as by-products from the named metallurgical process and/or are unimportant in terms of the quantity of waste produced within Europe.

In general the processes of non-ferrous pyro-metallurgical production can be divided as illustrated in **fig. 1**:



**Fig. 1:** Stages in non-ferrous metal production

In Europe, in addition to naturally occurring ore, raw materials are sourced in increasing quantities from non-ferrous metal waste (e.g. non-ferrous scrap, circuit board scrap, sludges from electro-plating processes containing metal), the recycling of which, in so-called secondary metallurgy, increasingly contributes to raw material requirements. Because of this, secondary metallurgical processes (e.g. rotary kiln process) are of considerable importance in this paper.

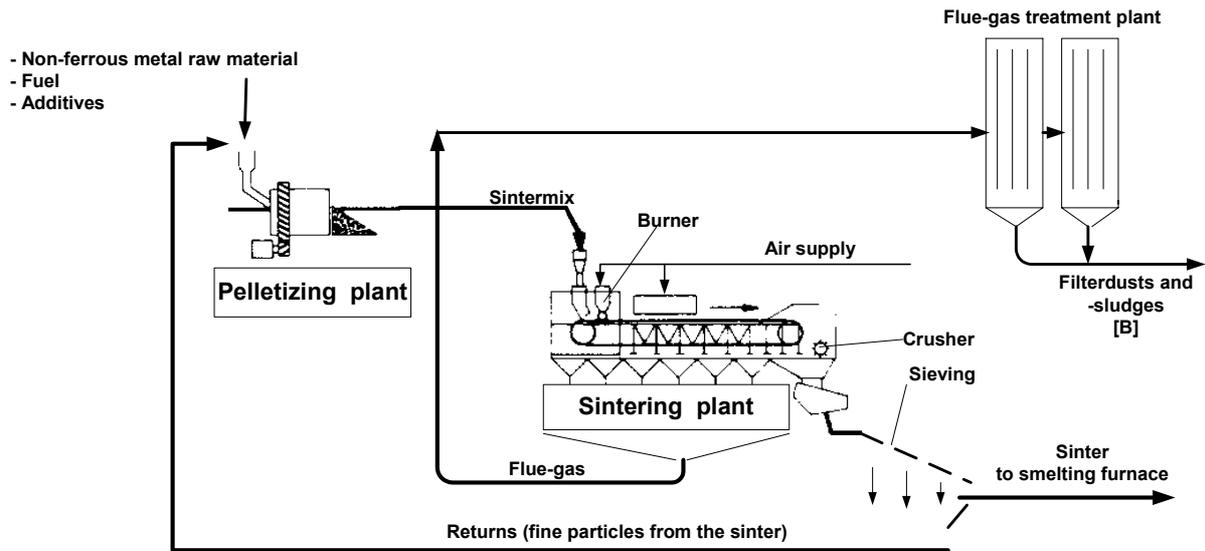
In terms of further processing (e.g. shaping processes such as warm rolling), please refer to subchapter 10 02 (iron and steel industry) as the technology is similar and the waste produced is comparable.

For waste from non-ferrous metal casting, there is one subchapter in the EWL 10 10.

Thermal aluminium metallurgy is dealt with in a separate category in the EWL, subchapter 10 03 and thermal zinc plating is dealt with subchapter 11 05.

## **1.2 Conditioning of raw material**

As well as naturally occurring ores, where in some cases the metal content must be increased in enrichment processes (e.g. leaching, weight concentration, flotation), the raw material used in non-ferrous metal extraction includes various non-ferrous metal scrap, filings, sludge and dust, etc. Before being fed into a furnace, finely grained raw material (flotation concentrate, ash, sludge, flue-gas dust etc.) must undergo an oxidising roasting and agglomeration in a sintering plant (see **fig. 2**). The heat required for the sintering process comes from oxidation of metal sulphide that is normally present in the ore. The sulphur content of the sinter mix is adjusted by addition of returns. If the sinter undergoes an initial process of pelletizing, the result is increased efficiency in sintering and in sulphur yield. Additives to bring about slag formation in reduction or smelting furnaces are added to the sinter. Slag formation must take place uniformly across the sinter product which should be hard (non-abrasive); there should be neither unroasted ore bits nor dense areas. The solidity and hardness are pre-requirements for stability in the smelter; at the same time the sinter should be foamy, cell-like. After sieving the so-called undersize powder, which is returned to the process as returns, the sinter is passed to the smelting plant ready for reduction.



**Fig. 2:** sintering plant with initial pelletizing

### 1.3 Smelting process

In pyro-metallurgical non-ferrous metal production a wide range of different types of reduction furnaces (e.g. shaft furnaces, ore flame furnaces, rotary kilns, electric furnaces) are used, depending on the material to be smelted, the available sources of energy and other local conditions. Reduction furnaces perform the following functions:

- 1) heating and reduction of oxidised raw material (ore, sinter),
- 2) generation of reduction gas from air (so-called wind, in some cases pre-heated) and coke around the level of the blast pipes, and
- 3) smelting the input and thereby separating it into metal and slag.

The principle of the process used in a reduction furnace is shown in the example of a shaft furnace in **fig 3**: Raw materials (e.g. ore oxide, sinter, etc.), fuel (e.g. coke) and additives (e.g. slag forming materials) are fed into the furnace through the throat, having in some cases been dressed (e.g. pelletizing, sintering). The charge moves as a mass from top to bottom, the fuel is converted into gas at the blast pipes, and as the gas rises it converts the charge into a liquid form. The liquid reaction products, metal and slag, collect in a crucible below the level of the blast pipes from where they are tapped off. The gaseous products escape as flue-gas through the throat and are then passed to a flue-gas treatment plant.

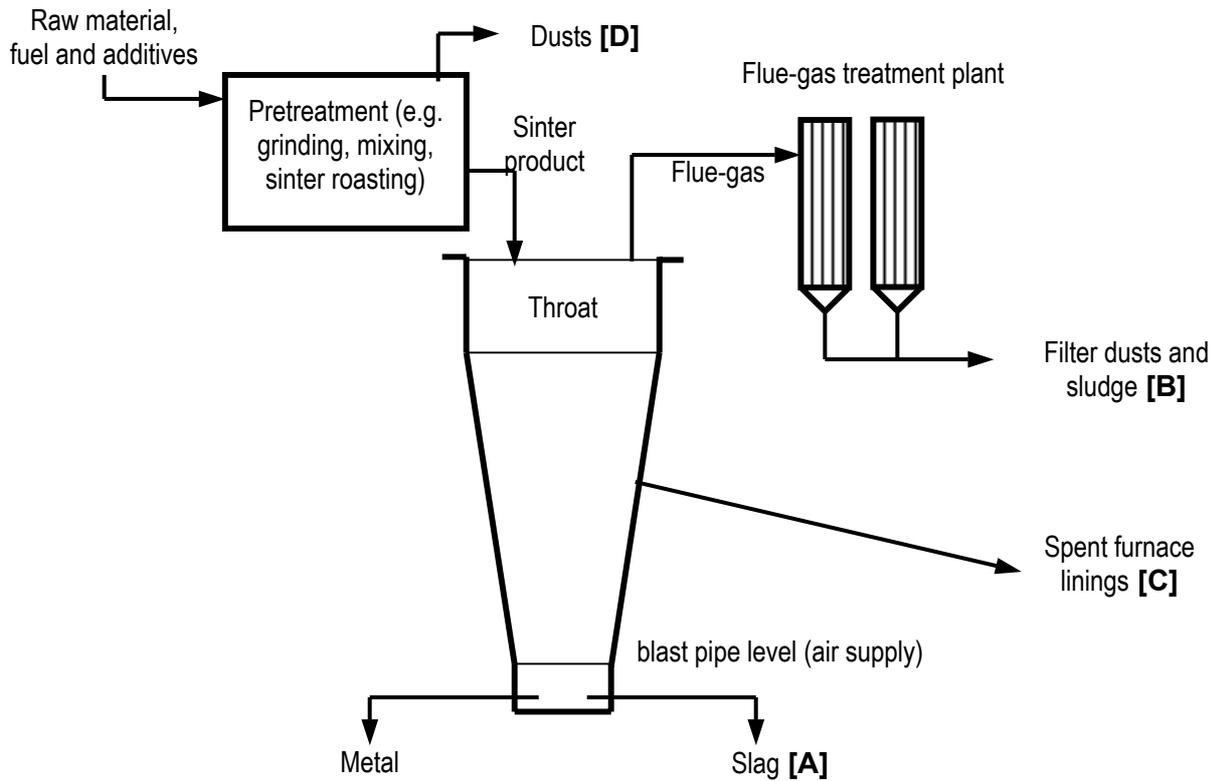
Especially in secondary metallurgy, rotary kilns are also used (see **fig. 4**). A rotary kiln consists of a slightly angled ( $3 - 5^\circ$ , depending on the purpose) heat-resistant, brick lined, steel cylinder, which is supported on bearings and which is turned slowly. The input material (e.g. ore, metal scrap, sludges containing metal) is fed in at the top, then moves slowly towards the output end under the effects of the turning motion and gravity. The rotation mixes the contents which are repeatedly brought into contact with the hot linings. The movement is supported by integral structures such as transport and turning plates. Air required for the process is fed in through blast pipes built into the casing or through blast pipe stones in the brickwork.

Parts of the reduction furnace (e.g. furnace lid, blast pipe level in the case of shaft furnaces) and aggregate positioned close to the furnace have to be continually cooled in cooling water canals. The cooling water is normally circulated. As a rule pre-treatment (e.g. decalcification) is required to make the water suitable for circulation and to maintain its condition. As a result, **sludges from cooling water treatment [E]** arise.

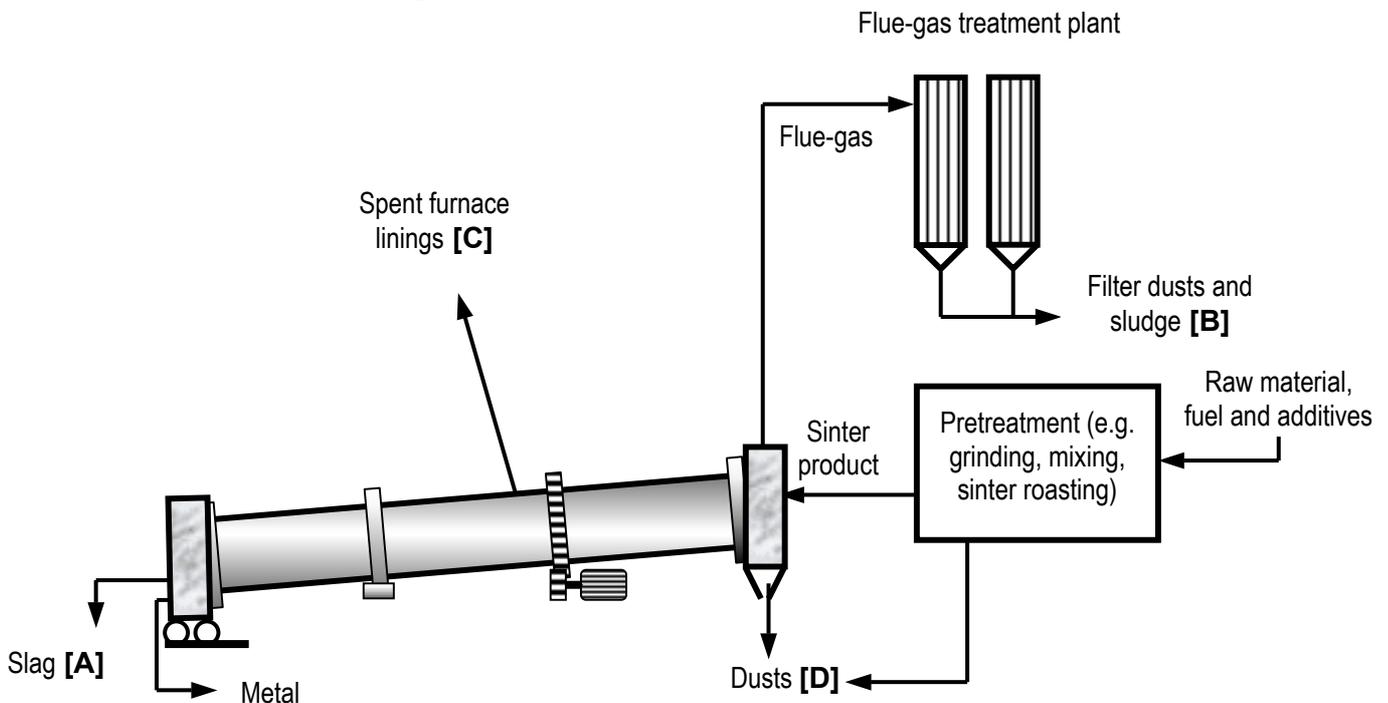
During pyro-metallurgical refining of metals, impurities dissolved in the base metal become concentrated in an almost insoluble phase. This can be achieved through variations in pressure and temperature (distillation process) in refining towers or by the addition of reagents and in some cases oxygen, for example in converters (chemical process), or through a combination of both methods. In some cases metal refining following the milling process is carried out pyro-metallurgically using pyro-metallurgical electrolysis.

The diagram of a converter in subchapter 10 02 (iron and the steel industry), paragraph 1.3 can, in principle, be applied to non-ferrous metallurgical processes as far as waste arising from refining processes (**slag, dross, skimmings [A], filter dusts and sludges [B]**) is concerned. Smelting furnaces as well as converters are internally fully lined with different fireproof materials. These undergo mechanical, chemical and thermal wear and tear and must therefore be regularly replenished or replaced. This results in **spent furnace linings [C]**.

By adjusting the electrical current during pyro-metallurgical electrolysis, impurities, contained in the metal (anode) and that are more precious than the main metal, are not dissolved at the anode but are separated out as anode sludge, while the main metal is dissolved at the anode. Correspondingly, the opposite is true for the separation of non-precious metals at the cathode. This results in waste from **pyro-metallurgical electrolysis [F]**.



**Fig. 3:** Simplified process diagram of a non-ferrous metal reduction shaft furnace and the resulting waste



**Fig. 4:** Simplified process diagram of a rotary kiln with resulting waste

#### 1.4 Lead production

The most common input material for lead extraction is sulphide lead concentrate, which is obtained from lead ore after metal enrichment processes (as a rule flotation). Lead can be extracted in one of three pyro-metallurgical ways: the most commonly used roast reduction process, the roast reaction process which is only used for minimal impurity content (e.g. zinc and silicic acid), and precipitation method that is occasionally used as a smelting process for accumulator scrap.

The roast reduction process is suitable for all lead ore and concentrate, especially impure material with a high zinc and copper content. As a rule, used or waste material containing lead is processed in this way. In the roast reduction process, sulphides are completely roasted and the oxides formed are then reduced to metal - copper, tin, arsenic, antimony, silver and bismuth, as well as impure raw lead, so-called work lead. As a rule, these accompanying metals are removed using pyro-metallurgical refining, finally resulting in the production of lead-free metal. Sometimes, arsenic is separated and discarded as **calcium arsenic [G]**. The lead produced is a commercial product.

The so-called imperial smelting process enables the simultaneous extraction of zinc and lead in shaft furnaces in one working process and is especially suitable for processing lead-zinc concentrates. As this deals with a zinc extraction process in which lead is also extracted, see paragraph 1.5.

In secondary lead metallurgy, waste containing lead (e.g. accumulators, projectile capture sand, cables) are smelted by reduction resulting in impure raw lead which is then freed of its impurities in a refinery. Also in other secondary metallurgical processes, lead is extracted as a by-product from waste containing lead.

#### 1.5 Zinc production

Similar to lead ore, zinc ore occurs mainly as sulphide which, after metal enrichment processes (as a rule flotation) exists as sulphurous zinc blende concentrate. Subsequent enrichment processes, specially for oxide ores low in zinc, slag and flue-gas dust, the so-called revolve process (rotary kiln process) and the so-called bessemerice process (converter process) are used.

Zinc blende concentrate, zinc ore and zinc spar are converted into zinc oxide using roasting processes before smelting. In the commonly-used roasting processes, fluidized bed reactors are used for zinc blende concentrate while sinter roasting is used for raw materials containing zinc and lead in the imperial smelting process (in accordance with lead production).

During the reduction of zinc oxide with carbon, zinc vapour is created that is condensed to milling zinc. Zinc dust arises as a by-product. The only pyro-metallurgical zinc extraction process of importance is the imperial smelting process carried out in shaft furnaces. Thereby, both zinc and lead are extracted.

Refining using smelting or distillation follows the smelting process. Liquid zinc is vaporised in indirectly heated retorts at a temperature of 950°C and then condensed to liquid metal. The condensed zinc is sold as cast sheets or blocks, dyestuff (Chinese white) or as zinc dust. Impurities with a higher boiling point (e.g. lead, iron, aluminium, tin and copper) remain in the so-called zinc wash which undergoes a segregate process (separation during solidification of the homogenous zinc wash smelt) and is again distilled.

In a similar refining process, secondary raw material containing zinc (e.g. dusts containing zinc, watertight sludge from flue-gas treatment plants, electroplating works and phosphating plants, as well as zinc dross, skimmings and metal scrap) is processed. The dressing processes used include grinding, drying, mixing with coal and sulphite liquor as binder, and briquetting. The briquettes are autogenously coked and then, at a temperature of 850°C, passed to a muffle furnace where zinc is vaporised in an indirectly heated, gas sealed chamber and then subsequently condensed.

Minerals also present in the ore, such as aluminium, calcium, iron, magnesium, silicon oxide and lead normally remain in the chamber ash during the reduction process. These are further processed to extract the residue metal and produce slag suitable as a building material.

Increasingly zinc is also obtained from return- or tailing material containing zinc. Removing zinc from scrap can be accomplished by heating in a rotary kiln under the effect of acids or alkalis.

## **1.6 Copper production**

Almost 80% of primary copper is obtained from low grade sulphide ore. Only a very small percentage is still smelted from rich oxide ore. About 15% primary copper is currently hydro-metallurgically extracted from low grade oxide ore and lower grade oxide intermediary products (see subchapter 11 02).

Almost all sulphide copper ore or other material containing copper is dressed before milling, because as complex ore it normally contains only a small quantity of copper and, in addition, often contains various metal sulphides together. The only dressing used is flotation.

In some cases, following sulphide ore flotation, roasting is carried out in order to adjust the copper – sulphur balance. If the copper content is high enough, roasting is not necessary.

Milling can be simply described as the separation of copper iron sulphide into three elements, or their oxides; raw copper, iron II oxide slag, and sulphur dioxide. The other, mainly metal, minerals (e.g. aluminium, nickel, zinc, tin, cobalt, alkali alkaline-earth metals, etc.) are only separated in the follow-up refining process in a converter.

Because of the increasing delivery of flotation concentrate, most primary copper finds its way through the so-called ore flame furnace. A newer form of smelting in electro-furnaces is, in principle, a variation of this type of furnace but using a different source of energy. In terms of production waste there are no differences in quality compared to the shaft furnace originally used.

About 40% of copper requirements are met by so-called secondary copper from old and waste copper recycling as well as sludges containing copper from electro-plating processes. This undergoes several stages of milling processes. After a sometimes necessary briquetting process, the input mix including additives (e.g. iron, silicate carriers and chalk) and coke are smelted at temperatures of over 1.200°C. The black copper thus produced has a copper content of 80%. This is enriched to approx. 95% in a converter with the addition of copper alloy scrap. With the addition of old copper, this converter copper is then refined to 99% copper content in anode furnaces and cast into anodes. These are finally processed into copper cathodes in electrolysis. Secondary copper with a higher content of other minerals is processed in other plants to form by-products that can be used in the chemical industry, the metal working industry and in some cases for building.

## **1.7 Silver, gold and platinum production**

Nowadays, silver is rarely extracted from silver ore but as a rule arises as a by-product in the milling of lead and lead/zinc, copper and copper/nickel as well as from gold and tin ore. Return material containing silver, old material and waste products are pyro-metallurgically processed, as a rule, in a lead/silver milling process (shaft furnace).

Raw silver from primary production of metal from ores, and raw silver from recycling processes is pure to about 98 - 99,5%. At this degree of purity, it may contain gold and platinum group metals. Silver refining is carried out exclusively in hydrometallurgical processes (see subchapter 11 02). As a rule, gas or oil heated flame furnaces are used for smelting fine silver. The smelt is poured into iron moulds to form bars.

The extraction of gold is normally carried out using gravity concentration, agglomeration and cyanide processes, followed by thermal processing (smelting to give raw gold). The raw gold contains metal impurities such as silver, copper, lead and iron which are separated using pyro-metallurgical chlorination process.

Gold arises as a by-product in the refining of lead, zinc, copper, silver and platinum as well as during the processing (smelting) of old material containing gold (e.g. process remains, slag, ash, furnace scale and precipitation and emulsion residue from precious metal processing industry) in so-called parting works.

Hydro-chemical methods (e.g. weight separation) are used in the extraction of raw material containing platinum. Concentration processes follow, as a rule using flotation, hydrometallurgical or chemical processes, or even chlorinating roasting. Smelting metallurgical production of platinum is carried out using shaft furnace processes during nickel ore dressing. 70% platinum is obtained following nickel refining electrolysis.

Wet chemical processes are used to a large extent in the recovery of platinum metal from secondary material. Lead shaft furnaces are sometimes used in processing slag, ash, dust, etc. containing platinum.

## **1.8 Nickel-, Magnesium- and tin production**

As with other non-ferrous metals, nickel ore exists as a sulphide and has to be concentrated (as a rule using flotation). In principle, pyro-metallurgical processing of nickel concentrate follows the basic operations which have already been described, i.e. roasting, smelting and converting. As a rule, roasting takes place in sintering plants or fluidized bed reactors. For the smelting process, flame furnaces, electro furnaces and flash smelting furnaces are currently used; nowadays rotary kilns, based on oxygen smelting, are also used. In the second smelting stage, conversion, almost all the iron sulphide is completely removed as slag from the liquid, so-called first raw matte, by oxidation and as a rule recycled to the smelting process in order to recover nickel and copper contained in it. The so-called nickel stone from the converter is, to a large extent, a smelt of nickel, copper and sulphur. Refining of nickel is carried out using hydro-metallurgical processes. Thereby, the other mineral metals present (precious metals, Cu, Co, etc) are extracted in a marketable pure form.

In secondary metallurgy, drying and pyro-metallurgical milling is carried out in a so-called nickel stone to concentrate the nickel, copper and cobalt content. Further processing of the nickel stone is carried out using hydrometallurgical processes.

Magnesium only exists in a compound because of its natural reactive properties. The silico-thermal reduction of magnesium oxide, usually in sealed furnaces under vacuum, is the pyro-metallurgical method used to extract magnesium. Magnesium produced in this way contains magnesium oxide, nitride and other oxide components. Refining is carried out in special refinery furnaces while using refining salts (alkali and alkaline-earth chloride and fluoride). The salts prevent the oxidation of burning of magnesium during smelting, cover the metal during pouring and absorb impurities (e.g. salts and oxide) during stirring.

As a rule, the processing of tin ore is carried out using gravimetric sorting processes because flotation, which is normally used in non-ferrous metal production, isn't effective for tin ore. Dressing, for example pyro-metallurgical enrichment of low grade raw material as well as roasting with or without additives, is necessary for the actual reduction which is carried out as a rule in flame-, rotary- or electric furnaces. Refining of raw tin can be carried out pyro-metallurgically, whereby iron, copper, nickel, lead, zinc, aluminium, etc. are separated out as by-products.

Old material containing tin, such as slag, ash, scrap (e.g. tinplate) etc., is smelted in several milling stages within secondary copper metallurgy and processed in other plants as a by-product.

## 2 Waste

### 2.1 Slag and dross from smelting and refining processes [A]

Floating slag from smelting processes (milling and refining) is creamed off metal baths. The main components of slag are non-ferrous metal oxides as well as calcium and silicon oxide from the milling of ore. In addition, it may contain metallic iron or, from secondary metallurgical processes, smelted alloy.

Slag, metallic oxide and other components which arise in addition to the smelt in smelting furnaces and converters are also known as dross and skimmings. They are created from the oxidation of the smelt with air or furnace atmosphere and solids contained in the smelt. If smelting salts have been added (e.g. magnesium production), salt slag is also present. Dross is heterogeneous and has to be dressed before it can be used. The composition and properties of the dross can be affected by additives. The metal content of the dross depends on the smelted alloy and as a rule it is higher than 10%.

#### Classification of waste in accordance with EWL:

From lead production:

10 04 01\* slags from primary and secondary production

10 04 02\* dross and skimmings from primary and secondary production

From zinc production :

10 05 01 slags from primary and secondary production

10 05 10\* dross and skimmings that are flammable or emit, upon contact with water, flammable gases in dangerous quantities

10 05 11 dross and skimmings other than those mentioned in 10 05 10

From copper production:

- 10 06 01 slags from primary and secondary production
- 10 06 02 dross and skimmings from primary and secondary production

From precious metal production:

- 10 07 01 slags from primary and secondary production
- 10 07 02 dross and skimmings from primary and secondary production

From magnesium production:

- 10 08 08\* salt slag from primary and secondary production
- 10 08 10\* dross and skimmings that are flammable or emit, upon contact with water, flammable gases in dangerous quantities

From nickel and tin production:

- 10 08 09 other slags
- 10 08 11 dross and skimmings other than those mentioned in 10 08 10

Notes on recycling, utilization and disposal:

As a rule returned to the smelting process. Slag containing metal which is not commercially viable can in some cases be used by the building industry.

Otherwise, disposal to HWL, in some cases UGL. If it does not contain dangerous substances, together with municipal waste or disposal to inert material landfill.

10 05 10\* and 10 08 10\*: Disposal of especially reactive dross and skimmings using chemical physical treatment plants (CPT) with chemical reaction or inactivation processes, making a subsequent disposal of the waste possible.

## **2.2 Waste from flue-gas treatment [B]**

Mineral waste from flue-gas treatment arises during non-ferrous metal production from sinter, smelting and refining processes and is present as dust or sludge, depending on whether wet or dry separation has been used. Furnace dusts contain incineration residue from the milling process and, if several processes are operating simultaneously, it should be separated into specific metals in order to optimise the utilization of metal components. Equally, sludges from wet separation of flue-gas and gas should be separated into specific metals.

As a rule, flue-gas from sintering plants contains 60-70% of the main metal, about 10% sulphur, as well as differing quantities of various accompanying metals..

Classification of waste in accordance with EWL:

From lead production:

- 10 04 06\* solid wastes from gas treatment
- 10 04 07\* sludges and filter cakes from gas treatment

From zinc production:

- 10 05 05\* solid wastes from gas treatment
- 10 05 06\* sludges and filter cakes from gas treatment

From copper production:

- 10 06 06\* solid wastes from gas treatment
- 10 06 07\* sludges and filter cakes from gas treatment

From precious metal production:

- 10 07 03 solid wastes from gas treatment
- 10 07 05 sludges and filter cakes from gas treatment

From nickel, magnesium and tin production:

- 10 08 17\* sludges and filter cakes from flue-gas treatment containing dangerous substances
- 10 08 18 sludges and filter cakes from flue-gas treatment other than those mentioned in 10 08 17

#### Notes on recycling, utilization and disposal:

Flue-gas from sintering is, as a rule, returned to the sinter mix as returns.

Otherwise, as a rule, return to the smelting process. If it contains metal which is not commercially viable disposal to HWL, in some cases UGL; if it does not contain dangerous substances together with municipal waste.

### **2.3 Spent furnace linings [C]**

Spent linings from smelting furnaces and converters arise during removal of fireproof linings which have to be renewed regularly and during the removal of burnt-on material. Fireproof linings are made of high temperature resistant mineral or ceramic materials and are either basic, acidic or neutral. Basic linings contain mainly metal oxide such as magnesite, chrome magnesite, chromite, dolomite or limestone. Acid linings contain mainly quartz. Neutral linings contain mainly aluminium oxide with silicon oxide. Other components are carbon, graphite and silicon carbide.

#### Classification of waste in accordance with EWL:

- 16 11 01\* carbon-based linings and refractories from metallurgical processes containing dangerous substances (exception)
- 16 11 02 carbon-based linings and refractories from metallurgical processes other than those mentioned in 16 11 01
- 16 11 03\* other linings and refractories from metallurgical processes containing dangerous substances (exception)
- 16 11 04 other linings and refractories from metallurgical processes other than those mentioned in 16 11 03 (rule)

#### Notes on recycling, utilization and disposal:

Burnt-on material removed from furnaces and ladles can be returned to the smelting process as scrap once it has been separated.

16 11 01\*: thermal treatment in HWI.

16 11 02: incineration, in some cases together with municipal waste.

10 11 03\* and 10 11 04: material use in the building industry.

Otherwise, disposal to HWL, if it does not contain dangerous substances together with municipal waste.

## **2.4 Dusts [D]**

During both primary and secondary metallurgy, dusts produced during raw material dressing (crushing, grinding, shredding, sieving, etc.) are, as a rule, collected dry in filter plants. Other dusts arise, for example, in the form of sweepings. The dusts contain the components of the processed material, normally as mineral compounds and, in some cases, contain heavy metals.

### Classification of waste in accordance with EWL:

From lead production:

- 10 04 04\* flue-gas dust
- 10 04 05\* other particulates and dust

From zinc production:

- 10 05 03\* flue-gas dust
- 10 05 04 other particulates and dust

From copper production:

- 10 06 03\* flue-gas dust
- 10 06 04 other particulates and dust

From precious metal production:

- 10 07 04 other particulates and dust

From nickel, magnesium and tin production:

- 10 08 04 other particulates and dust
- 10 08 15\* flue-gas dust containing dangerous substances
- 10 08 16 flue-gas dust other than those mentioned in 10 08 15

### Notes on recycling, utilization and disposal:

As a rule, return to the dressing process.

Otherwise, disposal to HWL, in some cases UGL. If it does not contain dangerous substances together with municipal waste.

## **2.5 Sludges from cooling water treatment [E]**

Cooling water used to cool smelting aggregates is normally circulated. Filter residue and sludge arises from the preparation of raw water (e.g. removal of solids, decalcification) as well as from the treatment of circulating water (removal of impurities). If the cooling water is exposed to surface cooling, it is often laden with oil and other lubricants which are separated in an oil separator.

### Classification of waste in accordance with EWL:

From lead production:

- 10 04 09\* wastes from cooling-water treatment containing oil

10 04 10 wastes from cooling-water treatment other than those mentioned in  
10 04 09

From zinc production:

10 05 08\* wastes from cooling-water treatment containing oil

10 05 09 wastes from cooling-water treatment other than those mentioned in  
10 05 08

From copper production:

10 06 09\* wastes from cooling-water treatment containing oil

10 06 10 wastes from cooling-water treatment other than those mentioned in  
10 06 09

From precious metal production:

10 07 07\* wastes from cooling-water treatment containing oil

10 07 08 wastes from cooling-water treatment other than those mentioned in  
10 07 07

From nickel, magnesium and tin production:

10 08 19\* wastes from cooling-water treatment containing oil

10 08 20 wastes from cooling-water treatment other than those mentioned in  
10 08 19

#### Notes on recycling, utilization and disposal:

At present there are no known viable treatment processes.

If there is a high organic content, incineration, otherwise disposal to landfill. If it does not contain dangerous substances, together with municipal waste.

### **2.6 Waste from pyro-metallurgical electrolysis [F]**

For pyro-metallurgical electrolysis with the cathode at the bottom of the cell, bricked trough formed cells which are lined with fireclay are used. The cell bottom is lined with charcoal or carbon mass (tar) which provide a large electrically conductive surface area to the cathode. Tar and other carbon-containing wastes, which contain other metals from refining, arise. Anode scrap originates from the isolated anode sludge and mainly contains metal compounds from refining.

#### Classification of waste in accordance with EWL:

10 08 12\* tar-containing wastes from anode manufacture

10 08 13 carbon-containing wastes from anode manufacture other than those  
mentioned in 10 08 12

10 08 14 anode scrap

#### Notes on recycling, utilization and disposal:

10 08 12\* and 10 08 13: Incineration in HWI; if it does not contain dangerous substances, together with municipal waste. Incineration residue can in some cases be returned to pyro-metallurgical dressing.

10 08 14: As a rule, return to the smelting process.

## 2.7 Calcium arsenate [G]

Calcium arsenate arises from precipitation of arsenic during pyro-metallurgical mill lead refining.

Classification of waste in accordance with EWL:

10 04 03\* calcium arsenate

Notes on recycling, utilization and disposal:

At present there are no known viable treatment processes.

Disposal to HWL, in some cases UGL.

## 3 Overview of waste classification - material flow

Extract from EWL	Material flow	Treatment
<b>10 04 wastes from lead thermal metallurgy</b>		
10 04 01* slags from primary and secondary production	A	1) material use, 2) HWL, UGL
10 04 02* dross and skimmings from primary and secondary production	A	1) material use, 2) HWL, UGL
10 04 03* calcium arsenate	G	HWL, UGL
10 04 04* flue-gas dust	D	1) material use, 2) HWL, UGL
10 04 05* other particulates and dust	D	1) material use, 2) HWL, UGL
10 04 06* solid wastes from gas treatment	B	1) material use, 2) HWL, UGL
10 04 07* sludges and filter cakes from gas treatment	B	1) material use, 2) HWL, UGL
10 04 09* wastes from cooling-water treatment containing oil	E	1) incineration, 2) HWI
10 04 10 waste from cooling-water treatment other than those mentioned in 10 04 09	E	with municipal waste
10 04 99 wastes not otherwise specified	not normally required	

<b>10 05 wastes from zinc thermal metallurgy</b>		
10 05 01 slags from primary and secondary production	A	1) material use, 2) inert waste landfill, 3) with municipal waste
10 05 03* flue-gas dust	D	1) material use, 2) HWL, UGL

10 05 04	other particulates and dust	D	1) material use, 2) inert waste landfill, 3) with municipal waste
10 05 05*	solid waste from gas treatment	B	1) material use, 2) HWL, UGL
10 05 06*	sludges and filter cakes from gas treatment	B	1) material use, 2) HWL, UGL
10 05 08*	wastes from cooling-water treatment containing oil	E	1) incineration, 2) HWI
10 05 09	wastes from cooling-water treatment other than those mentioned in 10 05 08	E	with municipal waste
10 05 10*	dross and skimmings that are flammable or emit, upon contact with water, flammable gases in dangerous quantities	A	1) material use, 2) CPT
10 05 11	dross and skimmings other than those mentioned in 10 05 10	A	1) material use, 2) inert waste landfill, 3) with municipal waste
10 05 99	wastes not otherwise specified	not normally required	

<b>10 06</b>	<b>wastes from copper thermal metallurgy</b>		
10 06 01	slags from primary and secondary production	A	1) material use, 2) inert waste landfill, 3) with municipal waste
10 06 02	dross and skimmings from primary and secondary production	A	1) material use, 2) inert waste landfill, 3) with municipal waste
10 06 03*	flue-gas dust	D	1) material use, 2) HWL, UGL
10 06 04	other particulates and dust	D	1) material use, 2) with municipal waste
10 06 06*	solid wastes from gas treatment	B	1) material use, 2) HWL, UGL
10 06 07*	sludges and filter cakes from gas treatment	B	1) material use, 2) HWL, UGL
10 06 09*	wastes from cooling-water treatment containing oil	E	1) incineration, 2) HWI

10 06 10	waste from cooling-water treatment other than those mentioned in 10 06 09	E	with municipal waste
10 06 99	wastes not otherwise specified	not normally required	

<b>10 07</b>	<b>wastes from silver, gold and platinum thermal metallurgy</b>		
10 07 01	slags from primary and secondary production	A	material use
10 07 02	dross and skimmings from primary and secondary production	A	material use
10 07 03	solid wastes from gas treatment	B	1) material use, 2) with municipal waste
10 07 04	other particulates and dust	D	1) material use, 2) with municipal waste
10 07 05	sludges and filter cakes from gas treatment	B	1) material use, 2) with municipal waste
10 07 07*	wastes from cooling-water treatment containing oil	E	1) incineration, 2) HWI
10 07 08	wastes from cooling-water treatment other than those mentioned in 10 07 07	E	with municipal waste
10 07 99	wastes not otherwise specified	not normally required	

<b>10 08</b>	<b>wastes from other non-ferrous thermal metallurgy</b>		
10 08 04	particulates and dust	D	1) material use, 2) with municipal waste
10 08 08*	salt slag from primary and secondary production	A	1) material use, 2) HWL, UGL
10 08 09	other slags	A	1) material use, 2) inert waste landfill, 3) with municipal waste
10 08 10*	dross and skimming that are flammable or emit, upon the contact with water, flammable gases in dangerous quantities	A	1) material use, 2) CPT
10 08 11	dross and skimmings other than those mentioned in 10 08 10	A	1) material use, 2) with municipal waste

10 08 12*	tar-containing waste from anode manufacture	F	HWI
10 08 13	carbon-containing wastes from anode manufacture other than those mentioned in 10 08 12	F	1) incineration, 2) with municipal waste
10 08 14	anode scrap	F	recycling
10 08 15*	flue-gas dust containing dangerous substances	D	1) material use, 2) HWL, UGL
10 08 16	flue-gas dust other than those mentioned in 10 08 15	D	1) material use, 2) with municipal waste
10 08 17*	sludges and filter cakes from flue-gas treatment containing dangerous substances	B	1) material use, 2) HWL, UGL
10 08 18	sludges and filter cakes from flue-gas treatment other than those mentioned in 10 08 17	B	1) material use, 2) with municipal waste
10 08 19*	wastes from cooling-water treatment containing oil	E	1) incineration, 2) HWI
10 08 20	wastes from cooling-water treatment other than those mentioned in 10 08 19	E	with municipal waste
10 08 99	wastes not otherwise specified	not normally required	

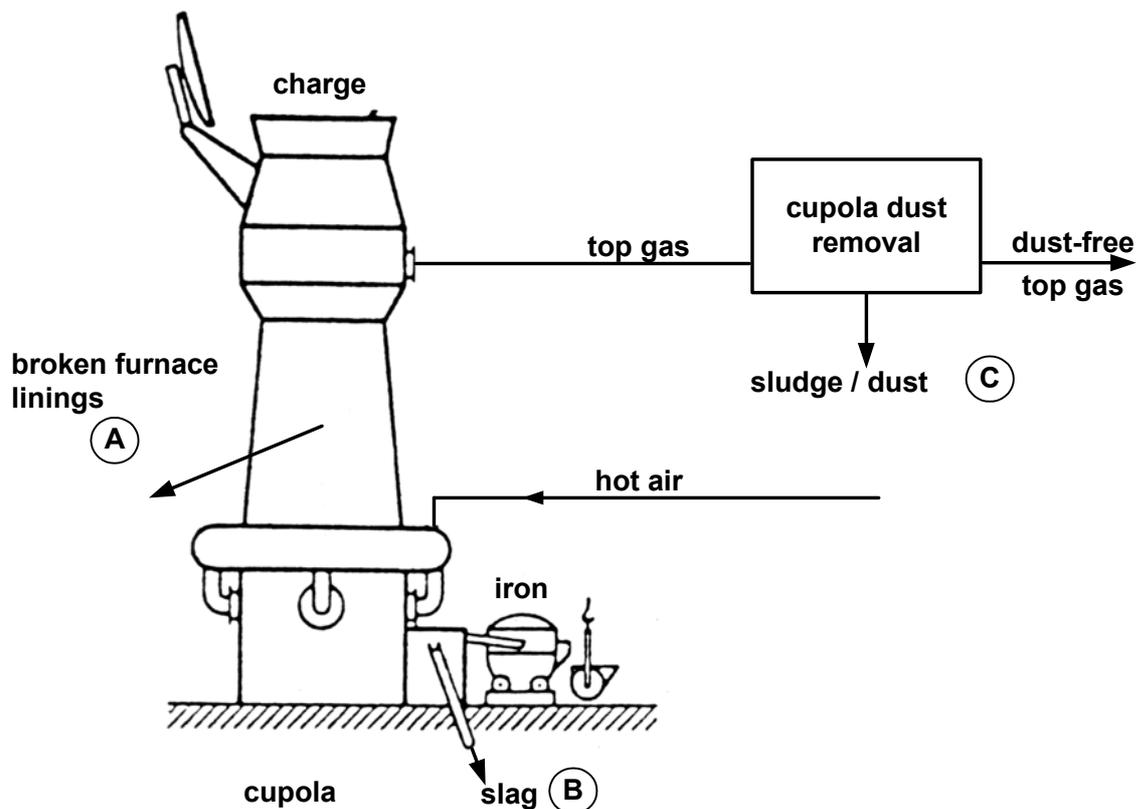
<b>wastes from non-ferrous thermal metallurgy to be classified under other waste categories</b>			
16 11 01*	carbon-based linings and refractories from metallurgical processes containing dangerous substances	C	HWI
16 11 02	carbon-based linings and refractories from metallurgical processes other than those mentioned in 16 11 01	C	1) incineration, 2) with municipal waste
16 11 03*	other linings and refractories from metallurgical processes containing dangerous substances	C	1) material use, 2) HWL, UGL
16 11 04	other linings and refractories from metallurgical processes other than those mentioned in 16 11 03	C	1) material use, 2) with municipal waste

## 10 09 Wastes from casting of ferrous pieces

<b>1</b>	<b>Processes</b> .....	<b>1</b>
1.1	<i>Smelting</i> .....	1
1.2	<i>Casting</i> .....	2
1.3	<i>Fettling, testing</i> .....	3
<b>2</b>	<b>Waste</b> .....	<b>3</b>
2.1	<i>moulds and casting cores which have not undergone pouring [D], binder remains [J]</i> .....	3
2.2	<i>Moulds and casting sand which have undergone pouring [E]</i> .....	4
2.3	<i>Fettling and shotblasting sand [I] and dust [C]</i> .....	5
2.4	<i>Spent crack-indicating agent [K]</i> .....	6
2.5	<i>Mineral waste from smelting</i> .....	6
<b>3</b>	<b>Overview of waste classification – material flow</b> .....	<b>9</b>

### 1 Processes

#### 1.1 Smelting

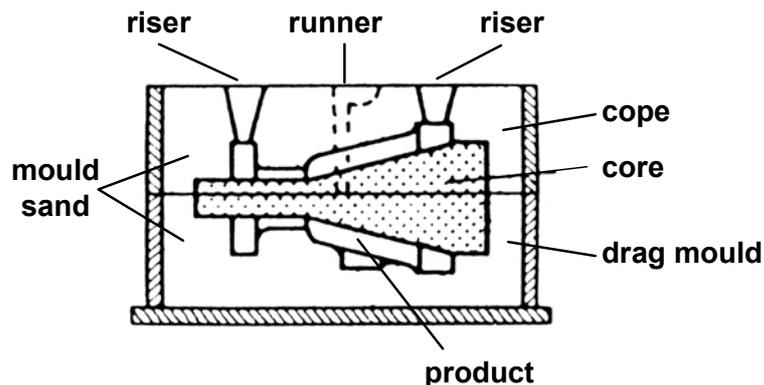


**Fig 1:** Smelting process (simplified representation) with cupola as example

In iron and steel foundries, iron metal is smelted in furnaces and the molten metal cast into a defined shape. The smelting equipment most commonly used is coke operated cupola or induction furnaces. In addition to the smelting furnaces, electric-arc furnaces as well as converters may be in use.

## 1.2 Casting

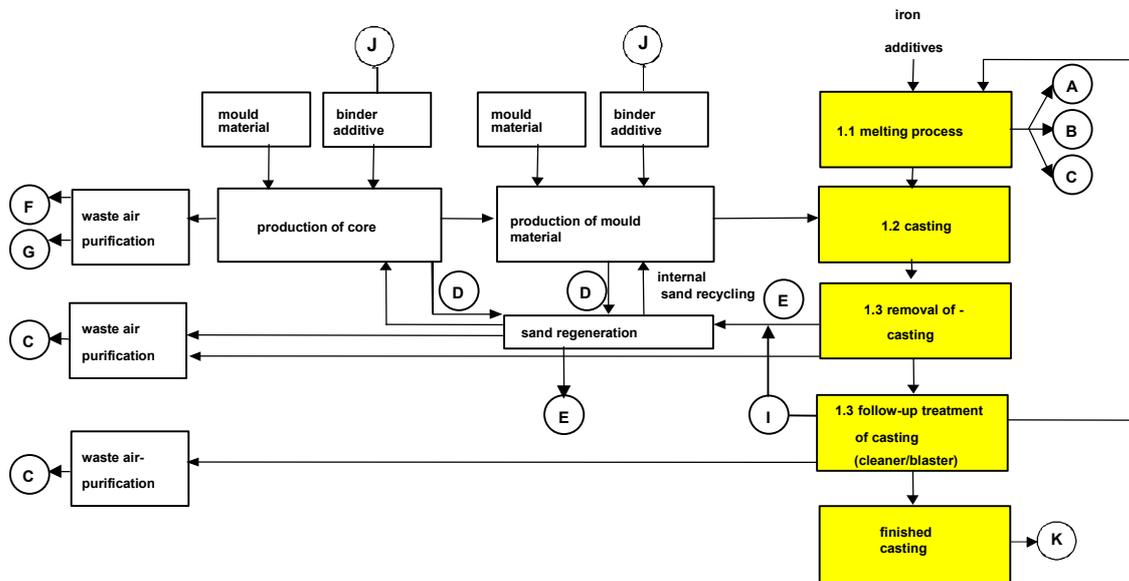
For the production of iron, steel and tempered casts, sand casting is predominantly used. This can be carried out, for example, by hand, machine or shell moulding, or lost foam, fine or vacuum casting. Figure 2 shows a mould ready for casting. For sand casting, a mixture of new unused sand, eg quartz sand, previously cast sand, binders (inorganic or organic), and in some cases other additives such as lustrous carbon are combined to produce a mould of the model which will take the molten metal. In most types of casting, it is necessary to fill the hollow cavities with mould pieces, called cores. Core sand is also a mixture of new unused sand, recycled sand and a mainly synthetic binder. After the metal has been cast and cooled in the moulds, the castings are removed and the sand moulds and cores become waste.



**Figure 2:** Mould ready for casting

The sand from casting, spent casting sand, is a mixture of core and mould sand. After reprocessing/regeneration (mould sand recycling) it is reused in the production of moulds. Some of the old sand, mainly fine sand with a high concentration of the smallest grains, is removed from the recycling process.

Figure 3 shows the whole casting process including the smelting process and the finishing of the castings.



**Figure 3:** Casting process using sand casting and mineral waste from ferrous metal casting foundries

### 1.3 Fettling, testing

After casting, the castings are cleaned of casting sand remains and fines of metal in the **fettling shop** by shot-blasting or grinding. For this process, mainly steel abrasive or wire shot are used and, as a result, dusts and sand are produced.

Following this, several quality tests are carried out on the finished pieces. Of particular importance is the testing for surface cracks which is carried out, for example, using a dye-penetration process.

## 2 Waste

### 2.1 Moulds and casting cores which have not undergone pouring [D], binder remains [J]

**Casting moulds and sand which have not undergone pouring [D]** (casting moulds and sand which have not undergone casting or been subjected to high temperatures) arise from production of moulds (overflow sand) or mould failures. They contain new sand, recycled sand from production moulds and cores, unhardened binder and in some cases other additives.

It is suggested that in accordance with H14 the values in the following table are used as criteria to distinguish between the two waste categories.

Classification of sand containing organic binders which has not been cast	Phenol
containing dangerous substances	eluate > 50 mg/l
without dangerous substances	eluate ≤ 50 mg/l

**Table 1:** Guidelines for classification of casting moulds and sands which have not undergone pouring

In addition, **binder remains [J]** may arise as waste.

Classification of waste in accordance with EWL:

- 10 09 05\* casting cores and moulds which have not undergone pouring containing dangerous substances
- 10 09 06 casting cores and moulds which have not undergone pouring other than those mentioned in 10 09 05
- 10 09 13\* waste binders containing dangerous substances (*rule for organic binders*)
- 10 09 14 waste binders other than those mentioned in 10 09 13 (*rule for inorganic binders*)

Notes on recycling, utilization and disposal:

- 10 09 05\*/
- 10 09 06: Treatment in sand regeneration plants and re-use as casting sand or material use in cement works.  
Otherwise disposal to HWL. If it does not contain dangerous substances, together with municipal waste.
- 10 09 13\*/
- 10 09 14: At present there are no known viable treatment processes.  
Incineration in HWI. If it does not contain dangerous substances, together with municipal waste.

## 2.2 Moulds and casting sand which have undergone pouring [E]

**Casting moulds and sand which have undergone pouring [E]** consist of casting sand with mainly inorganic binder (bentonite, cement or silica) as well as cores which have undergone casting containing mainly binder resins. In addition to the used sand, they contain hardened inorganic or organic binder remains, lustrous carbon, coating and in some cases other organic or inorganic additives and perhaps trace metal particles. When the used sand is subjected to high temperature, some of the organic components burn. As a result of pyrolysis through decomposition or reaction of the organic components, substances are produced, eg. polycyclic aromatic hydrocarbons (PAH) or phenol. The amount of organic materials and other additives

depends to a greater extent on the type of binder and sand regeneration/reprocessing used.

Classification of waste in accordance with EWL:

- 10 09 07\* casting cores and moulds which have undergone pouring containing dangerous substances
- 10 09 08 casting cores and moulds which have undergone pouring other than those mentioned in 10 09 07

Notes on recycling, utilization and disposal:

Treatment in sand regeneration plants and re-use as casting sand or material use in cement works.

Otherwise disposal to HWL. If it does not contain dangerous substances, together with municipal waste.

### **2.3 Fettling and shotblasting sand [I] and dust [C]**

In follow-up treatment, the castings are cleaned by grinding and shot-blasting. As a result, grinding and blasting dusts or sludges and blasting sand and fine sand are produced. In addition to the used sand component, **Fettling and shotblasting sand [I]** contains fine grains of blasting material, rubbed off pieces of metal and metal oxide. The classification of fettling and shotblasting sand is the same as for casting moulds and sand which have undergone pouring. This means that the waste flow E and I are comparable. The sucked-up **dusts** (from dry process) **or sludges** (from wet process) **[C]** contain fine particles from the moulds which have been used as well as iron which has been cast. The grinding dusts consist primarily of metal dust and rubbed off grinding material. The metal content can reach more than 50%. This differentiates them clearly from blasting dusts.

Classification of waste in accordance with EWL:

- 10 09 07\* casting cores and moulds which have undergone pouring containing dangerous substances (*exception*)
- 10 09 08 casting cores and moulds which have undergone pouring other than those mentioned in 10 09 07 (*rule*)
- 10 09 09\* flue-gas dust containing dangerous substances (*exception*)
- 10 09 10 flue-gas dust other than those mentioned in 10 09 09 (*rule*)
- 10 02 13\* sludges and filter cakes from gas treatment containing dangerous substances (*exception*)
- 10 02 14 sludges and filter cakes from gas treatment other than those mentioned in 10 02 13 (*rule*)

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Notes on recycling, utilization and disposal:

Material use in cement works.

10 09 10 / 10 09 14: If the metal content is high, processing in secondary metallurgy. Otherwise disposal to HWL. If it does not contain dangerous substances, together with municipal waste.

## **2.4 Spent crack-indicating agent [K]**

During workshop testing for surface cracks using dye-penetration process, waste and excess dyes may arise. Classification is carried out on the basis of the composition of the dye.

Classification of waste in accordance with EWL:

- 10 09 15\* waste crack-indicating agent containing dangerous substances
- 10 09 16 waste crack-indicating agent other than those mentioned in 10 09 15

Notes on recycling, utilization and disposal:

At present there are no known viable treatment processes.

Thermal treatment in HWI. If it does not contain dangerous substances, together with municipal waste.

## **2.5 Mineral waste from smelting**

### **2.5.1 Spent furnace and ladle linings [A]**

Waste linings from furnaces and ladles are produced while breaking up the heat-resistant linings which have to be renewed regularly and while removing baked-on material from furnaces and ladles. Heat-resistant linings are either basic, acidic or neutral. Basic linings contain mainly basic metal oxides such as magnesite, chrome magnesite, chromite, dolomite or limestone. Acidic linings contain mainly quartz while neutral linings contain mainly aluminium oxide with silicon oxide. Heat-resistant mineral or ceramic materials are resistant at high temperatures. Other components of heat-resistant products are carbon, graphite and silicon carbide.

The metal adhering to the broken linings can be recycled as scrap after being separated.

Classification of waste in accordance with EWL:

- 16 11 01\* carbon-based linings and refractories from metallurgical processes containing dangerous substances (*exception*)
- 16 11 02 carbon-based linings and refractories from metallurgical processes other than those mentioned in 16 11 01
- 16 11 03\* other linings and refractories from metallurgical processes containing dangerous substances (*exception*)
- 16 11 04 other linings and refractories from metallurgical processes other than those mentioned in 16 11 03 (*rule*)

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Notes on recycling, utilization and disposal:

At present there are no known viable treatment processes.

16 11 01\*: Thermal treatment in HWL.

16 11 02: Incineration, possibly together with municipal waste

16 11 03\*/

16 11 04: Material use in building and construction industry.

Otherwise disposal to HWL. If it does not contain dangerous substances, together with municipal waste.

### **2.5.2 Furnace slag [B]**

Furnace slag is produced during the smelting process. The quantity produced is strongly affected by the choice of materials used, the type of furnace and the method of production. The main components of cupola and electric furnace slag are oxides of silicon, iron, manganese, calcium, magnesium and aluminium.

Classification of waste in accordance with EWL:

10 09 03 furnace slag

Notes on recycling, utilization and disposal:

Material use in building and construction industry.

Otherwise as a rule disposal to inert waste landfill or together with municipal waste.

### **2.5.3 Dusts and sludges [C]**

As well as fuel ash, cupola dusts contain dust adhering to the raw materials, unburned additives, and mainly iron oxide and other metal oxides. In addition, volatile heavy metals such as zinc, lead or cadmium could be present if they have been introduced in the raw materials. The flue-gas is generally cleaned of flue-gas dusts by fabric filters. Furnace dusts from induction furnaces contain mainly iron oxide, other metal oxides, silicon oxide and pollutants.

Classification of waste in accordance with EWL:

10 09 09\* flue-gas dust containing dangerous substances (*as a rule in blast furnace dusts*)

10 09 10 flue-gas dust other than those mentioned in 10 09 09

Notes on recycling, utilization and disposal:

If the metal content is high (esp. zinc), processing in secondary metallurgy.

Otherwise disposal to UGL or HWL. If it does not contain dangerous substances, together with municipal waste.

Sludges from foundries arise in wet flue-gas treatment. If washers are installed on the furnace, flue-gas sludge is present after drainage. Pelletized

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sludge may be added to the smelting process. Components transfer to the slag. Heavy metals accumulate in the newly formed sludge.

Classification of waste in accordance with EWL:

10 02 13\* sludges and filter cakes from gas treatment containing dangerous substances

10 02 14 sludges and filter cakes from gas treatment other than those mentioned in 10 02 13

Notes on recycling, utilization and disposal:

If the metal content is high (esp. zinc), processing in secondary metallurgy.

Otherwise disposal to HWL. If it does not contain dangerous substances, together with municipal waste.

### 3 Overview of waste classification – material flow

Extract from EWL	Material flow	Treatment
<b>10 09 Waste from casting of ferrous pieces</b>		
10 09 03 furnace slag	B	1) material use, 2) inert waste landfill, 3) with municipal waste
10 09 05* casting cores and moulds which have not undergone pouring containing dangerous substances	D	1) recycling, 2) HWL
10 09 06 casting cores and moulds which have not undergone pouring other than those mentioned in 10 09 05	D	1) recycling, 2) with municipal waste
10 09 07* casting cores and moulds which have undergone pouring containing dangerous substances	E, I	1) recycling, 2) HWL
10 09 08 casting cores and moulds which have undergone pouring other than those mentioned in 10 09 07	E, I	1) recycling, 2) with municipal waste
10 09 09* flue-gas dust containing dangerous substances	C	material use, HWL
10 09 10 flue-gas dust other than those mentioned in 10 09 09	C	1) material use, 2) with municipal waste
10 09 11* other particulates containing dangerous substances	not normally required	
10 09 12 other particulates other than those mentioned in 10 09 11	not normally required	
10 09 13* waste binders containing dangerous substances	J	HWI
10 09 14 waste binders other than those mentioned in 10 09 13	J	With municipal waste
10 09 15* waste crack-indicating agent containing dangerous substances	K	HWI
10 09 16 waste crack-indicating agent other than those mentioned in 10 09 15	K	With municipal waste
10 09 99 waste not otherwise specified	not normally required	

<b>Waste from casting of ferrous pieces, to be classified in other subchapters</b>		
10 02 13*	sludges and filter cakes from gas treatment containing dangerous substances	C 1) material use, 2) HWL
10 02 14	sludges and filter cakes from gas treatment other than those mentioned in 10 02 13	C 1) material use, 2) with municipal waste
16 11 01*	carbon-based linings and refractories from metallurgical processes containing dangerous substances	A HWI
16 11 02	carbon-based linings and refractories from metallurgical processes other than those mentioned in 16 11 01	A 1) incineration, 2) with municipal waste
16 11 03*	other linings and refractories from metallurgical processes containing dangerous substances	A 1) material use, 2) HWL
16 11 04	other linings and refractories from metallurgical processes other than those mentioned in 16 11 03	A 1) material use, 2) with municipal waste

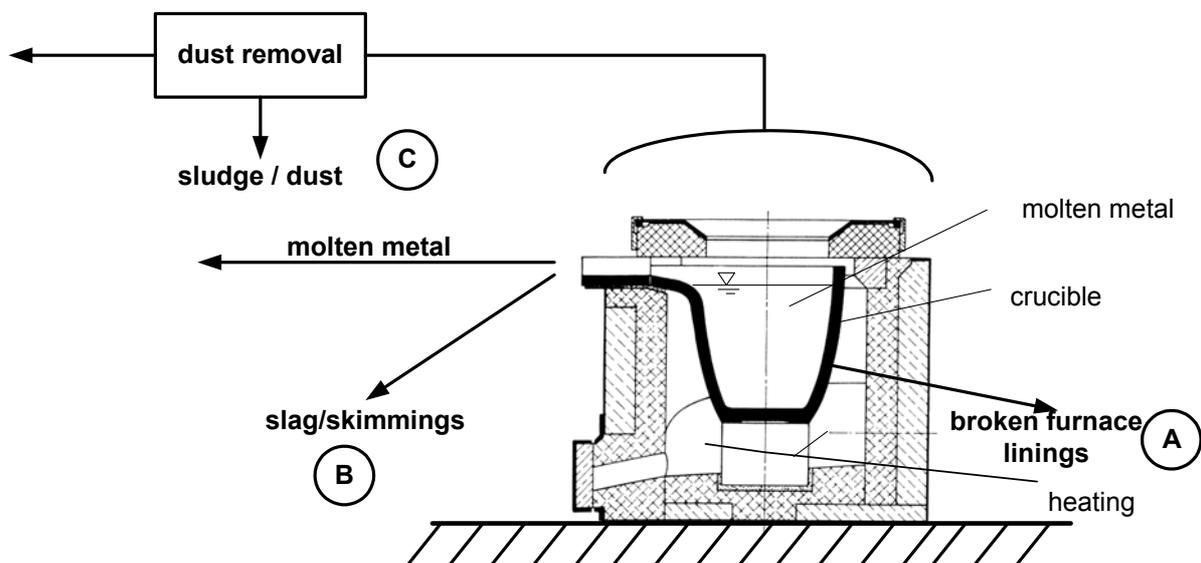
## 10 10 Waste from casting of non-ferrous pieces

<b>1</b>	<b>Processes</b> .....	<b>1</b>
1.1	<i>Smelting</i> .....	1
1.2	<i>Casting</i> .....	2
1.3	<i>Fettling, testing</i> .....	3
<b>2</b>	<b>Waste</b> .....	<b>4</b>
2.1	<i>moulds and casting cores which have not undergone pouring [D], binder remains [J]</i> .....	4
2.2	<i>Moulds and casting sand which have undergone pouring [E]</i> .....	5
2.3	<i>Fettling and shotblasting sand [I] and dust [C]</i> .....	5
2.4	<i>Spent crack-indicating agent [K]</i> .....	6
2.5	<i>Mineral waste from smelting</i> .....	6
<b>3</b>	<b>Overview of waste classification – material flow</b> .....	<b>9</b>

### 1 Processes

#### 1.1 Smelting

In non-ferrous metal foundries, metal is smelted in furnaces and the molten metal cast into a defined shape. Oil or gas fired furnaces as well as induction furnaces are used for smelting. In addition to the smelting furnaces, electric-arc furnaces as well as converters may be in use.

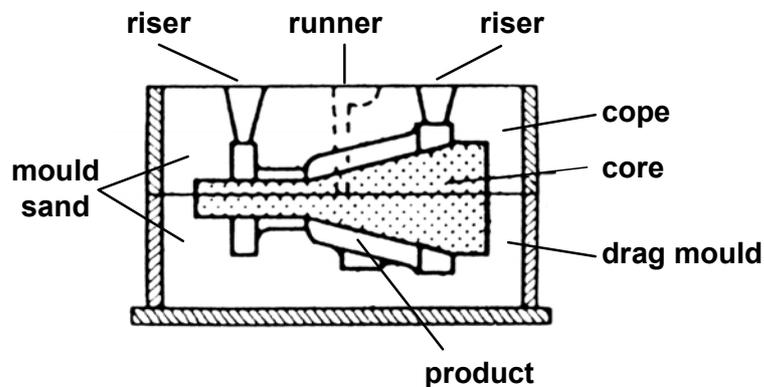


**Figure 1:** smelting process (simplified representation) with fossil-fuel fired crucible furnace as example.

## 1.2 Casting

In the casting of non-ferrous metals, a considerably greater range of processes are employed than by ferrous metal casting. In addition to sand casting, gravity die casting, centrifugal, continuous or pressure die casting are used. In contrast to the lost moulds, dies are preserved when the castings are separated from the dies. In die-casting, metal or sand cores can be employed. The casting process of non-ferrous metals includes the same steps of smelting, casting, removal of castings and follow-up treatment, flue-gas treatment and waste water treatment. If die casting is employed instead of sand casting without using sand cores, there is no process of mould and core production or their associated steps.

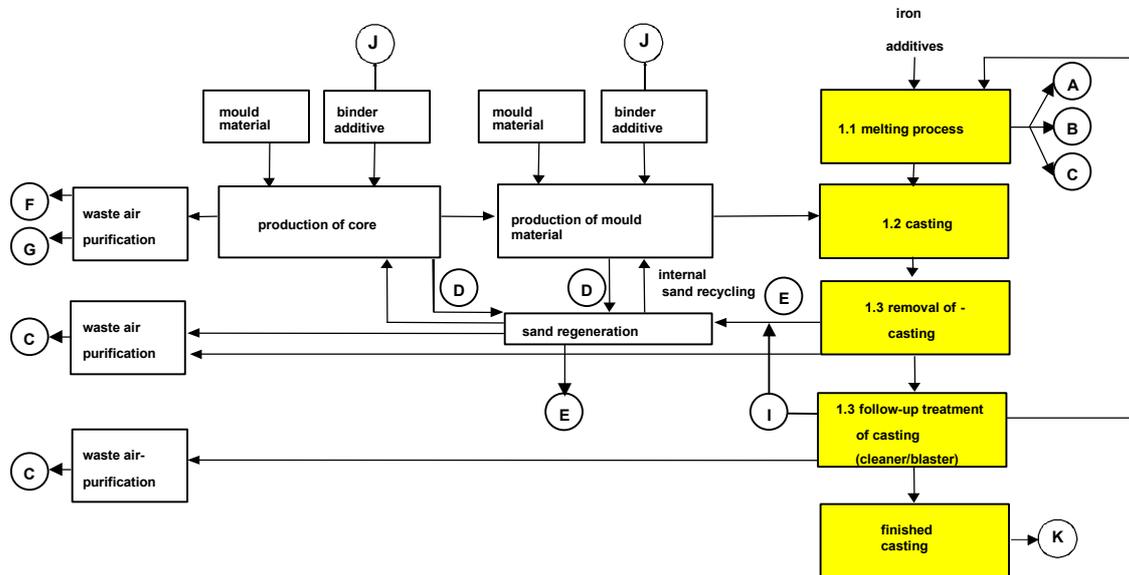
The sand casting process can be carried out, for example, by hand, machine or shell moulding, or lost foam; fine or vacuum casting. For sand casting, a mixture of new unused sand, eg quartz sand, previously cast sand, binders (inorganic or organic), and in some cases other additives are combined to produce a mould of the model which will take the molten metal. In most types of casting, it is necessary to fill the hollow cavities with mould pieces, called cores. Core sand is also a mixture of new unused sand, recycled sand and a mainly synthetic binder. Figure 2 shows a mould ready for casting. After the metal has been cast and cooled in the moulds, the castings are removed and the sand moulds and cores become waste.



**Figure 2:** Mould ready for casting

The sand from casting contains a mixture of core and mould sand. In contrast to iron and steel casting, in non-ferrous metal casting (especially light metal casting), the sand containing organic binders only partially disintegrates so that cores (mainly containing resin binders) and mould sand (mainly containing bentonite binders) which have been poured can be more readily separated. The mould sand which has been poured is again used to make moulds once it has been processed (mould sand recycling). Some of the old sand, mainly fine sand with a high concentration of the smallest grains, is removed from the recycling process. The cores which have been poured are either disposed of, or, following a thermal or mechanical regeneration, used instead of new sand to make cores.

During mould and core production, casting, follow-up treatment of the castings and sand recycling, various flue-gas flows are created which are required to be treated in dry or wet processes. Figure 3 shows the complete casting process including the smelting process and finishing of the castings.



**Figure 3:** Sand casting process and mineral waste from non-ferrous metal casting foundries [1]

### 1.3 Fettling, testing

After casting, the castings are cleaned of casting sand remains and fines of metal in the **fettling shop** by shot-blasting or grinding. For this process, mainly steel abrasive or wire shot are used and, as a result, dusts and sand are produced.

Following this, several quality tests are carried out on the finished pieces. Of particular importance is the testing for surface cracks which is carried out, for example, using a dye-penetration process.

## 2 Waste

### 2.1 Moulds and casting cores which have not undergone pouring [D], binder remains [J]

**Casting moulds and sand which have not undergone pouring [D]** (casting moulds and sand which have not undergone casting or been subjected to high temperatures) arise from production methods (overflow sand) or production failures. They contain new sand, recycled sand from production moulds and cores, unhardened binder and in some cases other additives.

It is suggested that in accordance with H14 the values in the following table are used as criteria to distinguish between the two waste categories.

Classification of sand containing organic binders which has not been cast	Phenol
containing dangerous substances	eluate > 50 mg/l
without dangerous substances	eluate ≤ 50 mg/l

**Table 1:** Guidelines for classification of casting moulds and sands which have not undergone pouring

In addition, **binder remains [J]** may arise as waste.

#### Classification of waste in accordance with EWL:

- 10 10 05\* casting cores and moulds which have not undergone pouring, containing dangerous substances
- 10 10 06 casting cores and moulds which have not undergone pouring, other than those mentioned in 10 10 05
- 10 10 13\* waste binders containing dangerous substances (*rule for organic binders*)
- 10 10 14 waste binders other than those mentioned in 10 10 13 (*rule for inorganic binders*)

#### Notes on recycling, utilization and disposal:

- 10 10 05\*/  
10 10 06: Treatment in sand regeneration plants and re-use as casting sand or material use in cement works.  
Otherwise disposal to HWL. If it does not contain dangerous substances, together with municipal waste.
- 10 10 13\*/  
10 10 14: At present there are no known viable treatment processes.  
Incineration in HWI. If it does not contain dangerous substances, together with municipal waste.

## 2.2 *Moulds and casting sand which have undergone pouring [E]*

**Casting moulds and sand which have undergone pouring [E]** consist of casting sand with mainly inorganic binder (bentonite, cement or silica) as well as cores which have undergone casting containing mainly binder resins. In addition to the used sand, they contain hardened inorganic or organic binder remains, coating, and in some cases other organic or inorganic additives and perhaps trace metal particles. When the sand is subjected to high temperature, some of the organic component burns. As a result of pyrolysis through decomposition or reaction of the organic components, substances are produced, eg. polycyclic aromatic hydrocarbons (PAH) or phenol. The amount of organic materials and other additives depends to a greater extent on the type of binder and regeneration/reprocessing used.

### Classification of waste in accordance with EWL:

- 10 10 07\* casting cores and moulds which have undergone pouring, containing dangerous substances
- 10 10 08 casting cores and moulds which have undergone pouring, other than those mentioned in 10 10 07

### Notes on recycling, utilization and disposal:

Treatment in sand regeneration plants and re-use as casting sand or material use in cement works.

Otherwise disposal to HWL. If it does not contain dangerous substances, together with municipal waste.

## 2.3 *Fettling and shotblasting sand [I] and dust [C]*

In follow-up treatment, the castings are cleaned by grinding and shot-blasting. As a result, grinding and blasting dusts or sludges and blasting sand and fine sand are produced. In addition to the used sand component, **Fettling and shotblasting sand [I]** contains fine grains of blasting material, rubbed off pieces of metal and metal oxide. The classification of fettling and shotblasting sand is the same as for casting moulds and sand which have undergone pouring. This means that the waste flow E and I are comparable. The sucked-up **dusts** (from dry process) **or sludges** (from wet process) **[C]** contain fine particles from the moulds which have been used as well as iron which has been cast. The grinding dusts consist primarily of metal dust and rubbed off grinding material. The metal content can reach more than 50%. This differentiates them clearly from blasting dusts.

In addition, non-ferrous filings and bits arise during work on castings. Especially during work on aluminium pieces aluminium dust is produced. This specific waste has to be separated and recycled.

Classification of waste in accordance with EWL:

- 10 10 07\* casting cores and moulds which have undergone pouring, containing dangerous substances (*exception*)
- 10 10 08 casting cores and moulds which have undergone pouring, other than those mentioned in 10 10 07 (*rule*)
- 10 10 09\* flue-gas dust containing dangerous substances
- 10 10 10 flue-gas dust other than those mentioned in 10 10 09 (*rule*)
- 10 03 25\* sludges and filter cakes from gas treatment containing dangerous substances
- 10 03 26 sludges and filter cakes from gas treatment other than those mentioned in 10 03 25

Notes on recycling, utilization and disposal:

Material use in cement works.

10 10 10 / 10 03 26: If the metal content is high, processing in secondary non ferrous metallurgy.

Otherwise disposal to HWL. If it does not contain dangerous substances, together with municipal waste.

## **2.4 Spent crack-indicating agent [K]**

During workshop testing for surface cracks using dye-penetration process, waste and excess dyes may arise. Classification is carried out on the basis of the composition of the dye.

Classification of waste in accordance with EWL:

- 10 10 15\* waste crack-indicating agent containing dangerous substances
- 10 10 16 waste crack-indicating agent other than those mentioned in 10 10 15

Notes on recycling, utilization and disposal:

At present there are no known viable treatment processes.

Thermal treatment in HWI. If it does not contain dangerous substances, together with municipal waste.

## **2.5 Mineral waste from smelting**

### **2.5.1 Spent furnace and ladle linings [A]**

Waste linings from furnaces and ladles are produced while breaking up the heat-resistant linings which have to be renewed regularly and while removing baked-on material from furnaces and ladles. Heat-resistant linings are either basic, acidic or neutral. Basic linings contain mainly basic metal oxides such as magnesite, chrome magnesite, chromite, dolomite or limestone. Acidic linings contain mainly quartz while neutral linings contain mainly aluminium oxide with silicon oxide. Heat-resistant

mineral or ceramic materials are resistant at high temperatures. Other components of heat-resistant products are carbon, graphite and silicon carbide.

Classification of waste in accordance with EWL:

- 16 11 01\* carbon-based linings and refractories from metallurgical processes containing dangerous substances
- 16 11 02 carbon-based linings and refractories from metallurgical processes other than those mentioned in 16 11 01
- 16 11 03\* other linings and refractories from metallurgical processes containing dangerous substances
- 16 11 04 other linings and refractories from metallurgical processes other than those mentioned in 16 11 03

Notes on recycling, utilization and disposal:

The metal adhering to the broken linings can be recycled as scrap after being separated.

Otherwise, at present there are no known viable treatment processes.

- 16 11 01\*: Thermal treatment in HWI.
- 16 11 02: Incineration, possibly together with municipal waste
- 16 11 03\*/
- 16 11 04: Material use in building and construction industry.  
Otherwise disposal to HWL. If it does not contain dangerous substances, together with municipal waste.

## **2.5.2 Furnace slag/skimmings [B]**

Slag, metal oxide and other components which are produced in the non-ferrous metal smelting plant in addition to the metal products in the smelting furnaces and holding furnaces are known as skimmings. They arise through oxidation of the molten metal with the air or furnace atmosphere and solids contained in the molten metal. If smelting salts are added, salt slag is integrated. Skimmings are heterogeneous and before being used have to be processed. The composition and characteristics of the skimmings can be affected by additives. The metal content of the skimmings is dependent on the molten alloy, and normally more than 10%.

Classification of waste in accordance with EWL:

- 10 10 03 furnace slag
- 10 03 15\* skimmings that are flammable or emit, upon contact with water, flammable gases in dangerous quantities
- 10 03 16 skimmings other than those mentioned in 10 03 15

Notes on recycling, utilization and disposal:

If the non ferrous metal content is high, processing in secondary non ferrous metallurgy.

Otherwise:

- 10 10 03: Disposal to inert waste landfill, or together with municipal waste.
- 10 03 15\*: As a rule disposal to UGL.
- 10 03 16: Disposal to landfill, possibly together with municipal waste.

### **2.5.3 Dusts and sludges [C]**

In the case of non-ferrous metals, mineral wastes from flue-gas treatment are furnace dust, sludges. Furnace dust from non-ferrous metal foundries contains residue from burning which should be separated into specific metals in order to make it easier to recycle. Similarly, sludges from flue-gas treatment in non-ferrous metal foundries should be separated into specific metals.

#### Classification of waste in accordance with EWL:

- 10 10 09\* flue-gas dust containing dangerous substances
- 10 10 10 flue-gas dust other than those mentioned in 10 10 09
- 10 03 25\* sludges and filter cakes from gas treatment containing dangerous substances
- 10 03 26 sludges and filter cakes from gas treatment other than those mentioned in 10 03 25

#### Notes on recycling, utilization and disposal:

If the non ferrous metal content is high, processing in secondary non ferrous metallurgy.

Otherwise disposal to UGL or HWL. If it does not contain dangerous substances, together with municipal waste.

### 3 Overview of waste classification – material flow

Extract from EWL	Material flow	Treatment
<b>10 10 Waste from casting of non-ferrous pieces</b>		
10 10 03 furnace slag	B	1) material use, 2) inert waste landfill, 3) with municipal waste
10 10 05* casting cores and moulds which have not undergone pouring, containing dangerous substances	D	1) recycling, 2) HWL
10 10 06 casting cores and moulds which have not undergone pouring, other than those mentioned in 10 10 05	D	1) recycling 2) with municipal waste
10 10 07* casting cores and moulds which have undergone pouring, containing dangerous substances	E, I	1) recycling, 2) HWL
10 10 08 casting cores and moulds which have undergone pouring, other than those mentioned in 10 10 07	E, I	1) recycling 2) with municipal waste
10 10 09* flue-gas dust containing dangerous substances	C	1) material use, 2) HWL
10 10 10 flue-gas dust other than those mentioned in 10 10 09	C	1) material use, 2) with municipal waste
10 10 11* other particulates containing dangerous substances	not normally required	
10 10 12 other particulates other than those mentioned in 10 10 11	not normally required	
10 10 13* waste binders containing dangerous substances	J	HWI
10 10 14 waste binders other than those mentioned in 10 10 13	J	With municipal waste
10 10 15* waste crack-indicating agent containing dangerous substances	K	HWI
10 10 16 waste crack-indicating agent other than those mentioned in 10 10 15	K	With municipal waste
10 10 99 wastes not otherwise specified	not normally required	

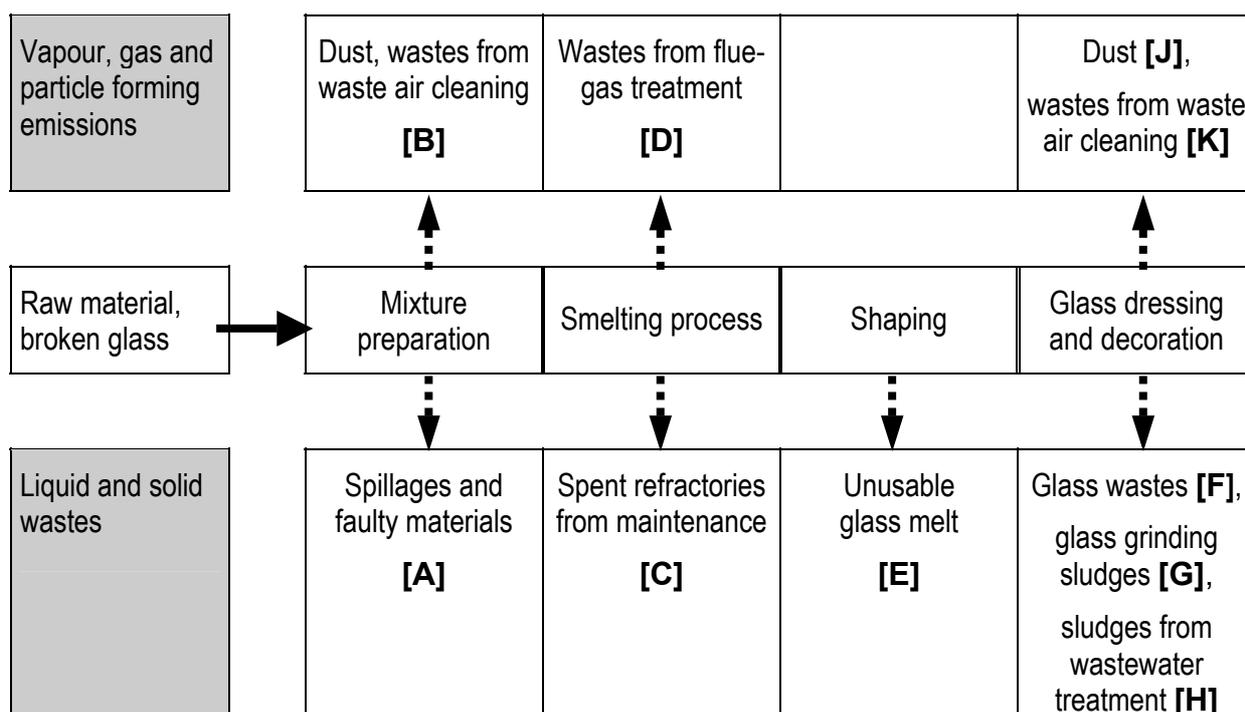
<b>Waste from casting of non-ferrous pieces, to be classified in other subchapters</b>			
10 03 15*	skimmings that are flammable or emit, upon contact with water, flammable gases in dangerous quantities	B	UGL
10 03 16	skimmings other than those mentioned in 10 03 15	B	With municipal waste
10 03 25*	sludges and filter cakes from gas treatment containing dangerous substances	C	1) material use, 2) HWL
10 03 26	sludges and filter cakes from gas treatment other than those mentioned in 10 03 25	C	1) material use, 2) with municipal waste
16 11 01*	carbon-based linings and refractories from metallurgical processes containing dangerous substances	A	HWI
16 11 02	carbon-based linings and refractories from metallurgical processes other than those mentioned in 16 11 01	A	1) incineration, 2) with municipal waste
16 11 03*	other linings and refractories from metallurgical processes containing dangerous substances	A	1) material use, 2) HWL
16 11 04	other linings and refractories from metallurgical processes other than those mentioned in 16 11 03	A	1) material use, 2) with municipal waste

## 10 11 Wastes from manufacture of glass and glass products

<b>1</b>	<b>Process</b> .....	<b>1</b>
<b>2</b>	<b>Wastes</b> .....	<b>2</b>
<b>3</b>	<b>Overview of waste classification – material flow</b> .....	<b>6</b>

### 1 Process

Glass production can be divided into mixture preparation including grinding, measuring and mixing processes, smelting which also includes the purification stage (gas removal from molten glass), homogenisation and standing stage in the furnace, shaping by moulding, rolling, drawing etc. and a final glass dressing and decorative process (fig 1).



**Fig 1:** Schematic representation of glass manufacturing processes and potential wastes and emissions

The main components of the raw materials used are quartz sand, sodium and calcium oxide, with, for example, large quantities (up to 25% weight) of aluminium (in glass fibre), barium (in picture tubes), lead (in lead crystal), potassium (in picture tubes and lead crystal), magnesium (in sheet glass, electric light bulbs and glass fibre) and boric trioxide (in laboratory equipment and glass fibre). Recycled glass, both on-site, production waste glass and foreign glass, plays an important role in the raw materials. The addition of a certain amount of ground glass to the raw material

mixture optimises the smelting process. The amount of recycled glass in the mixture can lie between 20 and 95%.

With the exception of a few special glasses, most types of glass are produced in a continuous smelting process.

## 2 Wastes

### ***Spillages and faulty materials before smelting [A]***

Spillages and faulty materials arise during the mixture preparation before the smelting process. In the process dangerous substances could arise, for example from unglazed lead oxide additives, or be transferred in the recycled glass (e.g. from picture tube recycling).

#### Classification of waste in accordance with EWL:

- 10 11 09\* waste preparation mixture before thermal processing, containing dangerous substances
- 10 11 10 waste preparation mixture before thermal processing, other than those mentioned in 10 11 09

#### Notes on recycling, utilization and disposal:

Spilled raw material and faulty materials resulting from mixture preparation are normally returned to the preparation process.

10 11 09\*: HWL, UGL

10 11 10: Disposing together with municipal waste.

### ***Dusts and wastes from waste air cleaning [B]***

Dusts arising from the mixture preparation are normally collected in filter plants (dry) or returned to the preparation process together with spillages (see above). The potentially dangerous substances correspond to the original mixture.

#### Classification of waste in accordance with EWL:

- 10 11 09\* waste preparation mixture before thermal processing, containing dangerous substances
- 10 11 10 waste preparation mixture before thermal processing, other than those mentioned in 10 11 09

#### Notes on recycling, utilization and disposal:

Dusts resulting from mixture preparation are normally returned to the preparation process.

10 11 09\*: HWL, UGL

10 11 10: Disposing together with municipal waste.

### ***Wastes from maintenance of kilns [C]***

Wastes of refractories from kilns may arise during maintenance and repair. They may contain dangerous substances such as asbestos.

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Classification of waste in accordance with EWL:

- 16 11 05\* linings and refractories from non-metallurgical processes containing dangerous substances
- 16 11 06 linings and refractories from non-metallurgical processes other than those mentioned in 16 11 05

Notes on recycling, utilization and disposal:

Asbestos free wastes from maintenance of kilns are normally used by recycling companies for production of fireproof materials.

16 11 05\*: HWL; for the contact with asbestos containing material on landfills additional regulations have to be followed.

16 11 06: Disposing together with municipal waste.

***Wastes from flue-gas treatment [D]***

Wastes from flue-gas treatment normally arise as solid, filter dusts, which may contain dangerous substances from the smelting process itself as well as particles from the raw material mixture (possibly containing heavy metals).

Classification of waste in accordance with EWL:

- 10 11 15\* solid wastes from flue-gas treatment containing dangerous substances
- 10 11 16 solid wastes from flue-gas treatment other than those mentioned in 10 11 15

Notes on recycling, utilization and disposal:

There are at present no viable treatment processes known.

10 11 15\*: UGL, HWL

10 11 16: Disposing together with municipal waste.

***Unusable glass melt [E]***

Unusable glass melt arises mainly as a result of interruptions during shaping, production disruption or product changes. As a rule, the glass melt is quenched, smashed, and recycled as raw material. There are, however, a number of applications where the direct recycling process is not possible on grounds of quality. The resulting glass waste is normally reused in the preparation process for the production of less sensitive glass products. Glass melt may contain dangerous substances from raw and recycled material.

Classification of waste in accordance with EWL:

- 10 11 11\* waste glass in small particles and glass powder containing heavy metals (for example from cathode ray tubes)
- 10 11 12 waste glass other than those mentioned in 10 11 11

Notes on recycling, utilization and disposal:

Unusable glass melts are normally returned to the preparation process.

10 11 11\*: HWL, UGL

10 11 12: Disposing together with municipal waste.

## **Glass waste [F]**

Glass waste includes, for example, reject products and glass particles from deburring and especially from glass fibre fragments. In principle, during production of glass fibres with a diameter of 5 to 25 µm there is a fragment content of 10 to 25%, depending on the type of shaping process and the diameter of the glass fibres. As a rule, the waste glass is returned directly for reuse as raw material. There are, however, a number of applications, for example glass fibre production or production of valuable, high-quality products such as special glass, where the direct recycling process is not possible on grounds of quality. The resulting glass waste is normally reused in the preparation process for the production of less sensitive glass products. Glass waste may contain dangerous substances as in the case of cathode ray tubes.

### Classification of waste in accordance with EWL:

- 10 11 03 waste glass-based fibrous materials
- 10 11 11\* waste glass in small particles and glass powder containing heavy metals (for example from cathode ray tubes)
- 10 11 12 waste glass other than those mentioned in 10 11 11

### Notes on recycling, utilization and disposal:

Glass wastes are normally returned to the preparation process.

10 11 11\*: UGL, HWL

10 11 12: Disposing together with municipal waste.

## **Glass-polishing and glass-grinding sludges [G]**

Glass-polishing and glass-grinding sludges arise during the treatment of grinding water from mechanical processes. This water is normally in a circulation system. Grinding water treatment is carried out by flocculation at neutral pH. The resulting sludges contain mainly the constituent materials of the used kinds of glass.

Glass grinding sludges may contain dangerous substances corresponding to the raw materials and coatings used as well as contaminants from coolants and lubricants used during grinding. Chemical processing of glass surfaces is carried out using etching mixtures containing hydrofluoric acid and glass etching colorants. Hydrofluoric acid causes serious burns and its vapour is poisonous. The resulting waste containing hydrofluoric acid can be precipitated using calcium hydroxide and is to be classified as hazardous waste.

### Classification of waste in accordance with EWL:

- 06 01 03\* hydrofluoric acid
- 10 11 13\* glass-polishing and –grinding sludge containing dangerous substances
- 10 11 14 glass-polishing and –grinding sludge other than those mentioned in 10 11 13

### Notes on recycling, utilization and disposal:

Sludges from the treatment of grinding water are normally returned to the preparation process.

06 01 03\*: Chemical-physical treatment (CPT) using precipitation/flocculation and filtration processes (see chapter 19 08, par. 2.5) to detoxify, neutralise and separate out the water phase which can then be fed into the sewerage system.

10 11 13\* and 10 11 14: Disposing, without dangerous substances together with municipal waste.

### ***Wastes from on-site wastewater treatment [H]***

Wastewater arises from cooling and quenching processes. To maintain quality, waste from process water filtration is normally not recycled but disposed of. It constitutes only 0.5 to 2% of the solid material throughput and contains mainly glass particles, glass fibres and their binder (glass fibre contains up to 25% water soluble binder), as well as about 50% water. The wastes from wastewater treatment may contain dangerous substances depending on the raw materials and coatings used in the glass production process.

#### Classification of waste in accordance with EWL:

- 10 12 19\* solid wastes from on-site effluent treatment containing dangerous substances
- 10 12 20 solid wastes from on-site effluent treatment other than those mentioned in 10 11 19

#### Notes on recycling, utilization and disposal:

There are at present no viable treatment processes known.

Disposing, without dangerous substances together with municipal waste.

### ***Particulates and dust [J]***

Particulates and dust arise during the final stage in the process, which involves glass dressing and decoration. They contain every raw material in finely dispersed form. The waste category used is for dust fraction, which is not classified as hazardous waste and not arising from waste air cleaning.

#### Classification of waste in accordance with EWL:

- 10 12 05 particulates and dust

#### Notes on recycling, utilization and disposal:

Particulates and dust are normally returned as raw material to the preparation process.

Disposing, as a rule together with municipal waste.

### ***Wastes from waste air cleaning [K]***

Dusts arising during glass processing are normally collected in the filter plants (dry or wet) and returned to the preparation process. Depending on the raw materials and coatings used, glass processing dusts may contain dangerous substances.

#### Classification of waste in accordance with EWL:

- 10 11 11\* waste glass in small particles and glass powder containing heavy metals (for example from cathode ray tubes)
- 10 11 12 waste glass other than those mentioned in 10 11 11

- 10 11 17\* sludges and filter cakes from flue-gas treatment containing dangerous substances
- 10 11 18 sludges and filter cakes from flue-gas treatment other than those mentioned in 10 11 17

Notes on recycling, utilization and disposal:

Filter dusts arising during glass processing are normally returned to the preparation process.

Otherwise disposing, HWL, UGL; without dangerous substances together with municipal waste.

### 3 Overview of waste classification – material flow

Extract from EWL	Material flow	Treatment
<b>10 11 Wastes from manufacture of glass and glass products</b>		
10 11 03 waste glass-based fibrous materials	F	1) Recycling, 2) with municipal waste
10 11 05 particulates and dust	J	1) Recycling, 2) with municipal waste
10 11 09* waste preparation mixture before thermal processing, containing dangerous substances	A, B	Recycling, HWL, UGL
10 11 10 waste preparation mixture before thermal processing, other than those mentioned in 10 11 09	A, B	1) Recycling, 2) with municipal waste
10 11 11* waste glass in small particles and glass powder containing heavy metals (for example from cathode ray tubes)	E, F, K	Recycling, HWL, UGL
10 11 12 waste glass other than those mentioned in 10 11 11	E, F, K	1) Recycling, 2) with municipal waste
10 11 13* glass-polishing and –grinding sludge containing dangerous substances	G	Recycling, HWL
10 11 14 glass-polishing and –grinding sludge other than those mentioned in 10 11 13	G	1) Recycling, 2) with municipal waste
10 11 15* solid wastes from flue-gas treatment containing dangerous substances	D	HWL, UGL
10 11 16 solid wastes from flue-gas treatment other than those mentioned in 10 11 15	D	With municipal waste
10 11 17* sludges and filter cakes from flue-gas treatment containing dangerous	K	HWL

substances			
10 11 18	sludges and filter cakes from flue-gas treatment other than those mentioned in 10 11 17	K	With municipal waste
10 11 19*	solid wastes from on-site effluent treatment containing dangerous substances	H	HWL
10 11 20	solid wastes from on-site effluent treatment other than those mentioned in 10 11 19	H	With municipal waste
10 11 99	waste not otherwise specified	Not normally required	

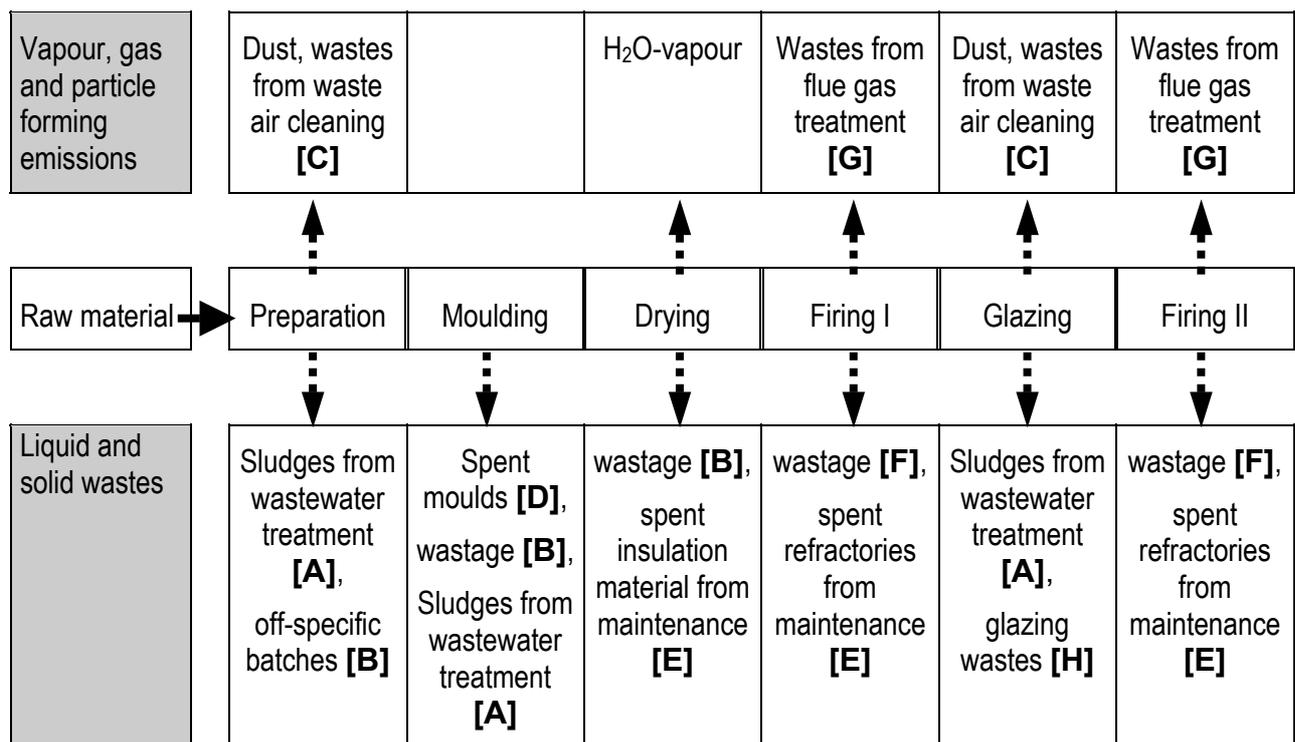
<b>Wastes from manufacture of glass and glass products to be classified under other waste categories</b>			
06 01 03*	hydrofluoric acid	G	CPT
16 11 05*	linings and refractories from non-metallurgical processes containing dangerous substances	C	Material recycling, HWL
16 11 06	linings and refractories from non-metallurgical processes other than those mentioned in 16 11 05	C	1) Material recycling, 2) with municipal waste

## 10 12 Wastes from manufacture of ceramic goods, bricks, tiles and construction products

<b>1</b>	<b>Process</b> .....	<b>1</b>
<b>2</b>	<b>Wastes</b> .....	<b>2</b>
<b>3</b>	<b>Overview of waste classification – material flow</b> .....	<b>5</b>

### 1 Process

The main raw material used during the production of ceramics (**fig 1**) is clay (kaolin and Illit), whose special properties are suited to moulding and firing. Additives, especially quartz (sand) and feldspar change the properties during firing (e.g. avoid shrinkage during drying, firing or glazing). Pigment may be added as required.



**Fig 1:** Example representation of a ceramic manufacturing process and the possible wastes and emissions

The raw materials are mixed, homogenised and moulded - dry or wet. Moulding is carried out by casting, pressing, or powder pressing processing. Having been moulded, the pieces are dried. During subsequent firing at temperatures of 900°C and 1800°C, the material is hardened in a sinter process. The finished fired pieces are then sanded and polished to exact measurements as required. Glazes are coatings similar to glass, which serve to seal, harden, smooth, strengthen or colour the ceramic pieces. Similar to glass, glazes are made of silicate compounds. For

special applications, a conducting metal coating can be applied over the fired ceramic surface. Depending on the type of ceramic product, there is a single (already with glaze), double or triple firing process.

## 2 Wastes

### ***Sludges from on-site wastewater treatment [A]***

Wastewater arises from several process steps. It contains all the raw materials of the ceramic product (incl. glazing raw material) in finely dispersed form. The wastewater treatment is carried out by flocculation in neutral pH range (normally using aluminium salts). The resulting sludges compose the largest part of waste produced in the ceramics industry.

#### Classification of waste in accordance with EWL:

10 12 13 sludge from on-site effluent treatment

#### Notes on recycling, utilization and disposal:

As a rule returning to the preparation process.

Disposal to landfill; normally together with municipal waste.

### ***Off-specific batches and wastage before firing [B]***

Off-specific batches resulting from raw material preparation and wastage created during moulding or drying contain, as a rule, the raw materials of the ceramic products (incl. glazing raw material) in dusty, in water suspended or bound or solid condition.

#### Classification of waste in accordance with EWL:

10 12 01 waste preparation mixture before thermal processing

#### Notes on recycling, utilization and disposal:

As a rule returning to the preparation process.

Disposal to landfill; normally together with municipal waste.

### ***Dusts and sludges from raw material processing [C]***

Dusts, which are created during raw material and glazing preparation, are collected in filter plants (dry or wet) and fed back to the preparation process of raw materials.

#### Classification of waste in accordance with EWL:

Dry separation:

10 12 03 particulates and dust

Wet separation:

10 12 05 sludges and filter cake from gas treatment

#### Notes on recycling, utilization and disposal:

As a rule returning to the preparation process.

Wet separation: Before returning the sludges to the preparation process, chemical-physical treatment (CPT) using filtration processes (see chapter 19 08, par. 2.5) to separate out the water phase and feed it back into the waste air washer, or possibly into the sewerage system.

Otherwise disposal to landfill; normally together with municipal waste.

### ***Wastes from moulding [D]***

The moulds for ceramic production are made of plaster, plastic or metal. Plaster moulds, naturally, have the shortest serviceable life. In contrast, plastic and metal moulds have a long serviceable life after which they are sent for plastic or metal recycling.

#### Classification of waste in accordance with EWL:

10 12 06      discarded moulds

#### Notes on recycling, utilization and disposal:

As a rule, used plastic and metal moulds are supplied to the plastic or metal recycling.

Otherwise disposal to landfill; normally together with municipal waste.

### ***Wastes from maintenance of driers and kilns [E]***

Wastes from insulation linings of driers or refractories from kilns may arise during maintenance and repair. They may contain dangerous materials, for example, asbestos.

#### Classification of waste in accordance with EWL:

16 11 05\*      linings and refractories from non-metallurgical processes containing dangerous substances

16 11 06      linings and refractories from non-metallurgical processes other than those mentioned in 16 11 05

#### Notes on recycling, utilization and disposal:

Asbestos free wastes from maintenance of driers and kilns are normally used for production of fireproof materials.

Otherwise disposal to landfill; when dealing with asbestos containing material on landfills additional requirements have to be met.

Without dangerous substances, disposal to landfill together with municipal waste.

### ***Waste after firing [F]***

Waste arising after firing is material that, as a rule, can be classified as not dangerous. After firing, glazes containing dangerous substances are glazed and as they are inert they should not, as a rule, be classified as dangerous materials.

#### Classification of waste in accordance with EWL:

10 12 08      Wastes ceramics, bricks, tiles and construction products (after thermal processing)

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Notes on recycling, utilization and disposal:

Wastes after firing can be utilized as raw material in the building and construction industry.

Otherwise disposal to landfill; normally together with municipal waste.

***Wastes from flue gas treatment [G]***

As a rule, wastes from flue gas treatment arise as solid filter dusts in which dangerous substances from firing as well as glazing particles (possibly containing heavy metals) may be present.

Classification of waste in accordance with EWL:

10 12 09\* solid wastes from gas treatment containing dangerous substances

10 12 10 solid wastes from gas treatment other than those mentioned in 10 12 09

Notes on recycling, utilization and disposal:

There are at present no viable treatment processes known.

Disposal to landfill; without dangerous substances, together with municipal waste.

***Glazing wastes [H]***

Glazing mixtures, including fireproof pigments are an especially expensive raw material for the ceramics industry. As a result, measures are taken in this area to avoid waste. Most importantly, glazing wastes may contain heavy metals.

Classification of waste in accordance with EWL:

10 12 11\* wastes from glazing containing heavy metals

10 12 12 wastes from glazing other than those mentioned in 10 12 11

Notes on recycling, utilization and disposal:

Disposal to landfill; not burnt, heavy metals containing glazing raw materials possibly in UGL.

Without dangerous substances, disposal to landfill together with municipal waste.

### 3 Overview of waste classification – material flow

Extract from EWL		Material flow	Treatment
<b>10 12</b>	<b>Wastes from manufacture of ceramic goods, bricks, tiles and construction products.</b>		
10 12 01	waste preparation mixture before thermal processing	B	1) Recycling, 2) with municipal waste
10 12 03	particulates and dust	C	1) Recycling, 2) with municipal waste
10 12 05	sludges and filter cakes from gas treatment	C	1) Recycling, 2) with municipal waste
10 12 06	discarded moulds	D	1) Recycling, 2) with municipal waste
10 12 08	waste ceramics, bricks, tiles and construction products (after thermal processing)	F	1) Material recycling, 2) with municipal waste
10 12 09*	solid wastes from gas treatment containing dangerous substances	G	HWL
10 12 10	solid wastes from gas treatment other than those mentioned in 10 12 09	G	Municipal waste
10 12 11*	wastes from glazing containing heavy metals	H	HWL, UGL
10 12 12	wastes from glazing other than those mentioned in 10 12 11	H	With municipal waste
10 12 13	sludge from on-site effluent treatment	A	1) Recycling, 2) with municipal waste
10 12 99	wastes not otherwise specified	Not normally required	
<b>Wastes from manufacture of ceramic goods, bricks, tiles and construction products to be classified under other waste categories</b>			
16 11 05*	linings and refractories from non-metallurgical processes containing dangerous substances	E	1) Material recycling, 2) HWL
16 11 06	linings and refractories from non-metallurgical processes other than those mentioned in 16 11 05	E	1) Material recycling, 2) with municipal waste

## 10 13 Wastes from manufacture of cement, lime and plaster and articles and products made from them

1	PROCESS .....	1
1.1	Cement manufacture .....	1
1.2	Manufacture of lime .....	3
1.3	Manufacture of plaster .....	4
1.4	Manufacture of cement, lime and plaster products .....	5
2	WASTES .....	5
3	OVERVIEW OF WASTE CLASSIFICATION – MATERIAL FLOW .....	8

### Foreword

This group includes waste from the manufacture and processing of cement, lime and plaster. The manufacturing processes for these building materials are described separately below. The manufacture of products from these materials is presented in paragraph 1.4.

### 1 Processes

#### 1.1 Cement manufacture

##### Raw material production

The most important cement raw materials are limestone and marl which are quarried. These raw materials are then transported to crushers in cement works.

##### Crushing

In crushers the stone is crushed to the size of road metal. It is then transported on conveyor belts to gravel silos where it is stored.

##### Raw material grinding and drying

More raw material (e.g. clay) is added to produce a preparation mixture. Mills grind the material to a fine flour powder, drying it at the same time. Dust filters collect **preparation mixture waste [A]**. The raw flour is stored in silos.

##### Thermal processing

The raw flour is pre-heated in heating kilns by reverse rotary kiln flue-gas. The raw flour is thermally processed in kilns to produce an intermediary product, cement

clinker. During thermal processing, the raw flour is dried and the limestone is calcinated at a temperature of 800°C ( $\text{CaCO}_3 \rightarrow \text{CaO}$ ). In the sinter area, in excess oxygen and at a temperature of approx. 1450°C, tricalcium silicate, that gives cement most of its properties, forms. The hot clinker is then cooled to approx. 100°C and stored in a clinker silo.

### Flue-gas treatment

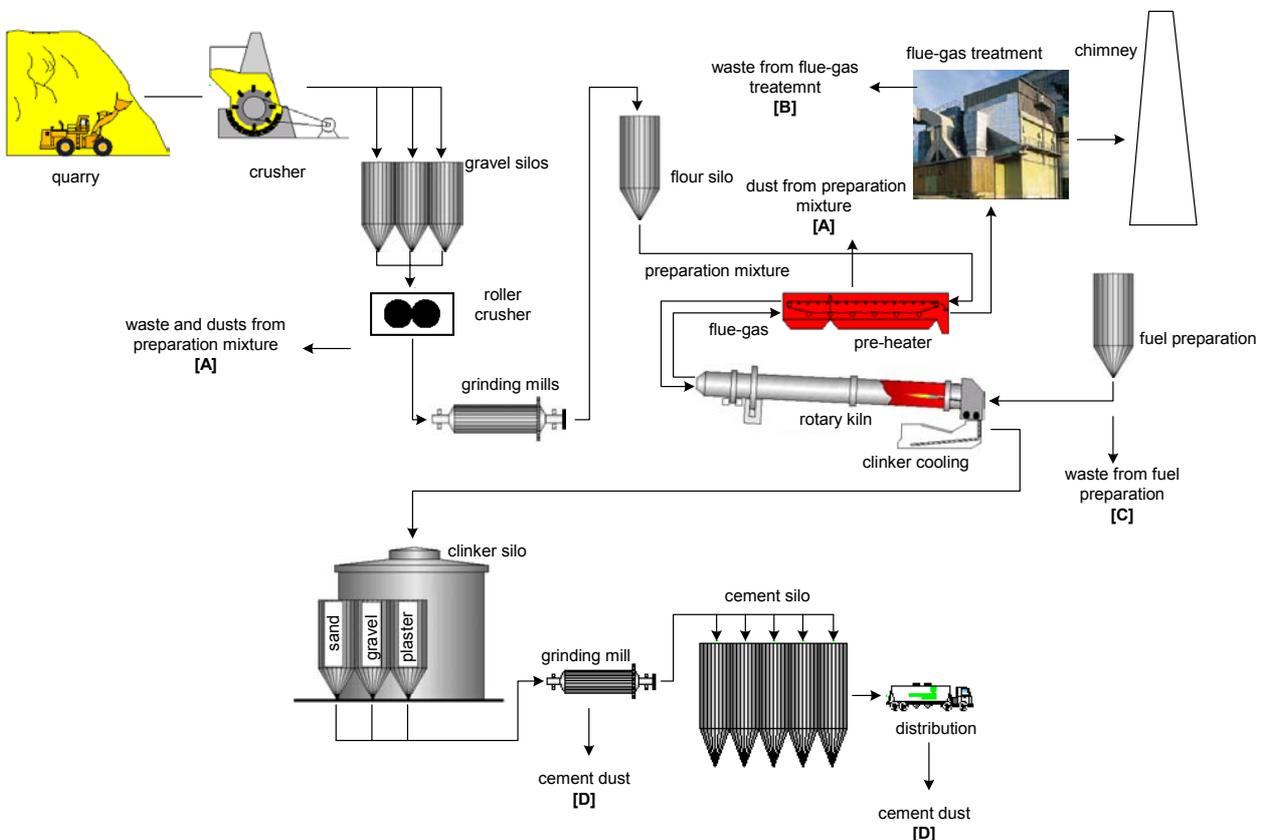
Rotary kilns are fired with coal, oil or waste with a high calorific value (e.g. used tyres, waste oil). After passing through pre-heaters, flue-gas is treated. Dust particles are separated in electro-filters and textile filters. This creates **waste from flue-gas treatment [B]**. In modern cement works, denitrification is also carried out. Desulphurisation of flue-gas is normally not carried out because the sulphur is bound into the clinker and the furnace dust.

### Cement grinding and preparation

In ball mills, clinker, together with plaster and specific types of ground material such as silica sand and gravel, is ground to form cement and then stored in silos. **Cement dusts [D]** arise in air filters.

### Packaging and distribution

Cement is then loaded onto delivery vehicles or packed in cement sacks.



**Fig. 1: Cement manufacture**

## 1.2 Manufacture of lime

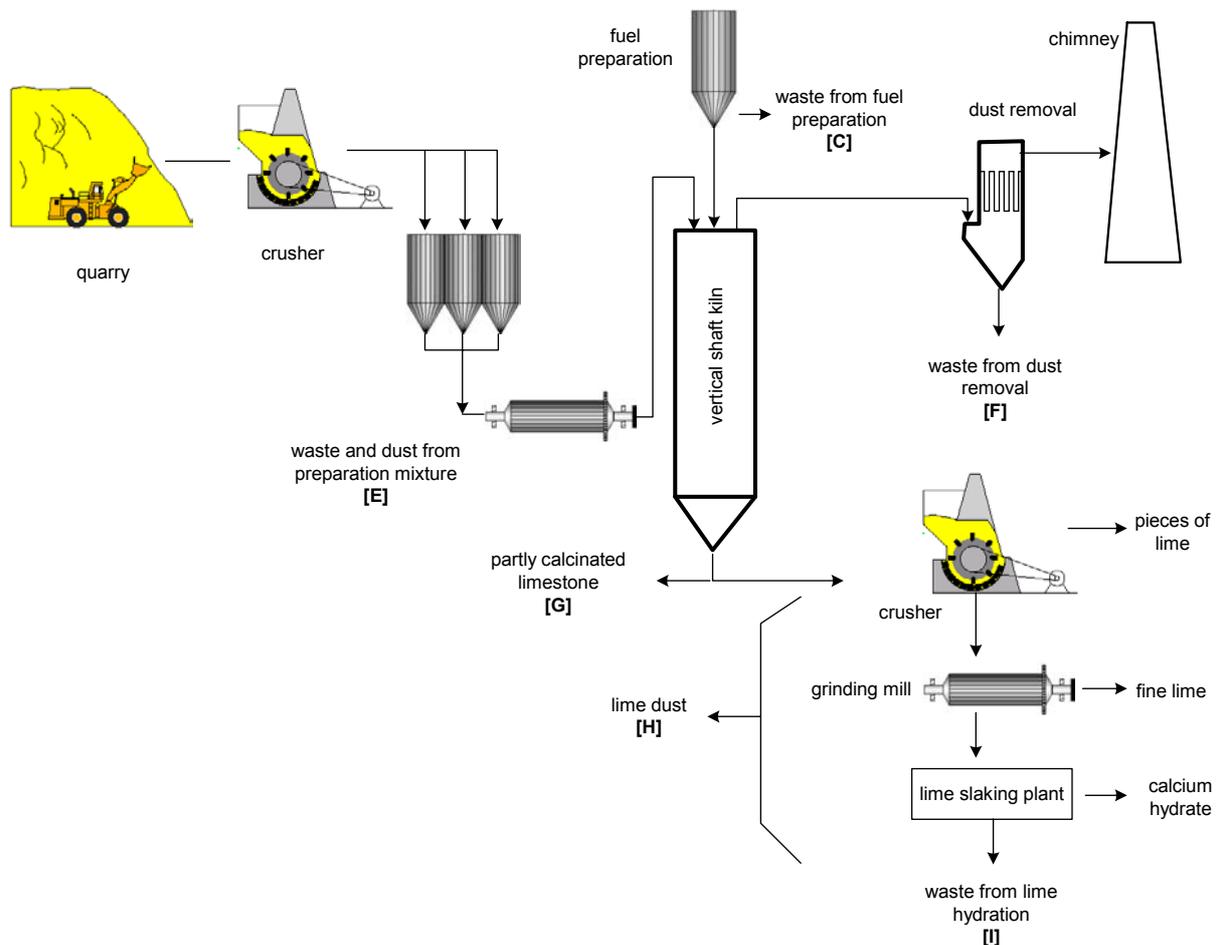
### Raw material production and crushing

Lime is produced from limestone, mainly  $\text{CaCO}_3$ . Limestone is quarried, crushed and thermally treated.

### Thermal treatment

Limestone is normally introduced into the thermal process in lumps. The kilns used are normally vertical shaft kilns or rotary kilns. Kiln flue-gases are treated in textile and electro-filters.

At temperatures of between 900 and 1200°C, limestone ( $\text{CaCO}_3$ ) is broken down (calcinated) into gaseous carbon dioxide ( $\text{CO}_2$ ) and calcium oxide ( $\text{CaO}$  = quicklime).



**Fig. 2:** Lime production

### Further processing

The main products of the lime industry are lime pieces, fine lime and slaked lime. Lime pieces are roughly crushed following thermal treatment and are mainly used in the iron and steel industry for slag production.

Fine lime is finely ground after being crushed and is mainly used in the building industry, however, it is also used in the treatment of effluents.

Calcium hydroxide (slaked lime) is the product of the reaction between lime and water, the lime is slaked. Quicklime ( $\text{CaO}$ ) and water ( $\text{H}_2\text{O}$ ) spontaneously form

calcium hydroxide ( $\text{Ca}(\text{OH})_2$  = Calcium hydroxide). Calcium hydroxide is mainly used in the building industry in mortars.

### 1.3 Manufacture of plaster

Plaster is mainly  $\text{CaSO}_4$  (Anhydrite),  $\text{CaSO}_4 \cdot 1/2 \text{H}_2\text{O}$  (hemihydrate = plaster of Paris) or a combination of both. It is produced by thermal treatment of gypsum stone or as the product of flue-gas desulphurisation (FGD plant gypsum). Only the production process from natural stone is described below.

#### Raw material extraction and crushing

The raw materials for plaster production are gypsum stone and anhydrite stone, which are either quarried or mined. Depending on the subsequent thermal treatment, the raw material is either crushed or ground.

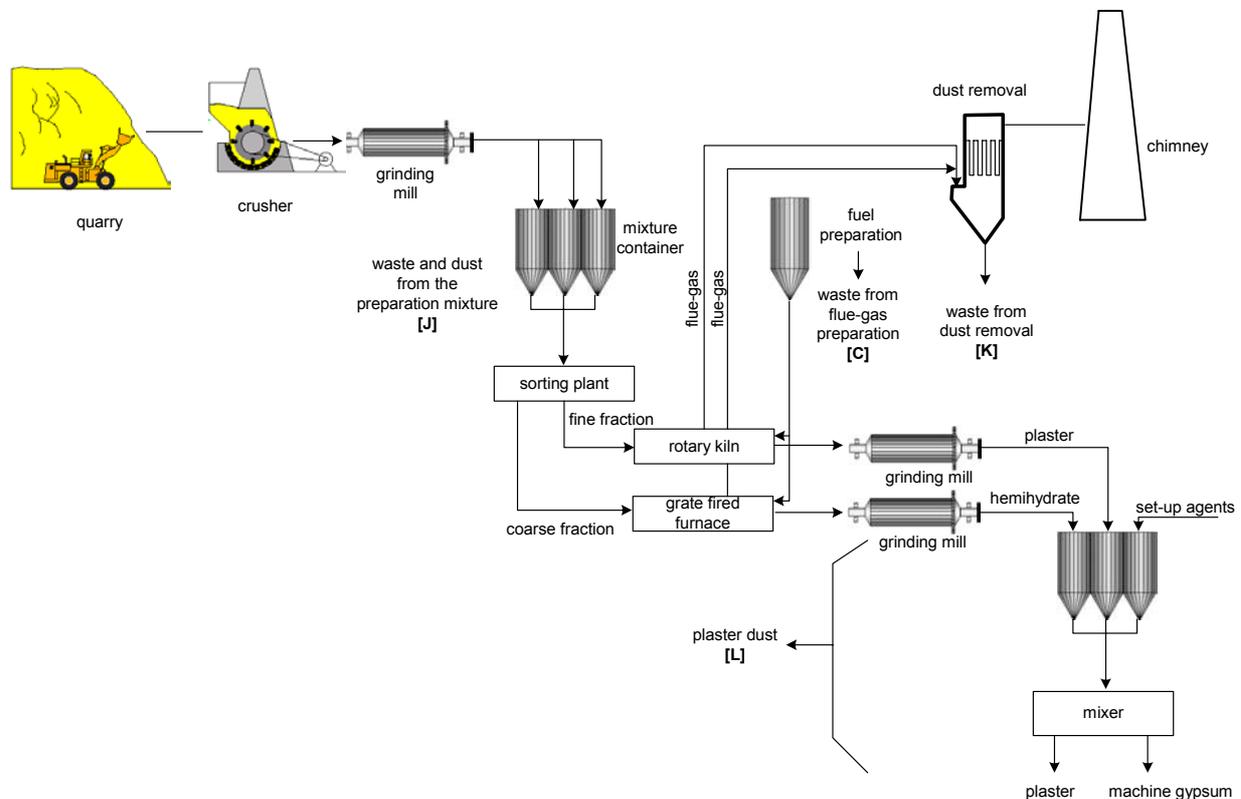


Fig. 3: plaster production

#### Thermal treatment

To remove the water of crystallisation (calcination) the raw material is thermally treated. Rotary kilns or grate-fired furnaces are used. For the production of plaster of Paris, gypsum stone is heated to 120 to 180°C. For the production of anhydrite a temperature of between 300 and 900°C is required. The flue-gases are treated in textile and electro-filters.

## Grinding and mixing

The thermally treated plaster is subsequently sieved and ground. Depending on the end-product (machine gypsum, plaster and wall plaster), different sorts of plaster are mixed.

### 1.4 Manufacture of cement, lime and plaster products

Cement is used exclusively in the building industry for the manufacture of concrete.

An exception is the manufacture of asbestos-cement. The manufacture and distribution is no longer permitted in Germany in accordance with the chemical prohibition regulation of November 1993. This prohibition is not yet in force throughout Europe. Asbestos-cement used to be used in the manufacture of flower pots, facings, roofing sheets and water pipes.

In addition, chalk and plaster are used in the steel industry, the chemical industry and in wastewater treatment. These applications are not included in sub-chapter 10 13.

Waste mainly arises as sludges and dusts when the building material is activated with water.

## 2 Wastes

### ***Wastes and dusts from preparation mixture [A] [E] [J]***

These wastes arise during raw material grinding, mixing, pre-heating and sieving processes before thermal treatment. As a rule, dusts are removed from the air using textile filters.

#### Classification of waste in accordance with EWL:

10 13 01 waste preparation mixture before thermal processing

For spent textile filters:

15 02 03 absorbents, filter materials, wiping cloths and protective clothing other than those mentioned in 15 02 02

#### Notes on recycling, utilization and disposal:

Recycling of dusts to production.

Otherwise, disposal to landfill, as a rule together with municipal waste.

### ***Wastes from air treatment and the removal of dust from kiln gases [B] [F] [K]***

Particles which are carried out together with kiln gases are separated in electro-filters (cement works) or in textile filters. In modern cement works denitrification is also carried out.

#### Classification of waste in accordance with EWL:

For wastes from denitrification:

10 13 07 sludges and filter cakes from gas treatment

For wastes from dust separation in cement works, plaster and lime works:

10 13 12\* solid wastes from gas treatment containing dangerous substances  
(exception)

10 13 13 solid wastes from gas treatment other than those mentioned in 10 13 12  
(rule)

Notes on recycling, utilization and disposal:

Solid and dust wastes can to some extent be recycled to the production.

Otherwise, disposal to landfill (HWL, UGL); if it does not contain dangerous substances, together with municipal waste.

**Fuel preparation [C]**

Dusts arise during the preparation of solid fuel.

Classification of waste in accordance with EWL:

10 01 25 wastes from fuel storage and preparation of coal-fired power plants

Notes on recycling, utilization and disposal:

The dusts can to some extent be recycled to production (rotary kilns).

Otherwise, incineration, as a rule together with municipal waste.

**Cement, lime and plaster dust [D] [H] [L]**

Dusts, released during grinding, mixing and loading of building material are removed, as a rule, in textile filters.

Classification of waste in accordance with EWL:

10 13 06 particulates and dust (except 10 13 12 and 10 13 13)

For spent textile filters:

15 02 03 absorbents, filter materials, wiping cloths and protective clothing other than those mentioned in 15 02 02

Notes on recycling, utilization and disposal:

The dusts can to some extent be recycled to the respective production process.

Otherwise, disposal to landfill, as a rule together with municipal waste.

**Wastes from calcination and hydration of lime [G,I]**

During the thermal treatment of limestone (calcination), partly calcinated fractions may arise especially during the rise and fall of the vertical shaft kilns. Sludges and solids arise during lime slaking (hydration).

Classification of waste in accordance with EWL:

10 13 04 wastes from calcination and hydration of lime

Notes on recycling, utilization and disposal:

Recycling to production processes.

Otherwise, disposal to landfill, as a rule together with municipal waste.

### ***Wastes from the manufacture of asbestos-cement.***

Waste which may contain asbestos arises during the manufacture of asbestos-cement. Today, asbestos-cement is no longer manufactured in Germany.

#### Classification of waste in accordance with EWL:

- 10 13 09\* wastes from asbestos-cement manufacture containing asbestos
- 10 13 10 wastes from asbestos-cement manufacture other than those mentioned in 10 13 09

#### Notes on recycling, utilization and disposal:

At present there are no known viable treatment processes.

- 10 13 09\* Disposal to HWL, UGL.  
If there is no free asbestos present, disposal to landfill together with municipal waste is possible.
- 10 13 10 Disposal to landfill, as a rule together with municipal waste.

### ***Waste from the manufacture of concrete.***

Solidified waste and sludges arise during the manufacture of concrete.

#### Classification of waste in accordance with EWL:

- 10 13 14 waste concrete and concrete sludge

#### Notes on recycling, utilization and disposal:

Material use in the building material industry.

Otherwise, disposal to landfill, as a rule together with municipal waste.

### 3 Overview of waste classification – material flow

Extract from EWL		Material Flow	Treatment
<b>10 13</b>	<b>wastes from manufacture of cement, lime and plaster and articles and products made from them</b>		
10 13 01	waste preparation mixture before thermal processing	A, E, J	1) recycling, 2) with municipal waste
10 13 04	wastes from calcination and hydration of lime	G, I	1) recycling, 2) with municipal waste
10 13 06	particulates and dust (except 10 13 12 and 10 13 13)	D, H, L	1) recycling, 2) with municipal waste
10 13 07	sludges and filter cakes from gas treatment	B, F, K	with municipal waste
10 13 09*	wastes from asbestos-cement manufacture containing asbestos	-	1) HWL, UGL, 2) with municipal waste
10 13 10	wastes from asbestos-cement manufacture other than those mentioned in 10 13 09	-	with municipal waste
10 13 11	wastes from cement-based composite materials other than those mentioned in 10 13 09 and 10 13 10	-	1) material use, 2) with municipal waste
10 13 12*	solid wastes from gas treatment containing dangerous substances	B, F, K	1) material use, 2) HWL, UGL
10 13 13	solid wastes from gas treatment other than those mentioned in 10 13 12	B, F, K	1) material use, 2) with municipal waste
10 13 14	waste concrete and concrete sludge	-	1) material use, 2) with municipal waste

	<b>wastes from manufacture of cement, lime and plaster and articles and products made from them to be classified under other waste categories</b>		
10 01 25	wastes from fuel storage and preparation of coal-fired power plants	C	1) incineration, 2) with municipal waste
15 02 03	absorbents, filter materials, wiping cloths and protective clothing other than those mentioned in 15 02 02	D, H, L	with municipal waste