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A Driver for Environmental Performance in Industry”
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BREF on the Production of Iron and Steel - conclusion on BAT

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1 Introduction

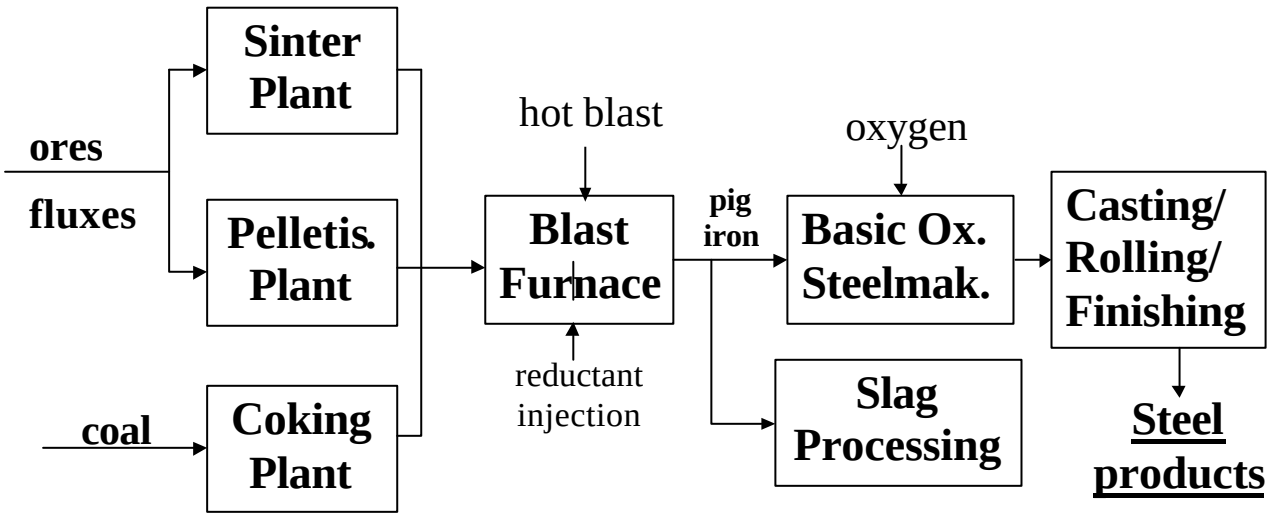
The final draft BREF on the production of Iron and Steel (I&S-BREF) is available since January 2000 [EC, 2000], and has been adopted at the 7. Meeting of the Information Exchange Forum (IEF) on 28/29 February 2000. In addition, during this meeting an official hand-over from the European IPPC Bureau (EIPPCB) to DG Environment of the European Commission took place. Thus the I&S-BREF and the BREF on the Production of Cement and Lime are the first final products of the so-called „Sevilla-Process".

The I&S-BREF comprises about 350 pages and contains detailed information on most environmental aspects of the sector. This presentation addresses how the BREF structure reflects the industry structure and, by hand of five examples, how conclusions on BAT have been developed.

2 The sector iron and steel industry

The scope of BREF covers the processes involved in the production of iron and steel in integrated steelworks. Following main production steps are included: sinter plants, pelletisation plants, coke oven plants, blast furnaces and basic oxygen steelmaking incl. casting (figure 1).

Figure 1: Simplified flow sheet illustrating the basic process sequence of integrated steelworks



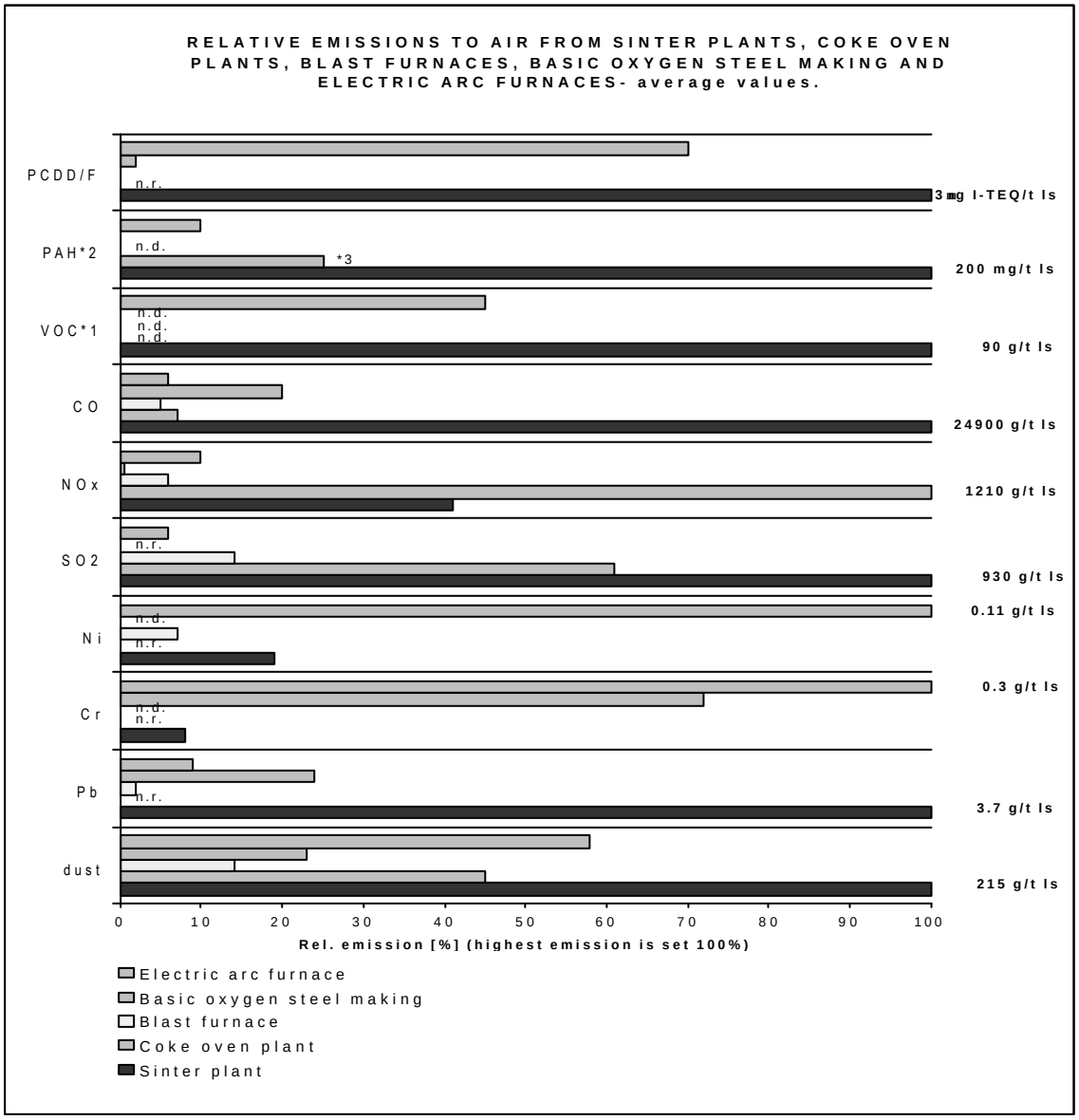
Not included is cold and hot rolling; these processes are covered by the BREF Ferrous Metal Processing. In addition electric steelmaking and casting (also including rolling) are within the scope. The sector is characterised by large scaled industries and relatively small numbers of installations. In the EU 15 there are 42 integrated steelworks and 246 electric arc furnaces.

3 Environmental relevance of the iron and steel industry

The iron and steel industry is highly intensive both in materials and energy. In 1995 for the production of 155.8 Mt of crude steel the total input of iron ore, scrap, coal, lime, limestone, fuel oil, gas oil and additives has been 316.5 Mt; thereby water and gaseous inputs are not considered. That means, that about half of the input results in crude steel only and the other half are solid residues/by-products and off gases.

Air pollution remains to be the most important issue of this sector. In integrated steelworks sinter plants are dominating the overall emissions to air for most pollutants, followed by coke-oven plants (figure 2). Regarding copper, nickel and PCDD/F emissions to air from electric arc furnaces are also of significant relevance.

Figure 2: Relative emissions to air of selected pollutants from sinter plants, coke oven plants, blast furnaces, basic oxygen steelmaking and from electric steelmaking



4 Structure of the I&S-BREF

The structure of the I&F-BREF reflects both the main installations of integrated steelworks and the material flow (see figure 1). The direct dependencies of sinter plants, pelletisation plants, coke oven plants, blast furnaces and basic oxygen steelmaking are relatively clearly defined. These plants are big units. Usually they are permitted as such. So it has been decided to provide the information 'en bloc' for these plants, that means the I&S-BREF contains for the above mentioned plants an information package covering present emission and consumption levels, techniques to consider in the determination of BAT, conclusions and emerging techniques. The same is for presenting information on electric steelmaking.

Although the I&S-BREF is structured plant-wise in the described way the conclusions on BAT for them have been developed with an integrated view of the whole steelworks. Thereby the "big issues" were in the foreground of discussion such as

- residual dust and PCDD/F content in off gases from sinter plants,
- maintenance programme and low emission operation of coke oven plants as well as coke oven desulphurisation and coke dry quenching,
- cast house de-dusting of blast furnaces,
- BOF gas recovery and secondary de-dusting of basic oxygen steelmaking,
- residual dust and PCDD/F content in off gases from electric arc furnaces

In this way the I&S-BREF can be addressed to be a balanced document. This is one of the main reasons that it enjoys broad acceptance.

5 How to conclude on BAT?

It has to be noted that the Technical Working Group (TWG) played the key role in the identification and determination of BAT. There is no scientific methodology available and applicable so far to determine BAT. Rather expert judgement within the TWG was most important. This approach inevitably includes compromises but at the same time the degree of balance and acceptance is optimised. In case of the iron and steel industry and emissions to air a sufficient measured number of emission values were available. So an approach could be to go, for instance, for the best of the best or for the 10% best performing plants. Another one is to cut off the 30% worst performing plants when considering a frequency distribution. The setting of such criteria is a fundamental approach. When determining BAT the TWG did not decide to follow such an approach. Thus BAT in one case may represent the 10% best performing plants and in another one the 70%, or other percentages. The overall consideration of BAT conclusions in the I&S-BREF leads to the statement that a high or very high level of environmental protection has been selected.

The following five examples have been chosen in order to explain the process of BAT selection/development.

5.1 BAT for residual dust and PCDD/F content in off gases from sinter plants

The fact is commonly accepted that sinter plants respectively sinter strands dominate the emissions to air from integrated steelworks (see figure 2). For these plants low achievable emission levels both for dust and PCDD/F have been concluded as follows:

„Waste gas de-dusting by application of:

- Advanced electrostatic precipitation (ESP) (moving electrode ESP, ESP pulse system, high voltage operation of ESP ...) *or*
- electrostatic precipitation plus fabric filter *or*
- pre-dedusting (e.g. ESP or cyclones) plus high pressure wet scrubbing system.

Using these techniques dust emission concentrations < 50 mg/Nm³ are achieved in normal operation. In case of application of a fabric filter, emissions of 10-20 mg/Nm³ are achieved."

„Minimising of PCDD/F emissions, by means of:

- Application of waste gas recirculation;
- Treatment of waste gas from sinter strand;
- use of fine wet scrubbing systems, values < 0.4 ng I-TEQ/Nm³ have been achieved.

Fabric filtration with addition of lignite coke powder also achieves low PCDD/F emissions (> 98 % reduction, 0.1 – 0.5 ng I-TEQ/Nm³. – this range is based on a 6 hours random sample and steady state conditions)."

About 10% best performing plants already meet these values.

The mentioned values for dust seem to be relatively high compared to other sources of particles, e.g. for electric arc furnaces (see 5.3.1). But the properties of dust from sinter plants is very specific and removal efficiency is significant different from dust of other sources, especially in case of application of electrostatic precipitators.

5.2 BAT for coke oven plants

5.2.1 Maintenance programme

The smooth and undisturbed operation of coke oven plants can only be secured by application of specific maintenance programmes. The quality of such programmes can not be specified or qualified by numbers. Nevertheless the introduction and performance of such programmes is of the most important

process-integrated measure for coke oven plants. The maintenance programme is described in detail as a technique to consider in the determination of BAT meanwhile the conclusion is:

> „Extensive maintenance of oven chambers, oven doors and frame seals, ascension pipes, charging holes and other equipment (systematic programme carried out by specially trained maintenance personnel)“

This example demonstrates that BAT can not be always defined along with associated emission concentrations or factors.

5.2.2 Coke dry quenching (CDQ)

Regarding coke dry quenching (CDQ) it has to be noted that world-wide CDQ plants are in operation at about 60 coke oven plants in 18 different countries. Most of them are located in the CIS countries (Commonwealth of Independent States) because of climate conditions (25 plants with 109 units) and in Japan (20 plants with about 33 units) because of high energy prices. In Japan CDQ is installed at 80% of plants. Nevertheless CDQ has not been unrestrictedly concluded to be BAT because of cost-environmental benefit aspects.

Example:

The investment cost for a 2 Mt/a plant is

- about 5 Mio Euro for a wet quenching facility
- about 100 Mio Euro for dry quenching; note: normally coke oven plants with CDQ also have to have a wet quenching facility because of low availability of CDQ units

The main advantages of dry quenching are:

- energy recovery (in Europe only covering operation cost, that means there is no pay back),
- no plumes,
- reduced dust emission (5-10 g/t instead of 10-25 g/t for wet quenching with emission optimised tower),
- lower emissions of H_2S and NH_3 but this reduction is not of high environmental relevance.

However CDQ is mentioned in the BAT conclusions but along with certain conditions for application:

> „Coke dry quenching (CDQ) with recovery of sensible heat and removal of dust from charging, handling and sieving operations by means of fabric filtration. With respect to present energy prices in the EU, „instrument/operational cost-environmental benefit“- consideration sets strong limitations on the applicability

of CDQ. In addition a use of recovered energy must be available."

5.3 BAT for electric steelmaking

5.3.1 BAT for residual dust content

Following conclusion has been drawn in the I&S-BREF:

„Well-designed fabric filter achieving less than 5 mg dust/Nm³ for new plants and less than 15 mg dust/Nm³ for existing plants, both determined as daily mean values."

The residual concentration dust concentration of 15 mg/Nm³ for existing installations certainly does not represent the 10 to 20 % best performing plants. Data from 1994, reported for 45 installations in Europe indicate that more than two third of the installations achieved this concentration already at that time [EC Study, 1996]. This statement can not put into perspective due to the fact that the qualification of these data is incomplete. Rather this value represents a compromise made by the TWG. Economic aspects have been the driving force for this conclusion.

5.3.2 BAT for residual PCDD/F content

In this case the TWG concluded BAT as follows:

„Minimising of organochlorine compounds, especially PCDD/F and PCB emissions, by means of:

- appropriate post-combustion within the off gas duct system or in a separate post-combustion chamber with subsequent rapid quenching in order to avoid de novo synthesis *and/or*
- injection of lignite powder into the duct before fabric filters.

Emission concentrations of PCDD/F 0.1 - 0.5 ng I-TEQ/Nm³ are achievable."

This conclusion characterises the techniques already installed at a few plants only in Europe. Thus it represents the best performing plants; in this case less than 10% of the existing plants.

6 CONCLUSION

The I&S-BREF is a document submitting reasonable, credible and technically good information on the best available techniques which can be a challenge to implement but always applicable in practice. It is broadly considered as a well-balanced document. No split views had to be reported. The BAT levels reflect a

high level of environmental protection and is fully in line with aims and demands of the IPPC-Directive.

Conclusions on BAT can also include descriptions of production-integrated measures without defining associated achievable values.

Residual dust contents may be different for different sources depending on physical-chemical properties of dusts.

7 REFERENCES

EC, European Commission, Joint Research Centre, IPTS, European IPPC Bureau, Harald Schoenberger, (2000): *Final draft Best Available Techniques Reference Document on the Production of Iron and Steel.*

The BREF on the Production of Iron and Steel has been posted in pdf format on the web site of the European IPPC Bureau (EIPPCB) http://eippcb.jrc.es /Activities– Iron and Steel Industry - Documents) and can be downloaded. The pdf- format is readable if one has the Adope Acrobat reader software.

EC Study, European Commission, Roederer, C.; Gourtsoyannis, L., (1996): *Coordinated Study 'Steel-Environment'*. DG XII - EUR 16955 EN

Best Available Techniques Reference Document on the Production of Iron and Steel

Responsible expert at EIPPCB:

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Institute for Prospective Technological Studies

European Integrated Pollution Prevention and Control Bureau

JOINT RESEARCH CENTRE
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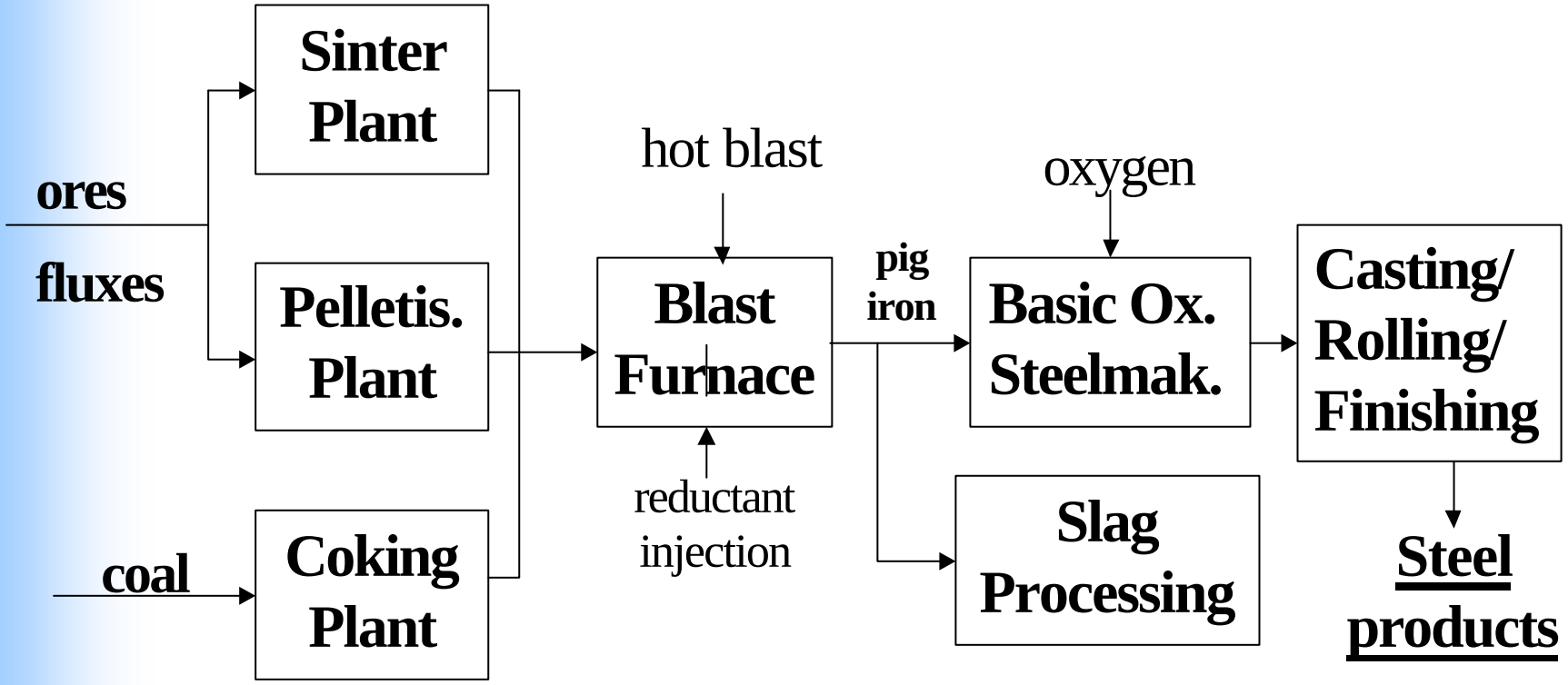
Structure of presentation

- Concerned processes / scope
- Structure of the I&S-BREF
- Overall input/output of the I&S-industry
- How to conclude on BAT ?
  - ☞ Examples

Main processes for steelmaking in integrated steelworks



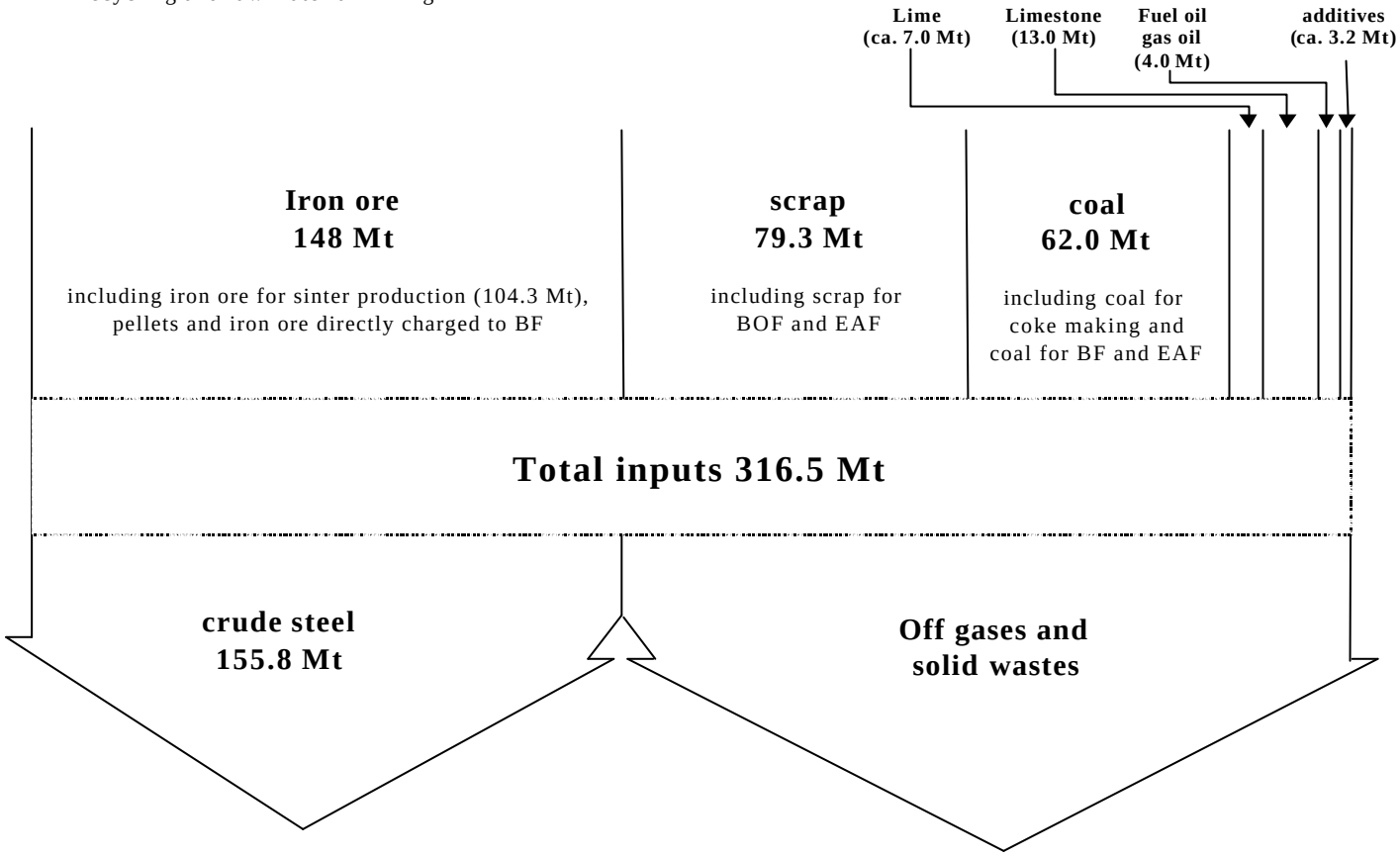
Structure of the I&S-BREF

- Sinter plants
- Pelletisation plants
- Coke oven plants
- Blast furnaces
- Basic oxygen steelmaking
- Electric arc furnace steelmaking

Input/Output of the I&S-Industry in the EU 15

Input and Output of the Iron and Steel Industry in the EU 15 in 1995

very rough overview about the most important mass streams (without water and gaseous inputs) without consideration of any recycling and raw material mining



How to conclude on BAT?

Procedure:

- **TWG played key role!!**
- **no scientific methodology but expert judgement considering the whole sector**

  ⇒ includes compromises but improves degree of balance and acceptance
- **frequency distribution: BAT: 10% best or 70% best (cut off of 30% worst)?**

Determination of BAT

Examples:

- **maintenance of coke ovens**
- **coke dry quenching**
- **dust and PCDD/F emissions from sinter plants**
- **dust and PCDD/F emissions from EAF**

BAT for coke oven plants

Maintenance programme:

"Extensive maintenance of oven chambers, oven doors and frame seals, ascension pipes, charging holes and other equipment (systematic programme carried out by specially trained maintenance personnel)"

BAT for coke quenching

Considerations:

The investment cost for a 2 Mt/a plant is

- about 5 Mio Euro for a wet and about 100 Mio Euro for a dry quenching plant

The main advantages of dry quenching are:

- ➢ energy recovery (no pay back)
- ➢ no plumes,
- ➢ reduced dust emission
- ➢ lower emissions of H_2S and NH_3

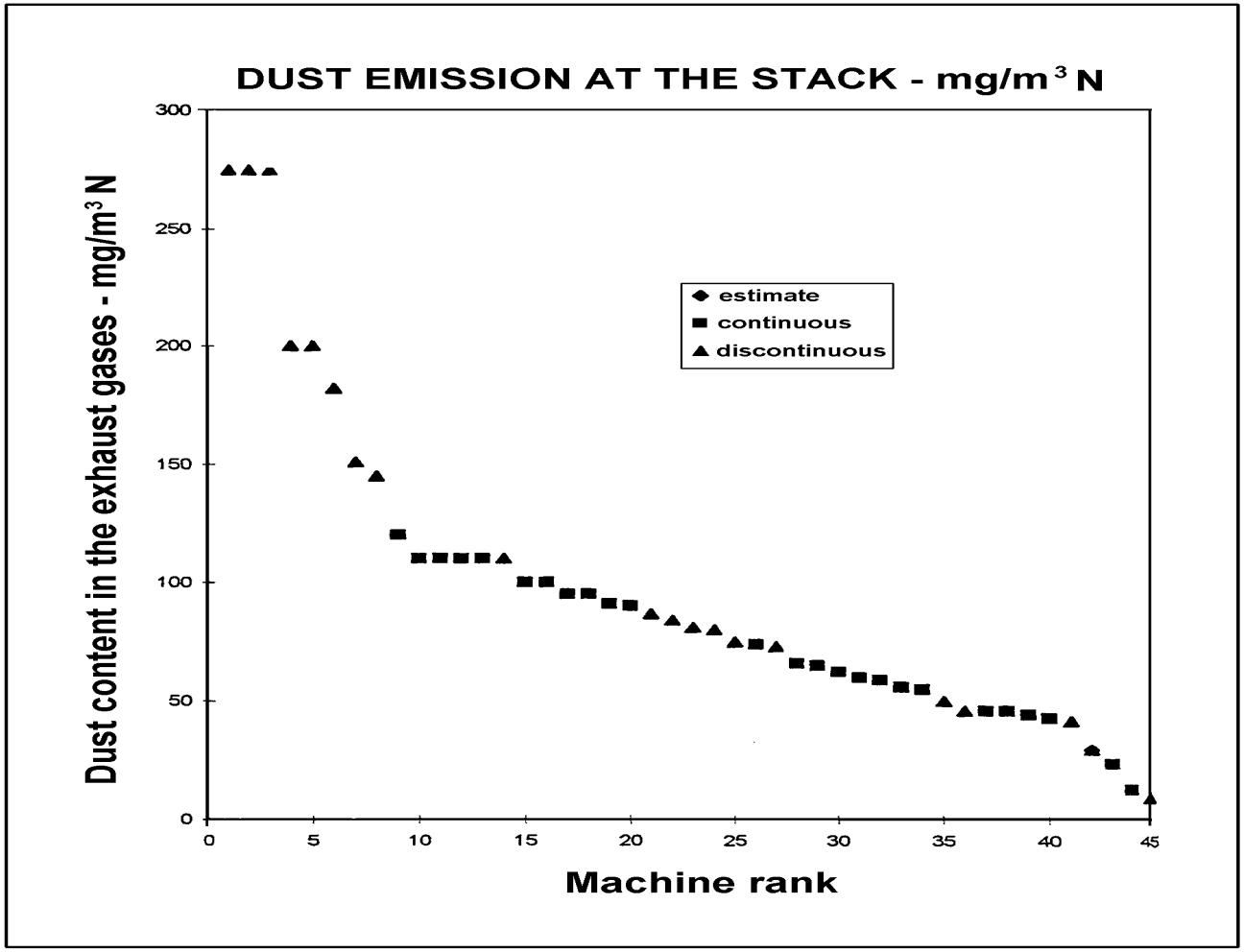
- Reduction is not of high environmental relevance

BAT for coke quenching

Conclusion:

"Coke dry quenching (CDQ) with recovery of sensible heat and removal of dust from charging, handling and sieving operations by means of fabric filtration. With respect to present energy prices in the EU, "instrument/operational cost-environmental benefit"- consideration sets strong limitations on the applicability of CDQ. In addition a use of recovered energy must be available."

Dust in waste gas from sinter strands



BAT for sinter plants

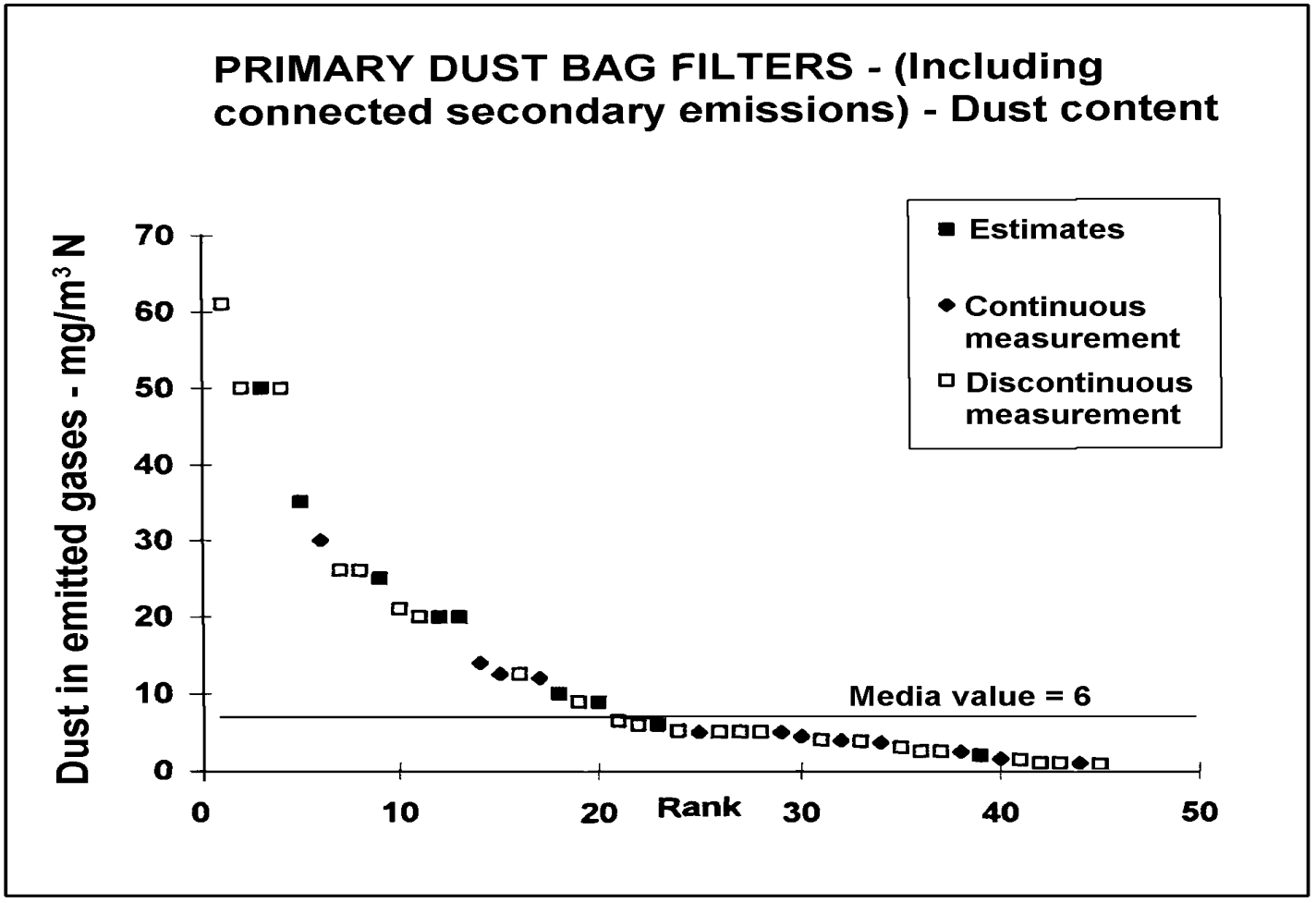
PCDD/F emissions to air:

- Fine scrubbing system: < 0.4 ng I-TEQ/Nm^3
- Coke powder and fabric filter: 0.1-0.5 ng I-TEQ/Nm^3

Dust emissions to air:

- Advanced electrostatic precipitation (ESP) *or*
- Electrostatic precipitation plus fabric filter *or*
- Pre-dedusting plus high pressure wet scrubbing system
  - ☞ < 50 mg/Nm^3;
  - ☞ 10-20 mg/Nm^3 in case of fabric filter

Dust in waste gas from EAF



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BAT for electric arc furnaces

PCDD/F emissions to air:

- *"appropriate post-combustion within the off gas duct system or in a separate post-combustion chamber with subsequent rapid quenching in order to avoid de novo synthesis and/or*
- *injection of lignite powder into the duct before fabric filters."*

☞ PCDD/F 0.1 - 0.5 ng I-TEQ/Nm^3

Dust emissions to air:

"We*ll-designed fabric filter achieving less than 5 mg dust/Nm^3 for new plants and less than 15 mg dust/Nm^3 for existing plants, both determined as daily mean values."*