Glass Melting: Emission sources – Implementation of Best Available Techniques (BAT) and Associated Emission levels (BAT-AELs)

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BEST AVAILABLE TECHNIQUES (BAT) AND INTEGRATED POLLUTION PREVENTION APPROACH

- Permit conditions for industrial installations should be set on the basis of best available techniques (Industrial Emissions Directive 2010/75/EU)

- BAT reference documents (BREFs) are drawn up, reviewed and updated in order to establish BAT conclusions based on best available techniques and associated emission and/or consumption levels

- Therefore, the identification and use/implementation of BAT is the key issue in the integrated control system
MANUFACTURE OF GLASS – ACTIVITIES UNDER INDUSTRIAL EMISSIONS DIRECTIVE 2010/75/EU (IED)

- European Reference Document on Best Available Techniques (BAT):
  - Includes mandatory conclusions for IED permit
  - Covers installations for melting of mineral substances, including glass fibre, with a melting capacity >20 tonnes/day
  - Does not cover:
    - production of water glass (covered by Large Volume Inorganic Chemicals – Solids and Other Industry -LVIC-S BREF)
    - Polycrystalline wool
    - Production of mirrors (Surface Treatment using Organic Solvents – STS BREF)
### Article 3(10) Directive 2010/75/EU

| BEST | Most effective in achieving a **high general level of protection** of the environment **as a whole** |
| AVAILABLE | Developed on a scale which allows implementation in the relevant industrial sector, under **economically and technically viable conditions** |
| TECHNOQUES | Both the technology used and the way in which the installation is designed, built, maintained, operated and decommissioned |
TYPICAL PRODUCTION FLOWCHART FOR THE MANUFACTURE OF GLASS

Batch Preparation

Glass melting and refining

Conditioning

Coating (including binder) and lubricant application

Glass forming

Annealing

Hot surface treatment

Surface treatments

To quality control and packaging
MAIN ENVIRONMENTAL ISSUES FOR THE GLASS MANUFACTURING INDUSTRY

- Energy intensive process
  \[ \approx 18 \text{ million tonnes CO}_2 \text{ direct emissions in the EU} \]

- Air emissions from the melting process
  - Dust (evaporation from glass melt)
  - Nitrogen oxides (NOx) from combustion and/or nitrates
  - Sulphur oxides (SOx) from raw materials and/or fuel
  - Other substances (HCl, HF, metals from raw materials)

- Air emissions from downstream activities (more relevant for mineral wool and continuous filament glass fibre production)

- Emissions to water are relatively low
BAT CONCLUSIONS under Directive 2010/75/EU

- **Substantial changes** in the structure of previous conclusions

- Designed to be a **standalone document** (legally binding)

- **BAT conclusions agreed at the final TWG meeting** are reported in full

- A short **description** of techniques and information to assess their **applicability** are provided
BAT CONCLUSIONS AND ASSOCIATED EMISSION LEVELS (BAT AND BAT-AELs)

- BAT and BAT-AELs based on extensive data collection, taking into account:
  - Achieved environmental benefits
  - Cross-media effects
  - Applicability issues
  - Economic considerations

- BAT conclusions the result of a negotiation between different positions

Are data comparable?
Gold plating vs lenient
BAT CONCLUSIONS – MAIN ISSUES

- Should be based on **solid technical and economic information** (not always available)

- **Overall environmental performance** should take into account **cross media effects**, in particular:
  - Energy consumption
  - Production of residues/waste
  - Consumption of raw materials and water

- **Restrictions on applicability** (often underestimated)

- Formulation of BAT-AELs may vary depending on the available information
BAT CONCLUSIONS – ECONOMIC CONSIDERATIONS

- **Economic data not always adequate** for assessing BAT.

- **Important issues to be consider:**
  - Year of reference/purchase
  - New vs existing plants
  - Cost-effectiveness of the technique (e.g. EUR per abated mass of pollutant)
  - Put cost into context (information on the market for the sector)

Economies of scale
**Accurate technical description** may provide important elements:

- **explain** associated emission levels (BAT-AELs)
- **justify** some limitations to the applicability of the technique, e.g.:
  - Dimensions of the necessary structure for implementing BAT
  - Required temperature
  - Physical and/or chemical characteristics of the released materials (air, water and soil emissions) consequent to the use of the technique
A successful technique in one application may have dissimilar implications if used in another sector or even at a different installation in the same sector.

Restrictions to the applicability may be associated with:

- **Plant age** (new or existing installation – Implementation at the time of furnace rebuild)
- **Plant size** (large or small)
- **Type of product** or quality requirements
- **Factors involved in retrofitting** (e.g. space availability)
- **Technical restrictions** (temperature window, waste gas composition)
- **Limitations due to availability of raw materials and fuels**
GLASS BAT CONCLUSIONS – MAIN PRINCIPLES

- No major developments in depollution techniques for the glass sector; therefore:
  - No major changes in BAT-AELs

- Significant differences between the eight sectors:
  - A given BAT does not fit all sectors
  - BAT-AELs may vary among different sectors

- Melting technique and fuel choice are BAT; although, with significant restrictions to applicability:
  - Energy efficiency, production flexibility, etc.
  - Energy policy of Member States
MAIN DISCUSSION POINTS FOR GLASS BAT CONCLUSIONS

- BAT-AELs given in **concentrations** (mg/Nm$^3$) and **mass emissions** (kg/tonne melted glass)  
  
  **Applied to most BAT-AELs**

- BAT-AEPLs for **energy** consumption  
  
  **Requested by some MS – No agreement on values**

- BAT-AELs for **NOx emissions**: primary, secondary techniques; use of nitrates  
  
  **Diverging opinions – Use of nitrates may become difficult**

- BAT-AELs for **SOx emissions**: recycle of filter dust, high levels of cullet  
  
  **Relevant cross-media effects not fully considered**
CONCENTRATION vs SPECIFIC MASS EMISSIONS (1)

Concentration (mg/Nm³) is not always adequate to describe emission levels:
- Energy efficient furnaces vs not so efficient furnaces
- Oxidant used for combustion (air, oxygen, enriched air)

Specific mass emissions (kg/tonne melted glass) provide a better assessment of BAT:
- Comparison between different furnace types
- Take into account influencing parameters, such as:
  - Furnace age and size
  - Cullet %
  - Type of fuel
Conversion factor from concentration to specific mass emissions for glass sectors and (in some cases) glass types within the sector:

\[ \text{Conversion factor} = \left( \frac{Q}{P} \right) \times 10^{-6} \]

\( Q = \text{Waste gas volume in Nm}^3/\text{h} \)

\( P = \text{Pull rate in tonnes melted glass per hour} \)
GLS BAT CONCLUSIONS – SOME CRITICAL ASPECTS

Cross-media effects taken into account when assessing BAT performance:
- Low SOx emissions and solid waste production
- Low NOx emissions and ammonia slip (SCR, SNCR)

Residual life of the furnace:
- Different BAT-AELs for existing or newly (re)built furnaces

Specifications and characteristics of the final product:
- Different BAT-AELs for special glasses:
  - NOx emissions for batch compositions with nitrates
  - Se emissions for coloured or flint glasses
  - Pb emissions for lead crystal glasses
BAT AND BAT-AELs – IT IS IMPORTANT TO KNOW....

- Techniques listed and described in the BAT Conclusions are neither prescriptive nor exhaustive.

- Other techniques may be used that ensure at least an equivalent level of environmental protection.

- BAT-AELs are referred to normal operating conditions of the installation.

- Special procedures can be defined for specific operating conditions:
  - Start-up and shutdown operations
  - Special operations which could affect the proper functioning of waste gas treatment system
  - Insufficient waste gas flow or temperature which prevents the use of the system at full capacity
The use of a secondary technique (filtration systems) is BAT for all sectors.

- BAT-AELs: <10 – 20 mg/Nm³
- BAT-AELs: <1 – 10 mg/Nm³

Some distinctions for continuous filament glass fibre (primary measures) and domestic glass (economic considerations).
Primary techniques are BAT for all glass sectors:

- Combustion modifications
- Electric melting
- Special furnace design
- Oxy-fuel melting
- Fenix process

Secondary techniques are BAT for the main sectors:

- Selective catalytic reduction (SCR)
- Selective non-catalytic reduction (SNCR)
- Chemical reduction by fuel (only for flat glass)

Special BAT conclusions for the use of nitrates in the batch
# Technique and BAT-AELs for NOx Emissions - Applicability Issues

<table>
<thead>
<tr>
<th>Technique</th>
<th>Applicability</th>
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<tbody>
<tr>
<td>Reduction of air/fuel ratio</td>
<td>Applicable to air/fuel conventional furnaces. Full benefits are achieved at normal or complete furnace rebuild, when combined with optimum furnace design and geometry.</td>
</tr>
<tr>
<td>Electric melting</td>
<td>Not applicable for large volume glass productions (&gt;300 tonnes/day). Not applicable for productions requiring large pull variations. The implementation requires a complete furnace rebuild.</td>
</tr>
<tr>
<td>Oxy-fuel melting</td>
<td>The maximum environmental benefits are achieved for applications at the time of a complete furnace rebuild.</td>
</tr>
<tr>
<td>Selective non-catalytic reduction (SNCR)</td>
<td>The technique is applicable to recuperative furnaces. Very limited applicability to conventional regenerative furnaces, where the correct temperature window is difficult to access or does not allow a good mixing of the flue-gases with the reagent. It may be applicable to new regenerative furnaces equipped with split regenerators; however, the temperature window is difficult to maintain due to the reversal of fire between the chambers that causes a cyclical temperature change.</td>
</tr>
</tbody>
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Different BAT-AELs for gas-fired and oil-fired furnaces

For some sectors, specific BAT-AEL for electric melting

Main issues:

- **Sulphur balance** (retention of sulphur in glass; requirements for certain glass formulations)
- Cross-media effects (**waste production**)
- Availability of **low-sulphur fuels**
**BAT CONCLUSIONS FOR SO\textsubscript{x} EMISSIONS – EXAMPLE**

<table>
<thead>
<tr>
<th>Technique (^{(1)})</th>
<th>Applicability</th>
</tr>
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<tbody>
<tr>
<td>i. <strong>Dry or semi-dry scrubbing, in combination with a filtration system</strong></td>
<td>The technique is <em>generally applicable</em></td>
</tr>
<tr>
<td>ii. <strong>Minimisation of the sulphur content in the batch formulation and optimisation of the sulphur balance</strong></td>
<td>The minimisation of the sulphur content in the batch formulation is generally applicable within the constraints of <em>quality requirements</em> of the final glass product. The application of <em>sulphur balance optimisation</em> requires a trade-off approach between the removal of SO\textsubscript{x} emissions and the management of the solid waste (filter dust).</td>
</tr>
<tr>
<td>iii. <strong>Use of low sulphur content fuels</strong></td>
<td>The applicability may be limited by the constraints associated with the availability of low sulphur fuels and the prevailing economic conditions and energy policy of the Member State</td>
</tr>
</tbody>
</table>

\(^{(1)}\) A description of the techniques is given in Section 1.10.3.
CONCLUSIONS (1)

Significant improvements have been introduced in the BAT conclusions in terms of clarity and user friendliness of the document.

Implementation of BAT and BAT-AELs identified for the glass manufacturing sector may be “easier”:

- Important information on applicability of BAT is provided.
- BAT-AELs ranges are often given, taking into account factors influencing emission levels.
CONCLUSIONS (2)

- The **different characteristics and product requirements** of the eight glass sectors have been **taken into account**.

- **Important cross-media effects** concerning the applicability of some BAT have been **considered**.

Nevertheless, the **implementation of BAT conclusions** and BAT-AELs may still be **a challenge for the glass industry**.

- **BAT-AELs for NOx and SOx emissions**: a challenge in particular for the main glass sectors (container and flat glass).
Thank you very much for your attention

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