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)

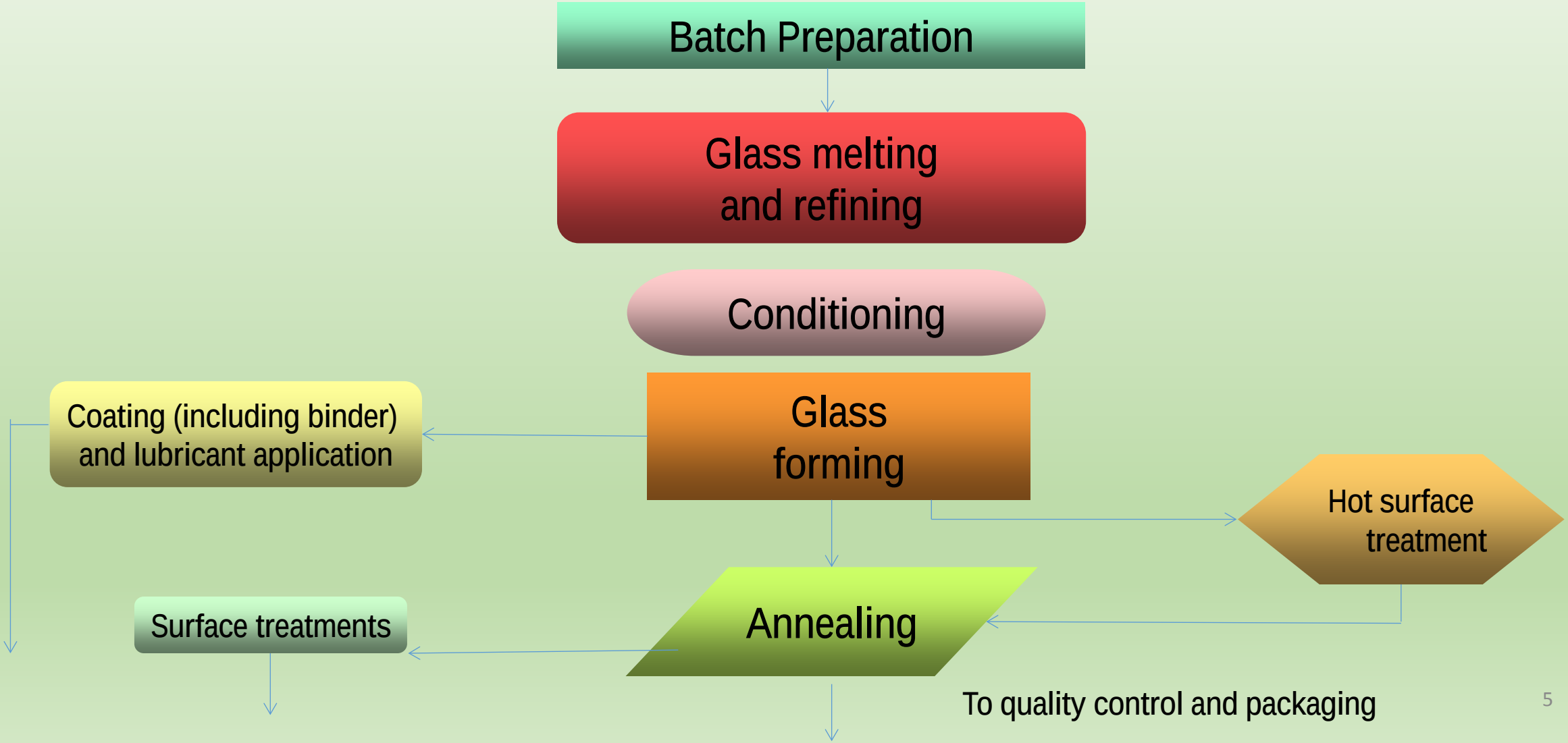
- **European Reference Document on Best Available Techniques (BAT):**
  - ✓ Includes **mandatory conclusions** for IED permit
  - ✓ Covers installations for melting of mineral substances, including glass fibre, with a **melting capacity >20 tonnes/day**
  - ✓ **Does not cover:**
    - o production of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

DEFINITION OF BEST AVAILABLE TECHNIQUES (BAT)

- 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**
TECHNIQUES	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



MAIN ENVIRONMENTAL ISSUES FOR THE GLASS MANUFACTURING INDUSTRY

- **Energy intensive process**

  ≈ 18 million tonnes CO_2 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

Are data comparable?

- **BAT conclusions** ⟶ **the result of a negotiation between different positions**

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

BAT CONCLUSIONS – TECHNICAL INFORMATION

- **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

ASSESSMENT OF BAT – APPLICABILITY

- **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

CONCENTRATION vs SPECIFIC MASS EMISSIONS (2)

- **Conversion factor from concentration to specific mass emissions for glass sectors and (in some cases) glass types within the sector:**

Conversion factor = (Q/P) x 10^{-6}

Q = Waste gas volume in Nm^3/h

P= 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

BAT AND BAT-AELs FOR DUST EMISSIONS

- The use of a secondary technique (filtration systems) is BAT for all sectors

BAT-AELs: <10 – 20 mg/Nm^3

BAT-AELs: <1 – 10 mg/Nm^3 — When using dangerous substances

- Some distinctions for continuous filament glass fibre (primary measures) and domestic glass (economic considerations)

BAT AND BAT-AELs FOR NOx EMISSIONS

- 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**

BAT AND BAT-AELs FOR NOx EMISSIONS – APPLICABILITY ISSUES

Technique	Applicability
Reduction of air/fuel ratio	Applicable to air/fuel conventional furnaces Full benefits are achieved at normal or complete furnace rebuild, when combined with optimum furnace design and geometry
Electric melting	Not applicable for large volume glass productions (>300 tonnes/day) Not applicable for productions requiring large pull variations The implementation requires a complete furnace rebuild
Oxy-fuel melting	The maximum environmental benefits are achieved for applications at the time of a complete furnace rebuild
Selective non-catalytic reduction (SNCR)	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

BAT AND BAT-AELs FOR SOx EMISSIONS

- 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 CONCUSIONS FOR SOx EMISSIONS – EXAMPLE

Technique ([1])	Applicability
i. **Dry or semi-dry scrubbing**, in combination with a **filtration system**	The technique is **generally applicable**
ii. **Minimisation of the sulphur content** in the batch formulation and optimisation of the sulphur balance	The minimisation of the sulphur content in the batch formulation is generally applicable within the constraints of **quality requirements** of the final glass product. The application of **sulphur balance optimisation** requires a trade-off approach between the removal of SO_X emissions and the management of the solid waste (filter dust)
iii. **Use of low sulphur content fuels**	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
([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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