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II *Non-legislative acts*

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([1]) Text with EEA relevance

EN

Acts whose titles are printed in light type are those relating to day-to-day management of agricultural matters, and are generally valid for a limited period.

The titles of all other acts are printed in bold type and preceded by an asterisk.

II

(Non-legislative acts)

DECISIONS

COMMISSION IMPLEMENTING DECISION

of 28 February 2012

establishing the best available techniques (BAT) conclusions under Directive 2010/75/EU of the European Parliament and of the Council on industrial emissions for the manufacture of glass

(notified under document C(2012) 865)

(Text with EEA relevance)

(2012/134/EU)

THE EUROPEAN COMMISSION,

Having regard to the Treaty on the Functioning of the European Union,

Having regard to Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control) [1] and in particular Article 13(5) thereof,

Whereas:

(1) Article 13(1) of Directive 2010/75/EU requires the Commission to organise an exchange of information on industrial emissions between it and Member States, the industries concerned and non-governmental organisations promoting environmental protection in order to facilitate the drawing up of best available techniques (BAT) reference documents as defined in Article 3(11) of that Directive.

(2) In accordance with Article 13(2) of Directive 2010/75/EU, the exchange of information is to address the performance of installations and techniques in terms of emissions, expressed as short- and long-term averages, where appropriate, and the associated reference conditions, consumption and nature of raw materials, water consumption, use of energy and generation of waste and the techniques used, associated monitoring, cross-media effects, economic and technical viability and developments therein and best available techniques and emerging techniques identified after considering the issues mentioned in points (a) and (b) of Article 13(2) of that Directive.

(3) 'BAT conclusions' as defined in Article 3(12) of Directive 2010/75/EU are the key element of BAT reference documents and lay down the conclusions on best available techniques, their description, information to assess their applicability, the emission levels associated with the best available techniques, associated monitoring, associated consumption levels and, where appropriate, relevant site remediation measures.

(4) In accordance with Article 14(3) of Directive 2010/75/EU, BAT conclusions are to be the reference for setting permit conditions for installations covered by Chapter 2 of that Directive.

(5) Article 15(3) of Directive 2010/75/EU requires the competent authority to set emission limit values that ensure that, under normal operating conditions, emissions do not exceed the emission levels associated with the best available techniques as laid down in the decisions on BAT conclusions referred to in Article 13(5) of Directive 2010/75/EU.

(6) Article 15(4) of Directive 2010/75/EU provides for derogations from the requirement laid down in Article 15(3) only where the costs associated with the achievement of emissions levels disproportionately outweigh the environmental benefits due to the geographical location, the local environmental conditions or the technical characteristics of the installation concerned.

(7) Article 16(1) of Directive 2010/75/EU provides that the monitoring requirements in the permit referred to in point (c) of Article 14(1) of the Directive are to be based on the conclusions on monitoring as described in the BAT conclusions.

[1] OJ L 334, 17.12.2010, p. 17.

(8) In accordance with Article 21(3) of Directive 2010/75/EU, within 4 years of publication of decisions on BAT conclusions, the competent authority is to reconsider and, if necessary, update all the permit conditions and ensure that the installation complies with those permit conditions.

(9) Commission Decision of 16 May 2011 establishing a forum for the exchange of information pursuant to Article 13 of Directive 2010/75/EU on industrial emissions [1] established a forum composed of representatives of Member States, the industries concerned and non-governmental organisations promoting environmental protection.

(10) In accordance with Article 13(4) of Directive 2010/75/EU, the Commission obtained the opinion [2] of that forum on the proposed content of the BAT reference document for the manufacture of glass on 13 September 2011 and made it publicly available.

(11) The measures provided for in this Decision are in accordance with the opinion of the Committee established by Article 75(1) of Directive 2010/75/EU,

HAS ADOPTED THIS DECISION:

Article 1

The BAT conclusions for the manufacture of glass are set out in the Annex to this Decision.

Article 2

This Decision is addressed to the Member States.

Done at Brussels, 28 February 2012.

For the Commission

Janez POTOČNIK

Member of the Commission

(1) OJ C 146, 17.5.2011, p. 3.

(2) http://circa.europa.eu/Public/irc/env/ied/library?l=/ied_art_13_forum/opinions_article

ANNEX

BAT CONCLUSIONS FOR THE MANUFACTURE OF GLASS

SCOPE

These BAT conclusions concern the industrial activities specified in Annex I to Directive 2010/75/EU, namely:

— 3.3. Manufacture of glass including glass fibre with a melting capacity exceeding 20 tonnes per day;

— 3.4. Melting mineral substances including the production of mineral fibres with a melting capacity exceeding 20 tonnes per day.

These BAT conclusions do not address the following activities:

— Production of water glass, covered by the reference document Large Volume Inorganic Chemicals – Solids and Other Industry (LVIC-S)

— Production of polycrystalline wool

— Production of mirrors, covered by the reference document Surface Treatment Using Organic Solvents (STS)

Other reference documents which are of relevance for the activities covered by these BAT conclusions are the following:

Reference documents	Activity
Emissions from Storage (EFS)	Storage and handling of raw materials
Energy Efficiency (ENE)	General energy efficiency
Economic and Cross-Media Effects (ECM)	Economics and cross-media effects of techniques
General Principles of Monitoring (MON)	Emissions and consumption monitoring

The techniques listed and described in these BAT conclusions are neither prescriptive nor exhaustive. Other techniques may be used that ensure at least an equivalent level of environmental protection.

DEFINITIONS

For the purposes of these BAT conclusions, the following definitions apply:

Term used	Definition
New plant	A plant introduced on the site of the installation following the publication of these BAT conclusions or a complete replacement of a plant on the existing foundations of the installation following the publication of these BAT conclusions
Existing plant	A plant which is not a new plant
New furnace	A furnace introduced on the site of the installation following the publication of these BAT conclusions or a complete rebuild of a furnace following the publication of these BAT conclusions
Normal furnace rebuild	A rebuild between campaigns without a significant change in furnace requirements or technology and in which the furnace frame is not significantly adjusted and the furnace dimensions remain basically unchanged. The refractory of the furnace and, where appropriate, the regenerators are repaired by the full or partial replacement of the material.
Complete furnace rebuild	A rebuild involving a major change in the furnace requirements or technology and with major adjustment or replacement of the furnace and associated equipments.

GENERAL CONSIDERATIONS

Averaging periods and reference conditions for air emissions

Unless stated otherwise, emission levels associated with the best available techniques (BAT-AELs) for air emissions given in these BAT conclusions apply under the reference conditions shown in Table 1. All values for concentrations in waste gases refer to standard conditions: dry gas, temperature 273,15 K, pressure 101,3 kPa.

For discontinuous measurements	BAT-AELs refer to the average value of three spot samples of at least 30 minutes each; for regenerative furnaces the measuring period should cover a minimum of two firing reversals of the regenerator chambers
For continuous measurements	BAT-AELs refer to daily average values

Table 1

Reference conditions for BAT-AELs concerning air emissions

Activities		Unit	Reference conditions
Melting activities	Conventional melting furnace in continuous melters	mg/Nm^3	8 % oxygen by volume
	Conventional melting furnace in discontinuous melters	mg/Nm^3	13 % oxygen by volume
	Oxy-fuel-fired furnaces	kg/tonne melted glass	The expression of emission levels measured as mg/Nm^3 to a reference oxygen concentration is not applicable
	Electric furnaces	mg/Nm^3 or kg/tonne melted glass	The expression of emission levels measured as mg/Nm^3 to a reference oxygen concentration is not applicable
	Frit melting furnaces	mg/Nm^3 or kg/tonne melted frit	Concentrations refer to 15 % oxygen by volume. When air-gas firing is used, BAT AELs expressed as emission concentration (mg/Nm^3) apply. When only oxy-fuel firing is employed, BAT AELs expressed as specific mass emissions (kg/tonne melted frit) apply. When oxygen-enriched air-fuel firing is used, BAT AELs expressed as either emission concentration (mg/Nm^3) or as specific mass emissions (kg/tonne melted frit) apply
	All type of furnaces	kg/tonne melted glass	The specific mass emissions refer to 1 tonne of melted glass
Non-melting activities, including downstream processes	All processes	mg/Nm^3	No correction for oxygen
	All processes	kg/tonne glass	The specific mass emissions refer to 1 tonne of produced glass

Conversion to reference oxygen concentration

The formula for calculating the emissions concentration at a reference oxygen level (see Table 1) is shown below.

$$E_R = \frac{21 - O_R}{21 - O_M} \times E_M$$

Where:

E_R (mg/Nm^3): emissions concentration corrected to the reference oxygen level O_R

O_R (vol %): reference oxygen level

E_M (mg/Nm^3): emissions concentration referred to the measured oxygen level O_M

O_M (vol %): measured oxygen level.

Conversion from concentrations to specific mass emissions

BAT-AELs given in Sections 1.2 to 1.9 as specific mass emissions (kg/tonne melted glass) are based on the calculation reported below except for oxy-fuel fired furnaces and, in a limited number of cases, for electric melting where BAT-AELs given in kg/tonne melted glass were derived from specific reported data.

The calculation procedure used for the conversion from concentrations to specific mass emissions is shown below.

Specific mass emission (kg/tonne of melted glass) = conversion factor × emissions concentration (mg/Nm^3)

Where: conversion factor = $(Q/P) \times 10^{-6}$

with Q = waste gas volume in Nm^3/h

P = pull rate in tonnes of melted glass/h.

The waste gas volume (Q) is determined by the specific energy consumption, type of fuel, and the oxidant (air, air enriched by oxygen and oxygen with purity depending on the production process). The energy consumption is a complex function of (predominantly) the type of furnace, the type of glass and the cullet percentage.

However, a range of factors can influence the relationship between concentration and specific mass flow, including:

— type of furnace (air preheating temperature, melting technique)

— type of glass produced (energy requirement for melting)

— energy mix (fossil fuel/electric boosting)

— type of fossil fuel (oil, gas)

— type of oxidant (oxygen, air, oxygen-enriched air)

— cullet percentage

— batch composition

— age of the furnace

— furnace size.

The conversion factors given in Table 2 have been used for converting BAT-AELs from concentrations into specific mass emissions.

The conversion factors have been determined on the basis of energy efficient furnaces and relate only to full air/fuel-fired furnaces.

Table 2

Indicative factors used for converting mg/Nm^3 into kg/tonne of melted glass based on energy efficient fuel-air furnaces

Sectors		Factors to convert mg/Nm^3 into kg/tonne of melted glass
Flat glass		$2,5 \times 10^{-3}$
Container glass	General case	$1,5 \times 10^{-3}$
	Specific cases (1)	Case-by-case study (often $3,0 \times 10^{-3}$)
Continuous filament glass fibre		$4,5 \times 10^{-3}$

Sectors		Factors to convert mg/Nm^3 into kg/tonne of melted glass
Domestic glass	Soda lime	$2{,}5 \times 10^{-3}$
	Specific cases (2)	Case-by-case study (between 2,5 and > 10 × 10^{-3}; often 3,0 × 10^{-3})
Mineral wool	Glass wool	2×10^{-3}
	Stone wool cupola	$2{,}5 \times 10^{-3}$
Special glass	TV glass (panels)	3×10^{-3}
	TV glass (funnel)	$2{,}5 \times 10^{-3}$
	Borosilicate (tube)	4×10^{-3}
	Glass ceramics	$6{,}5 \times 10^{-3}$
	Lighting glass (soda-lime)	$2{,}5 \times 10^{-3}$
Frits		Case-by-case study (between 5 – 7,5 × 10^{-3})

(1) Specific cases correspond to less favourable cases (i.e. small special furnaces with a production of generally below 100 tonnes/day and a cullet rate of below 30 %). This category represents only 1 or 2 % of the container glass production.
(2) Specific cases corresponding to less favourable cases and/or non-soda-lime glasses: borosilicates, glass ceramic, crystal glass and, less frequently, lead crystal glass.

DEFINITIONS FOR CERTAIN AIR POLLUTANTS

For the purpose of these BAT conclusions and for the BAT-AELs reported in Sections 1.2 to 1.9, the following definitions apply:

NO_X expressed as NO_2	The sum of nitrogen oxide (NO) and nitrogen dioxide (NO_2) expressed as NO_2
SO_X expressed as SO_2	The sum of sulphur dioxide (SO_2) and sulphur trioxide (SO_3) expressed as SO_2
Hydrogen chloride expressed as HCl	All gaseous chlorides expressed as HCl
Hydrogen fluoride expressed as HF	All gaseous fluorides expressed as HF

AVERAGING PERIODS FOR WASTE WATER DISCHARGES

Unless stated otherwise, emission levels associated with the best available techniques (BAT-AELs) for waste water emissions given in these BAT conclusions refer to the average value of a composite sample taken over a period of 2 hours or 24 hours.

1.1. *General BAT conclusions for the manufacture of glass*

Unless otherwise stated, the BAT conclusions presented in this section can be applied to all installations.

The process-specific BAT included in Sections 1.2 – 1.9 apply in addition to the general BAT mentioned in this section.

1.1.1. Environmental management systems

1. BAT is to implement and adhere to an environmental management system (EMS) that incorporates all of the following features:

(i) commitment of the management, including senior management;

(ii) definition of an environmental policy that includes the continuous improvement for the installation by the management;

(iii) planning and establishing the necessary procedures, objectives and targets, in conjunction with financial planning and investment;

(iv) implementation of the procedures paying particular attention to:

(a) structure and responsibility

(b) training, awareness and competence

(c) communication

(d) employee involvement

(e) documentation

(f) efficient process control

(g) maintenance programmes

(h) emergency preparedness and response

(i) safeguarding compliance with environmental legislation.

(v) checking performance and taking corrective action, paying particular attention to:

(a) monitoring and measurement (see also the reference document on the General Principles of Monitoring)

(b) corrective and preventive action

(c) maintenance of records

(d) independent (where practicable) internal or external auditing in order to determine whether or not the EMS conforms to planned arrangements and has been properly implemented and maintained;

(vi) review of the EMS and its continuing suitability, adequacy and effectiveness by senior management;

(vii) following the development of cleaner technologies;

(viii) consideration for the environmental impacts from the eventual decommissioning of the installation at the stage of designing a new plant, and throughout its operating life;

(ix) application of sectoral benchmarking on a regular basis.

Applicability

The scope (e.g. level of details) and nature of the EMS (e.g. standardised or non-standardised) will generally be related to the nature, scale and complexity of the installation, and the range of environmental impacts it may have.

1.1.2. Energy efficiency

2. BAT is to reduce the specific energy consumption by using one or a combination of the following techniques:

Technique	Applicability
(i) Process optimisation, through the control of the operating parameters	The techniques are generally applicable
(ii) Regular maintenance of the melting furnace	
(iii) Optimisation of the furnace design and the selection of the melting technique	Applicable for new plants. For existing plants, the implementation requires a complete rebuild of the furnace
(iv) Application of combustion control techniques	Applicable to fuel/air and oxy-fuel fired furnaces

Technique	Applicability
(v) Use of increasing levels of cullet, where available and economically and technically viable	Not applicable to the continuous filament glass fibre, high temperature insulation wool and frits sectors
(vi) Use of a waste heat boiler for energy recovery, where technically and economically viable	Applicable to fuel/air and oxy-fuel fired furnaces. The applicability and economic viability of the technique is dictated by the overall efficiency that may be obtained, including the effective use of the steam generated
(vii) Use of batch and cullet preheating, where technically and economically viable	Applicable to fuel/air and oxy-fuel fired furnaces. The applicability is normally restricted to batch compositions with more than 50 % cullet

1.1.3. Materials storage and handling

3. BAT is to prevent, or where that is not practicable, to reduce diffuse dust emissions from the storage and handling of solid materials by using one or a combination of the following techniques:

I. Storage of raw materials

(i) Store bulk powder materials in enclosed silos equipped with a dust abatement system (e.g. fabric filter)

(ii) Store fine materials in enclosed containers or sealed bags

(iii) Store under cover stockpiles of coarse dusty materials

(iv) Use of road cleaning vehicles and water damping techniques

II. Handling of raw materials

Technique	Applicability
(i) For materials which are transported by above ground, use enclosed conveyors to prevent material loss	The techniques are generally applicable
(ii) Where pneumatic conveying is used, apply a sealed system equipped with a filter to clean the transport air before release	
(iii) Moistening of the batch	The use of this technique is limited by the negative consequences on the furnace energy efficiency. Restrictions may apply to some batch formulations, in particular for borosilicate glass production
(iv) Application of a slightly negative pressure within the furnace	Applicable only as an inherent aspect of operation (i.e. melting furnaces for frits production) due to a detrimental impact on furnace energy efficiency
(v) Use of raw materials that do not cause decrepitation phenomena (mainly dolomite and limestone). These phenomena consist of minerals that 'crackle' when exposed to heat, with a consequent potential increase of dust emissions	Applicable within the constraints associated with the availability of raw materials
(vi) Use of an extraction which vents to a filter system in processes where dust is likely to be generated (e.g. bag opening, frits batch mixing, fabric filter dust disposal, cold-top melters)	The techniques are generally applicable
(vii) Use of enclosed screw feeders	
(viii) Enclosure of feed pockets	Generally applicable. Cooling may be necessary to avoid damage to the equipment

4. BAT is to prevent, or where that is not practicable, to reduce diffuse gaseous emissions from the storage and handling of volatile raw materials by using one or a combination of the following techniques:

(i) Use of tank paint with low solar absorbency for bulk storage subject to temperature changes due to solar heating.

(ii) Control of temperature in the storage of volatile raw materials.

(iii) Tank insulation in the storage of volatile raw materials.

(iv) Inventory management

(v) Use of floating roof tanks in the storage of large quantities of volatile petroleum products.

(vi) Use of vapour return transfer systems in the transfer of volatile fluids (e.g. from tank trucks to storage tank).

(vii) Use of bladder roof tanks in the storage of liquid raw materials.

(viii) Use of pressure/vacuum valves in tanks designed to withstand pressure fluctuations.

(ix) Application of a release treatment (e.g. adsorption, absorption, condensation) in the storage of hazardous materials.

(x) Application of subsurface filling in the storage of liquids that tend to foam.

1.1.4. General primary techniques

5. BAT is to reduce energy consumption and emissions to air by carrying out a constant monitoring of the operational parameters and a programmed maintenance of the melting furnace.

Technique	Applicability
The technique consists of a series of monitoring and maintenance operations which can be used individually or in combination appropriate to the type of furnace, with the aim of minimising the ageing effects on the furnace, such as sealing the furnace and burner blocks, keep the maximum insulation, control the stabilised flame conditions, control the fuel/air ratio, etc.	Applicable to regenerative, recuperative, and oxy-fuel fired furnaces. The applicability to other types of furnaces requires an installation-specific assessment

6. BAT is to carry out a careful selection and control of all substances and raw materials entering the melting furnace in order to reduce or prevent emissions to air by using one or a combination of the following techniques.

Technique	Applicability
(i) Use of raw materials and external cullet with low levels of impurities (e.g. metals, chlorides, fluorides)	Applicable within the constraints of the type of glass produced at the installation and the availability of raw materials and fuels
(ii) Use of alternative raw materials (e.g. less volatile)	
(iii) Use of fuels with low metal impurities	

7. BAT is to carry out monitoring of emissions and/or other relevant process parameters on a regular basis, including the following:

Technique	Applicability
(i) Continuous monitoring of critical process parameters to ensure process stability, e.g. temperature, fuel feed and airflow	The techniques are generally applicable
(ii) Regular monitoring of process parameters to prevent/reduce pollution, e.g. O_2 content of the combustion gases to control the fuel/air ratio.	
(iii) Continuous measurements of dust, NO_X and SO_2 emissions or discontinuous measurements at least twice per year, associated with the control of surrogate parameters to ensure that the treatment system is working properly between measurements	
(iv) Continuous or regular periodic measurements of NH_3 emissions, when selective catalytic reduction (SCR) or selective non-catalytic reduction (SNCR) techniques are applied	The techniques are generally applicable
(v) Continuous or regular periodic measurements of CO emissions when primary techniques or chemical reduction by fuel techniques are applied for NO_X emissions reductions or partial combustion may occur.	
(vi) Regular periodic measurements of emissions of HCl, HF, CO and metals, in particular when raw materials containing such substances are used or partial combustion may occur	The techniques are generally applicable
(vii) Continuous monitoring of surrogate parameters to ensure that the waste gas treatment system is working properly and that the emission levels are maintained between discontinuous measurements. The monitoring of surrogate parameters includes: reagent feed, temperature, water feed, voltage, dust removal, fan speed, etc.	

8. BAT is to operate the waste gas treatment systems during normal operating conditions at optimal capacity and availability in order to prevent or reduce emissions

Applicability

Special procedures can be defined for specific operating conditions, in particular:

(i) during start-up and shutdown operations

(ii) during other special operations which could affect the proper functioning of the systems (e.g. regular and extra-ordinary maintenance work and cleaning operations of the furnace and/or of the waste gas treatment system, or severe production change)

(iii) in the case of insufficient waste gas flow or temperature which prevents the use of the system at full capacity.

9. BAT is to limit carbon monoxide (CO) emissions from the melting furnace, when applying primary techniques or chemical reduction by fuel, for the reduction of NO_X emissions

Technique	Applicability
Primary techniques for the reduction of NO_X emissions are based on combustion modifications (e.g. reduction of air/fuel ratio, staged combustion low-NO_X burners, etc.). Chemical reduction by fuel consists of the addition of hydrocarbon fuel to the waste gas stream to reduce the NO_X formed in the furnace. The increase in CO emissions due to the application of these techniques can be limited by a careful control of the operational parameters	Applicable to conventional air/fuel fired furnaces.

Table 3

BAT-AELs for carbon monoxide emissions from melting furnaces

Parameter	BAT-AEL
Carbon monoxide, expressed as CO	< 100 mg/Nm^3

10. BAT is to limit ammonia (NH_3) emissions, when applying selective catalytic reduction (SCR) or selective non-catalytic reduction (SNCR) techniques for a high efficiency NO_X emissions reduction

Technique	Applicability
The technique consists of adopting and maintaining suitable operating conditions of the SCR or SNCR waste gas treatment systems, with the aim of limiting emissions of unreacted ammonia	Applicable to melting furnaces fitted with SCR or SNCR

Table 4

BAT-AELs for ammonia emissions, when SCR or SNCR techniques are applied

Parameter	BAT-AELs (1)
Ammonia, expressed as NH_3	< 5 – 30 mg/Nm^3

(1) The higher levels are associated with higher inlet NO_X concentrations, higher reduction rates and the ageing of the catalyst.

11. BAT is to reduce boron emissions from the melting furnace, when boron compounds are used in the batch formulation, by using one or a combination of the following techniques:

Technique (1)	Applicability
(i) Operation of a filtration system at a suitable temperature for enhancing the separation of boron compounds in the solid state, taking into account that some boric acid species may be present in the flue-gas as gaseous compounds at temperatures below 200 °C, but also as low as 60 °C	The applicability to existing plants may be limited by technical constraints associated with the position and characteristics of the existing filter system
(ii) Use of dry or semi-dry scrubbing in combination with a filtration system	The applicability may be limited by a decreased removal efficiency of other gaseous pollutants (SO_X, HCl, HF) caused by the deposition of boron compounds on the surface of the dry alkaline reagent
(iii) Use of wet scrubbing	The applicability to existing plants may be limited by the need of a specific waste water treatment

(1) A description of the techniques is given in Sections 1.10.1, 1.10.4 and 1.10.6.

Monitoring

The monitoring of boron emissions should be carried out according to a specific methodology which allows measurement of both solid and gaseous forms and to determine the effective removal of these species from the flue gases.

1.1.5. Emissions to water from glass manufacturing processes

12. BAT is to reduce water consumption by using one or a combination of the following techniques:

Technique	Applicability
(i) Minimisation of spillages and leaks	The technique is generally applicable
(ii) Reuse of cooling and cleaning waters after purging	The technique is generally applicable. Recirculation of scrubbing water is applicable to most scrubbing systems; however, periodic discharge and replacement of the scrubbing medium may be necessary

Technique	Applicability
(iii) Operate a quasi-closed loop water system as far as technically and economically feasible	The applicability of this technique may be limited by the constraints associated with the safety management of the production process. In particular: — open circuit cooling may be used when safety issues require for it (e.g. incidents when large quantities of glass need to be cooled) — water used in some specific process (e.g. downstream activities in the continuous filament glass fibre sector, acid polishing in the domestic and special glass sectors, etc.) may have to be discharged in total or in part to the waste water treatment system

13. BAT is to reduce the emission load of pollutants in the waste water discharges by using one or a combination of the following waste water treatment systems:

Technique	Applicability
(i) Standard pollution control techniques, such as settlement, screening, skimming, neutralisation, filtration, aeration, precipitation, coagulation and flocculation, etc. Standard good practice techniques to control emissions from storage of liquid raw materials and intermediates, such as containments, inspection/testing of tanks, overfill protection, etc.	The techniques are generally applicable
(ii) Biological treatment systems, such as activated sludge, biofiltration to remove/degrade the organic compounds	The applicability is limited to the sectors which use organic substances in the production process (e.g. continuous filament glass fibre and mineral wool sectors)
(iii) Discharge to municipal waste water treatment Plants	Applicable to installations where further reduction of pollutants is necessary
(iv) External reuse of waste waters	The applicability is generally limited to the frits sector (possible reuse in the ceramic industry)

Table 5

BAT-AELs for waste water discharges to surface waters from the manufacture of glass

Parameter [1]	Unit	BAT-AEL [2] (composite sample)
pH	—	6,5 – 9
Total suspended solids	mg/l	< 30
Chemical oxygen demand (COD)	mg/l	< 5 – 130 [3]
Sulphates, expressed as SO_4^{2-}	mg/l	< 1 000
Fluorides, expressed as F^-	mg/l	< 6 [4]
Total hydrocarbons	mg/l	< 15 [5]
Lead, expressed as Pb	mg/l	< 0,05 – 0,3 [6]
Antimony, expressed as Sb	mg/l	< 0,5
Arsenic, expressed as As	mg/l	< 0,3
Barium, expressed as Ba	mg/l	< 3,0

Parameter [1]	Unit	BAT-AEL [2] (composite sample)
Zinc, expressed as Zn	mg/l	< 0,5
Copper, expressed as Cu	mg/l	< 0,3
Chromium, expressed as Cr	mg/l	< 0,3
Cadmium, expressed as Cd	mg/l	< 0,05
Tin, expressed as Sn	mg/l	< 0,5
Nickel, expressed as Ni	mg/l	< 0,5
Ammonia, expressed as NH_4	mg/l	< 10
Boron, expressed as B	mg/l	< 1 – 3
Phenol	mg/l	< 1

(1) The relevance of the pollutants listed in the table depends on the sector of the glass industry and on the different activities carried out at the plant.
(2) The levels refer to a composite sample taken over a time period of 2 hours or 24 hours.
(3) For the continuous filament glass fibre sector, BAT-AEL is < 200 mg/l.
(4) The level refers to treated water coming from activities involving acid polishing.
(5) In general, total hydrocarbons are composed of mineral oils.
(6) The higher level of the range is associated with downstream processes for the production of lead crystal glass.

1.1.6. Waste from the glass manufacturing processes

14. BAT is to reduce the production of solid waste to be disposed of by using one or a combination of the following techniques:

Technique	Applicability
(i) Recycling of waste batch materials, where quality requirements allow for it	The applicability may be limited by the constraints associated with the quality of the final glass product
(ii) Minimising material losses during the storage and handling of raw materials	The technique is generally applicable
(iii) Recycling of internal cullet from rejected production	Generally, not applicable to the continuous filament glass fibre, high temperature insulation wool and frits sectors
(iv) Recycling of dust in the batch formulation where quality requirements allow for it	The applicability may be limited by different factors: — quality requirements of the final glass product — cullet percentage used in the batch formulation — potential carryover phenomena and corrosion of the refractory materials — sulphur balance constraints
(v) Valorisation of solid waste and/or sludge through appropriate use on-site (e.g. sludge from water treatment) or in other industries	Generally applicable to the domestic glass sector (for lead crystal cutting sludge) and to the container glass sector (fine particles of glass mixed with oil). Limited applicability to other glass manufacturing sectors due to unpredictable, contaminated composition, low volumes and economic viability
(vi) Valorisation of end-of-life refractory materials for possible use in other industries	The applicability is limited by the constraints imposed by the refractory manufacturers and potential end-users
(vii) Applying cement bonded briquetting of waste for recycling into hot blast cupola furnaces where quality requirements allow for it	The applicability of cement bonded briquetting of waste is limited to the stone wool sector. A trade-off approach between air emissions and the generation of solid waste stream should be undertaken

1.1.7. Noise from the glass manufacturing processes

15. BAT is to reduce noise emissions by using one or a combination of the following techniques:

(i) Make an environmental noise assessment and formulate a noise management plan as appropriate to the local environment

(ii) Enclose noisy equipment/operation in a separate structure/unit

(iii) Use embankments to screen the source of noise

(iv) Carry out noisy outdoor activities during the day

(v) Use noise protection walls or natural barriers (trees, bushes) between the installation and the protected area, on the basis of local conditions.

1.2. *BAT conclusions for container glass manufacturing*

Unless otherwise stated, the BAT conclusions presented in this section can be applied to all container glass manufacturing installations.

1.2.1. Dust emissions from melting furnaces

16. BAT is to reduce dust emissions from the waste gases of the melting furnace by applying a flue-gas cleaning system such as an electrostatic precipitator or a bag filter.

Technique [1]	Applicability
The flue-gas cleaning systems consist of end-of-pipe techniques based on the filtration of all materials that are solid at the point of measurement	The technique is generally applicable

[1] A description of filtration systems (i.e. electrostatic precipitator, bag filter) is given in Section 1.10.1.

Table 6

BAT-AELs for dust emissions from the melting furnace in the container glass sector

Parameter	BAT-AEL	
	mg/Nm^3	kg/tonne melted glass [1]
Dust	< 10 – 20	< 0,015 – 0,06

[1] The conversion factors of $1,5 \times 10^{-3}$ and 3×10^{-3} have been used for the determination of the lower and higher value of the range respectively.

1.2.2. Nitrogen oxides (NO_X) from melting furnaces

17. BAT is to reduce NO_X emissions from the melting furnace by using one or a combination of the following techniques:

I. primary techniques, such as:

Technique [1]	Applicability
(i) Combustion modifications	
(a) 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
(b) Reduced combustion air temperature	Applicable only under installation-specific circumstances due to a lower furnace efficiency and higher fuel demand (i.e. use of recuperative furnaces in place of regenerative furnaces)

Technique (¹)	Applicability
(c) Staged combustion: — Air staging — Fuel staging	Fuel staging is applicable to most conventional air/fuel furnaces. Air staging has very limited applicability due to its technical complexity
(d) Flue-gas recirculation	The applicability of this technique is limited to the use of special burners with automatic recirculation of the waste gas
(e) Low-NO_X burners	The technique is generally applicable. The achieved environmental benefits are generally lower for applications to cross-fired, gas-fired furnaces due to technical constraints and a lower degree of flexibility of the furnace. Full benefits are achieved at normal or complete furnace rebuild, when combined with optimum furnace design and geometry
(f) Fuel choice	The applicability is limited by the constraints associated with the availability of different types of fuel, which may be impacted by the energy policy of the Member State
(ii) Special furnace design	The applicability is limited to batch formulations that contain high levels of external cullet (> 70 %). The application requires a complete rebuild of the melting furnace. The shape of the furnace (long and narrow) may pose space restrictions
(iii) 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
(iv) Oxy-fuel melting	The maximum environmental benefits are achieved for applications at the time of a complete furnace rebuild

(¹) A description of the techniques is given in Section 1.10.2.

II. secondary techniques, such as:

Technique (¹)	Applicability
(i) Selective catalytic reduction (SCR)	The application may require an upgrade of the dust abatement system in order to guarantee a dust concentration of below 10 – 15 mg/Nm^3 and a desulphurisation system for the removal of SO_X emissions. Due to the optimum operating temperature window, the applicability is limited to the use of electrostatic precipitators. In general, the technique is not used with a bag filter system because the low operating temperature, in the range of 180 – 200 °C, would require reheating of the waste gases. The implementation of the technique may require significant space availability
(ii) 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

(¹) A description of the techniques is given in Section 1.10.2.

Table 7

BAT-AELs for NO_X emissions from the melting furnace in the container glass sector

Parameter	BAT	BAT-AEL	
		mg/Nm^3	kg/tonne melted glass (1)
NO_X expressed as NO_2	Combustion modifications, special furnace designs (2) (3)	500 – 800	0,75 – 1,2
	Electric melting	< 100	< 0,3
	Oxy-fuel melting (4)	Not applicable	< 0,5 – 0,8
	Secondary techniques	< 500	< 0,75

(1) The conversion factor reported in Table 2 for general cases ($1,5 \times 10^{-3}$) has been applied, with the exception of electric melting (specific cases: 3×10^{-3}).
(2) The lower value refers to the use of special furnace designs, where applicable.
(3) These values should be reconsidered in the occasion of a normal or complete rebuild of the melting furnace.
(4) The achievable levels depend on the quality of the natural gas and oxygen available (nitrogen content).

18. When nitrates are used in the batch formulation and/or special oxidising combustion conditions are required in the melting furnace for ensuring the quality of the final product, BAT is to reduce NO_X emissions by minimising the use of these raw materials, in combination with primary or secondary techniques

The BAT-AELs are set out in Table 7.

If nitrates are used in the batch formulation for short campaigns or for melting furnaces with a capacity of < 100 t/day, the BAT-AEL is set out in Table 8.

Technique (1)	Applicability
Primary techniques: — Minimising the use of nitrates in the batch formulation The use of nitrates is applied for very high quality products (i.e. flacconage, perfume bottles and cosmetic containers). Effective alternative materials are sulphates, arsenic oxides, cerium oxide. The application of process modifications (e.g. special oxidising combustion conditions) represents an alternative to the use of nitrates	The substitution of nitrates in the batch formulation may be limited by the high costs and/or higher environmental impact of the alternative materials

(1) A description of the techniques is given in Section 1.10.2.

Table 8

BAT-AEL for NO_X emissions from the melting furnace in the container glass sector, when nitrates are used in the batch formulation and/or special oxidising combustion conditions in cases of short campaigns or for melting furnaces with a capacity of < 100 t/day

Parameter	BAT	BAT-AEL	
		mg/Nm^3	kg/tonne melted glass (1)
NO_X expressed as NO_2	Primary techniques	< 1 000	< 3

(1) The conversion factor reported in Table 2 for specific cases (3×10^{-3}) has been applied.

1.2.3. Sulphur oxides (SO_X) from melting furnaces

19. BAT is to reduce SO_X emissions from the melting furnace by using one or a combination of the following techniques:

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). The effective reduction of SO_X emissions depends on the retention of sulphur compounds in the glass which may vary significantly depending on the glass type
(iii) Use of low sulphur content fuels	The applicability may be limited by the constraints associated with the availability of low sulphur fuels, which may be impacted by the energy policy of the Member State

[1] A description of the techniques is given in Section 1.10.3.

Table 9

BAT-AELs for SO_X emissions from the melting furnace in the container glass sector

Parameter	Fuel	BAT-AEL [1] [2]	
		mg/Nm^3	kg/tonne melted glass [3]
SO_X expressed as SO_2	Natural gas	< 200 – 500	< 0,3 – 0,75
	Fuel oil [4]	< 500 – 1 200	< 0,75 – 1,8

[1] For special types of coloured glasses (e.g. reduced green glasses), concerns related to the achievable emission levels may require investigating the sulphur balance. Values reported in the table may be difficult to achieve in combination with filter dust recycling and the rate of recycling of external cullet.
[2] The lower levels are associated with conditions where the reduction of SO_X is a high priority over a lower production of solid waste corresponding to the sulphate-rich filter dust.
[3] The conversion factor reported in Table 2 for general cases ($1,5 \times 10^{-3}$) has been applied.
[4] The associated emission levels are related to the use of 1 % sulphur fuel oil in combination with secondary abatement techniques.

1.2.4. Hydrogen chloride (HCl) and hydrogen fluoride (HF) from melting furnaces

20. BAT is to reduce HCl and HF emissions from the melting furnace (possibly combined with flue-gases from hot-end coating activities) by using one or a combination of the following techniques:

Technique [1]	Applicability
(i) Selection of raw materials for the batch formulation with a low content of chlorine and fluorine	The applicability may be limited by the constraints of the type of glass produced at the installation and the availability of raw materials
(ii) Dry or semi-dry scrubbing, in combination with a filtration system	The technique is generally applicable

[1] A description of the techniques is given in Section 1.10.4.

Table 10

BAT-AELs for HCl and HF emissions from the melting furnace in the container glass sector

Parameter	BAT-AEL	
	mg/Nm^3	kg/tonne melted glass (1)
Hydrogen chloride, expressed as HCl (2)	< 10 – 20	< 0,02 – 0,03
Hydrogen fluoride, expressed as HF	< 1 – 5	< 0,001 – 0,008

(1) The conversion factor for general cases, reported in Table 2 ($1,5 \times 10^{-3}$) has been applied.
(2) The higher levels are associated with the simultaneous treatment of flue-gases from hot-end coating operations.

1.2.5. Metals from melting furnaces

21. BAT is to reduce metal emissions from the melting furnace by using one or a combination of the following techniques:

Technique (1)	Applicability
(i) Selection of raw materials for the batch formulation with a low content of metals	The applicability may be limited by the constraints imposed by the type of glass produced at the installation and the availability of the raw materials
(ii) Minimising the use of metal compounds in the batch formulation, where colouring and decolourising of glass is needed, subject to consumer glass quality requirements	
(iii) Applying a filtration system (bag filter or electrostatic precipitator)	The techniques are generally applicable
(iv) Applying a dry or semi-dry scrubbing, in combination with a filtration system	

(1) A description of the techniques is given in Section 1.10.5.

Table 11

BAT-AELs for metal emissions from the melting furnace in the container glass sector

Parameter	BAT-AEL (1) (2) (3)	
	mg/Nm^3	kg/tonne melted glass (4)
Σ (As, Co, Ni, Cd, Se, Cr_{VI})	< 0,2 – 1 (5)	$< 0,3 - 1,5 \times 10^{-3}$
Σ (As, Co, Ni, Cd, Se, Cr_{VI}, Sb, Pb, Cr_{III}, Cu, Mn, V, Sn)	< 1 – 5	$< 1,5 - 7,5 \times 10^{-3}$

(1) The levels refer to the sum of metals present in the flue-gases in both solid and gaseous phases.
(2) The lower levels are BAT-AELs when metal compounds are not intentionally used in the batch formulation.
(3) The upper levels are associated with the use of metals for colouring or decolourising the glass, or when the flue-gases from the hot-end coating operations are treated together with the melting furnace emissions.
(4) The conversion factor for general cases, reported in Table 2 ($1,5 \times 10^{-3}$) has been applied.
(5) In specific cases, when high quality flint glass is produced requiring higher amounts of selenium for decolourising (depending on the raw materials), higher values are reported, up to 3 mg/Nm^3.

1.2.6. Emissions from downstream processes

22. When tin, organotin or titanium compounds are used for hot-end coating operations, BAT is to reduce emissions by using one or a combination of the following techniques:

Technique	Applicability
(i) Minimising the losses of the coating product by ensuring a good sealing of the application system and applying an effective extracting hood. A good construction and sealing of the application system is essential for minimising losses of unreacted product into the air	The technique is generally applicable

Technique	Applicability
(ii) Combining the flue-gas from the coating operations with the waste gas from the melting furnace or with the combustion air of the furnace, when a secondary treatment system is applied (filter and dry or semi-dry scrubber). Based on the chemical compatibility, the waste gases from the coating operations may be combined with other flue-gases before treatment. These two options may be applied: — combination with the flue gases from the melting furnace, upstream of a secondary abatement system (dry or semi-dry scrubbing plus filtration system) — combination with combustion air before entering the regenerator, followed by secondary abatement treatment of the waste gases generated during the melting process (dry or semi-dry scrubbing + filtration system)	The combination with flue gases from the melting furnace is generally applicable. The combination with combustion air may be affected by technical constraints due to some potential effects on the glass chemistry and on the regenerator materials
(iii) Applying a secondary technique, e.g. wet scrubbing, dry scrubbing plus filtration ([1])	The techniques are generally applicable

([1]) A description of the techniques is given in Sections 1.10.4 and 1.10.7.

Table 12

BAT-AELs for air emissions from hot-end coating activities in the container glass sector when the flue-gases from downstream operations are treated separately

Parameter	BAT-AEL
	mg/Nm^3
Dust	< 10
Titanium compounds expressed as Ti	< 5
Tin compounds, including organotin, expressed as Sn	< 5
Hydrogen chloride, expressed as HCl	< 30

23. When SO_3 is used for surface treatment operations, BAT is to reduce SO_X emissions by using one or a combination of the following techniques:

Technique ([1])	Applicability
(i) Minimising the product losses by ensuring a good sealing of the application system A good construction and maintenance of the application system is essential for minimising the losses of unreacted product into the air	The techniques are generally applicable
(ii) Applying a secondary technique, e.g. wet scrubbing	

([1]) A description of the techniques is given in Section 1.10.6.

Table 13

BAT-AEL for SO_X emissions from downstream activities when SO_3 is used for surface treatment operations in the container glass sector, when treated separately

Parameter	BAT-AEL
	mg/Nm^3
SO_x, expressed as SO_2	< 100 – 200

1.3. *BAT conclusions for flat glass manufacturing*

Unless otherwise stated, the BAT conclusions presented in this section can be applied to all flat glass manufacturing installations.

1.3.1. Dust emissions from melting furnaces

24. BAT is to reduce dust emissions from the waste gases of the melting furnace by applying an electrostatic precipitator or a bag filter system

A description of the techniques is given in Section 1.10.1.

Table 14

BAT-AELs for dust emissions from the melting furnace in the flat glass sector

Parameter	BAT-AEL	
	mg/Nm^3	kg/tonne melted glass [1]
Dust	< 10 – 20	< 0,025 – 0,05

[1] The conversion factor reported in Table 2 ($2,5 \times 10^{-3}$) has been applied.

1.3.2. Nitrogen oxides (NO_X) from melting furnaces

25. BAT is to reduce NO_X emissions from the melting furnace by using one or a combination of the following techniques:

I. primary techniques, such as:

Technique [1]	Applicability
(i) Combustion modifications	
(a) 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
(b) Reduced combustion air temperature	The applicability is restricted to small capacity furnaces for the production of specialty flat glass and under installation-specific circumstances, due to a lower furnace efficiency and higher fuel demand (i.e. use of recuperative furnaces in place of regenerative furnaces)
(c) Staged combustion: — Air staging — Fuel staging	Fuel staging is applicable to most conventional air/fuel furnaces. Air staging has very limited applicability due to its technical complexity
(d) Flue-gas recirculation	The applicability of this technique is limited to the use of special burners with automatic recirculation of the waste gas
(e) Low-NO_X burners	The technique is generally applicable. The achieved environmental benefits are generally lower for applications to cross-fired, gas-fired furnaces due to technical constraints and a lower degree of flexibility of the furnace. Full benefits are achieved at normal or complete furnace rebuild, when combined with optimum furnace design and geometry
(f) Fuel choice	The applicability is limited by the constraints associated with the availability of different types of fuel, which may be impacted by the energy policy of the Member State

Technique (1)	Applicability
(ii) Fenix process Based on the combination of a number of primary techniques for the optimisation of the combustion of cross-fired regenerative float furnaces. The main features are: — reduction of excess air — suppression of hotspots and homogenisation of the flame temperatures — controlled mixing of the fuel and combustion air	The applicability is limited to cross-fired regenerative furnaces. Applicable to new furnaces. For existing furnaces, the technique requires being directly integrated during the design and construction of the furnace, at a complete furnace rebuild
(iii) Oxy-fuel melting	The maximum environmental benefits are achieved for applications at the time of a complete furnace rebuild

(1) A description of the techniques is given in Section 1.10.2.

II. secondary techniques, such as:

Technique (1)	Applicability
(i) Chemical reduction by fuel	Applicable to regenerative furnaces. The applicability is limited by an increased fuel consumption and consequent environmental and economic impact
(ii) Selective catalytic reduction (SCR)	The application may require an upgrade of the dust abatement system in order to guarantee a dust concentration of below 10 – 15 mg/Nm^3 and a desulphurisation system for the removal of SO_X emissions Due to the optimum operating temperature window, the applicability is limited to the use of electrostatic precipitators. In general, the technique is not used with a bag filter system because the low operating temperature, in the range of 180 – 200 °C, would require reheating of the waste gases. The implementation of the technique may require significant space availability

(1) A description of the techniques is given in Section 1.10.2.

Table 15

BAT-AELs for NO_X emissions from the melting furnace in the flat glass sector

Parameter	BAT	BAT-AEL (1)	
		mg/Nm^3	kg/tonne melted glass (2)
NO_X expressed as NO_2	Combustion modifications, Fenix process (3)	700 – 800	1,75 – 2,0
	Oxy-fuel melting (4)	Not applicable	< 1,25 – 2,0
	Secondary techniques (5)	400 – 700	1,0 – 1,75

(1) Higher emission levels are expected when nitrates are used occasionally for the production of special glasses.
(2) The conversion factor reported in Table 2 ($2,5 \times 10^{-3}$) has been applied.
(3) The lower levels of the range are associated with the application of the Fenix process.
(4) The achievable levels depend on the quality of the natural gas and oxygen available (nitrogen content).
(5) The higher levels of the range are associated with existing plants until a normal or complete rebuild of the melting furnace. The lower levels are associated with newer/retrofitted plants.

26. When nitrates are used in the batch formulation, BAT is to reduce NO_X emissions by minimising the use of these raw materials, in combination with primary or secondary techniques. If secondary techniques are applied, the BAT-AELs reported in Table 15 are applicable.

If nitrates are used in the batch formulation for the production of special glasses in a limited number of short campaigns, the BAT-AELs are set out in Table 16.

Technique [1]	Applicability
Primary techniques: minimising the use of nitrates in the batch formulation The use of nitrates is applied for special productions (i.e. coloured glass). Effective alternative materials are sulphates, arsenic oxides, cerium oxide	The substitution of nitrates in the batch formulation may be limited by the high costs and/or higher environmental impact of the alternative materials

[1] A description of the technique is given in Section 1.10.2.

Table 16

BAT-AEL for NO_X emissions from the melting furnace in the flat glass sector, when nitrates are used in the batch formulation for the production of special glasses in a limited number of short campaigns

Parameter	BAT	BAT-AEL	
		mg/Nm^3	kg/tonne melted glass [1]
NO_X expressed as NO_2	Primary techniques	< 1 200	< 3

[1] The conversion factor reported in Table 2 for specific cases ($2,5 \times 10^{-3}$) has been applied

1.3.3. Sulphur oxides (SO_X) from melting furnaces

27. BAT is to reduce SO_X emissions from the melting furnace by using one or a combination of the following techniques:

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, which may be impacted by the energy policy of the Member State

[1] A description of the techniques is given in Section 1.10.3.

Table 17

BAT-AELs for SO_X emissions from the melting furnace in the flat glass sector

Parameter	Fuel	BAT-AEL [1]	
		mg/Nm^3	kg/tonne melted glass [2]
SO_x expressedas SO_2	Natural gas	< 300 – 500	< 0,75 – 1,25
	Fuel oil [3] [4]	500 – 1 300	1,25 – 3,25

[1] The lower levels are associated with conditions where the reduction of SO_X has a high priority over a lower production of solid waste corresponding to the sulphate-rich filter dust.
[2] The conversion factor reported in Table 2 ($2,5 \times 10^{-3}$) has been applied.
[3] The associated emission levels are related to the use of 1 % sulphur fuel oil in combination with secondary abatement techniques.
[4] For large flat glass furnaces, concerns related to the achievable emission levels may require investigating the sulphur balance. Values reported in the table may be difficult to achieve in combination with filter dust recycling.

1.3.4. Hydrogen chloride (HCl) and hydrogen fluoride (HF) from melting furnaces

28. BAT is to reduce HCl and HF emissions from the melting furnace by using one or a combination of the following techniques:

Technique (1)	Applicability
(i) Selection of raw materials for the batch formulation with a low content of chlorine and fluorine	The applicability may be limited by the constraints of the type of glass produced at the installation and the availability of raw materials
(ii) Dry or semi-dry scrubbing, in combination with a filtration system	The technique is generally applicable

(1) A description of the techniques is given in Section 1.10.4.

Table 18

BAT-AELs for HCl and HF emissions from the melting furnace in the flat glass sector

Parameter	BAT-AEL	
	mg/Nm^3	kg/tonne melted glass (1)
Hydrogen chloride, expressed as HCl (2)	< 10 – 25	< 0,025 – 0,0625
Hydrogen fluoride, expressed as HF	< 1 – 4	< 0,0025 – 0,010

(1) The conversion factor reported in Table 2 ($2,5 \times 10^{-3}$) has been applied.
(2) The higher levels of the range are associated with the recycling of filter dust in the batch formulation

1.3.5. Metals from melting furnaces

29. BAT is to reduce metal emissions from the melting furnace by using one or a combination of the following techniques:

Technique (1)	Applicability
(i) Selection of raw materials for the batch formulation with a low content of metals	The applicability may be limited by the constraints imposed by the type of glass produced at the installation and the availability of the raw materials.
(ii) Applying a filtration system	The technique is generally applicable
(iii) Applying a dry or semi-dry scrubbing, in combination with a filtration system	

(1) A description of the techniques is given in Section 1.10.5.

Table 19

BAT-AELs for metal emissions from the melting furnace in the flat glass sector, with the exception of selenium coloured glasses

Parameter	BAT-AEL (1)	
	mg/Nm^3	kg/tonne melted glass (2)
Σ (As, Co, Ni, Cd, Se, Cr_{VI})	< 0,2 – 1	$< 0,5 - 2,5 \times 10^{-3}$
Σ (As, Co, Ni, Cd, Se, Cr_{VI}, Sb, Pb, Cr_{III}, Cu, Mn, V, Sn)	< 1 – 5	$< 2,5 - 12,5 \times 10^{-3}$

(1) The ranges refer to the sum of metals present in the flue-gases in both solid and gaseous phases.
(2) The conversion factor reported in Table 2 ($2,5 \times 10^{-3}$) has been applied

30. When selenium compounds are used for colouring the glass, BAT is to reduce selenium emissions from the melting furnace by using one or a combination of the following techniques:

Technique [1]	Applicability
(i) Minimising the evaporation of selenium from the batch composition by selecting raw materials with a higher retention efficiency in the glass and reduced volatilisation	The applicability may be limited by the constraints imposed by the type of glass produced at the installation and the availability of the raw materials
(ii) Applying a filtration system	The technique is generally applicable
(iii) Applying a dry or semi-dry scrubbing, in combination with a filtration system	

[1] A description of the techniques is given in Section 1.10.5.

Table 20

BAT-AELs for selenium emissions from the melting furnace in the flat glass sector for the production of coloured glass

Parameter	BAT-AEL [1] [2]	
	mg/Nm^3	kg/tonne melted glass [3]
Selenium compounds, expressed as Se	1 – 3	$2{,}5 - 7{,}5 \times 10^{-3}$

[1] The values refer to the sum of selenium present in the flue-gases in both solid and gaseous phases.
[2] The lower levels correspond to conditions where the reduction of Se emissions is a priority over a lower production of solid waste from filter dust. In this case, a high stoichiometric ratio (reagent/pollutant) is applied and a significant solid waste stream is generated.
[3] The conversion factor reported in Table 2 ($2{,}5 \times 10^{-3}$) has been applied.

1.3.6. Emissions from downstream processes

31. BAT is to reduce emissions to air from the downstream processes by using one or a combination of the following techniques:

Technique [1]	Applicability
(i) Minimising the losses of coating products applied to the flat glass by ensuring a good sealing of the application system	The techniques are generally applicable
(ii) Minimising the losses of SO_2 from the annealing lehr, by operating the control system in an optimum manner	
(iii) Combining the SO_2 emissions from the lehr with the waste gas from the melting furnace, when technically feasible, and where a secondary treatment system is applied (filter and dry or semi-dry scrubber)	
(iv) Applying a secondary technique, e.g. wet scrubbing, or dry scrubbing and filtration	The techniques are generally applicable. The selection of the technique and its performance will depend on the inlet waste gas composition

[1] A description of the secondary treatment systems is given in Sections 1.10.3 and 1.10.6.

Table 21

BAT-AELs for air emissions from downstream processes in the flat glass sector, when treated separately

Parameter	BAT-AEL
	mg/Nm^3
Dust	< 15 – 20

Parameter	BAT-AEL
	mg/Nm^3
Hydrogen chloride, expressed as HCl	< 10
Hydrogen fluoride, expressed as HF	< 1 – 5
SO_X, expressed as SO_2	< 200
Σ (As, Co, Ni, Cd, Se, Cr_{VI})	< 1
Σ (As, Co, Ni, Cd, Se, Cr_{VI}, Sb, Pb, Cr_{III}, Cu, Mn, V, Sn)	< 5

1.4. *BAT conclusions for continuous filament glass fibre manufacturing*

Unless otherwise stated, the BAT conclusions presented in this section can be applied to all continuous filament glass fibre manufacturing installations.

1.4.1. Dust emissions from melting furnaces

The BAT-AELs reported in this section for dust refer to all materials that are solid at the point of measurement, including solid boron compounds. Gaseous boron compounds at the point of measurement are not included.

32. BAT is to reduce dust emissions from the waste gases of the melting furnace by using one or a combination of the following techniques:

Technique (1)	Applicability
(i) Reduction of the volatile components by raw material modifications The formulation of batch compositions without boron compounds or with low levels of boron is a primary measure for reducing dust emissions which are mainly generated by volatilisation phenomena. Boron is the main constituent of particulate matter emitted from the melting furnace	The application of the technique is limited by proprietary issues, since the boron-free or low-boron batch formulations are covered by a patent
(ii) Filtration system: electrostatic precipitator or bag filter	The technique is generally applicable. The maximum environmental benefits are achieved for applications on new plants where the positioning and characteristics of the filter may be decided without restrictions
(iii) Wet scrubbing system	The application to existing plants may be limited by technical constraints; i.e. need for a specific waste water treatment plant

(1) A description of the secondary treatment systems is given in Sections 1.10.1 and 1.10.7.

Table 22

BAT-AELs for dust emissions from the melting furnace in the continuous filament glass fibre sector

Parameter	BAT-AEL (1)	
	mg/Nm^3	kg/tonne melted glass (2)
Dust	< 10 – 20	< 0,045 – 0,09

(1) Values at levels of < 30 mg/Nm^3 (< 0,14 kg/tonne melted glass) have been reported for boron-free formulations, with the application of primary techniques.
(2) The conversion factor reported in Table 2 ($4,5 \times 10^{-3}$) has been applied.

1.4.2. Nitrogen oxides (NO_X) from melting furnaces

33. BAT is to reduce NO_X emissions from the melting furnace by using one or a combination of the following techniques:

Technique [1]	Applicability
(i) Combustion modifications	
(a) 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
(b) Reduced combustion air temperature	Applicable to air/fuel conventional furnaces within the constraints of the furnace energy efficiency and higher fuel demand. Most furnaces are already of the recuperative type.
(c) Staged combustion: (d) Air staging (e) Fuel staging	Fuel staging is applicable to most air/fuel, oxy-fuel furnaces. Air staging has very limited applicability due to its technical complexity
(d) Flue-gas recirculation	The applicability of this technique is limited to the use of special burners with automatic recirculation of the waste gas
(e) Low-NO_X burners	The technique is generally applicable. Full benefits are achieved at normal or complete furnace rebuild, when combined with optimum furnace design and geometry
(f) Fuel choice	The applicability is limited by the constraints associated with the availability of different types of fuel, which may be impacted by the energy policy of the Member State
(ii) Oxy-fuel melting	The maximum environmental benefits are achieved for applications at the time of a complete furnace rebuild

([1]) A description of the techniques is given in Section 1.10.2.

Table 23

BAT-AELs for NO_X emissions from the melting furnace in the continuous filament glass fibre sector

Parameter	BAT	BAT-AEL	
		mg/Nm^3	kg/tonne melted glass
NO_X expressed as NO_2	Combustion modifications	< 600 – 1 000	< 2,7 – 4,5 ([1])
	Oxy-fuel melting ([2])	Not applicable	< 0,5 – 1,5

([1]) The conversion factor reported in Table 2 ($4,5 \times 10^{-3}$) has been applied.
([2]) The achievable levels depend on the quality of the natural gas and oxygen available (nitrogen content).

1.4.3. Sulphur oxides (SO_X) from melting furnaces

34. BAT is to reduce SO_X emissions from the melting furnace by using one or a combination of the following techniques:

Technique ([1])	Applicability
(i) Minimisation of the sulphur content in the batch formulation and optimisation of the sulphur balance	The technique 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), which needs to be disposed of

Technique [1]	Applicability
(ii) Use of low sulphur content fuels	The applicability may be limited by the constraints associated with the availability of low sulphur fuels, which may be impacted by the energy policy of the Member State
(iii) Dry or semi-dry scrubbing, in combination with a filtration system	The technique is generally applicable. The presence of high concentrations of boron compounds in the flue-gases may limit the abatement efficiency of the reagent used in the dry or semi-dry scrubbing systems
(iv) Use of wet scrubbing	The technique is generally applicable within technical constraints; i.e. need for a specific waste water treatment plant

(1) A description of the techniques is given in Sections 1.10.3 and 1.10.6.

Table 24

BAT-AELs for SO_X emissions from the melting furnace in the continuous filament glass fibre sector

Parameter	Fuel	BAT-AEL [1]	
		mg/Nm^3	kg/tonne melted glass [2]
SO_x expressed as SO_2	Natural gas [3]	< 200 – 800	< 0,9 – 3,6
	Fuel oil [4] [5]	< 500 – 1 000	< 2,25 – 4,5

(1) The higher levels of the range are associated with the use of sulphates in the batch formulation for refining the glass.
(2) The conversion factor reported in Table 2 ($4,5 \times 10^{-3}$) has been applied.
(3) For oxy-fuel furnaces with the application of wet scrubbing, the BAT-AEL is reported to be < 0,1 kg/tonne melted glass of SO_X, expressed as SO_2.
(4) The associated emission levels are related to the use of 1 % sulphur fuel oil in combination with secondary abatement techniques.
(5) The lower levels correspond to conditions where the reduction of SO_X is a priority over a lower production of solid waste corresponding to the sulphate-rich filter dust. In this case, the lower levels are associated with the use of a bag filter.

1.4.4. Hydrogen chloride (HCl) and hydrogen fluoride (HF) from melting furnaces

35. BAT is to reduce HCl and HF emissions from the melting furnace by using one or a combination of the following techniques:

Technique [1]	Applicability
(i) Selection of raw materials for the batch formulation with a low content of chlorine and fluorine	The technique is generally applicable within the constraints of the batch formulation and the availability of raw materials
(ii) Minimisation of the fluorine content in the batch formulation The minimisation of fluorine emissions from the melting process may be achieved as follows: — minimising/reducing the quantity of fluorine compounds (e.g. fluorspar) used in the batch formulation to the minimum commensurate with the quality of the final product. Fluorine compounds are used to optimise the melting process, help fiberisation and minimise filament breakage — substituting fluorine compounds with alternative materials (e.g. sulphates)	The substitution of fluorine compounds with alternative materials is limited by quality requirements of the product
(iii) dry or semi-dry scrubbing, in combination with a filtration system	The technique is generally applicable
(iv) wet scrubbing	The technique is generally applicable within technical constraints; i.e. need for a specific waste water treatment plant.

(1) A description of the techniques is given in Sections 1.10.4 and 1.10.6.

Table 25

BAT-AELs for HCl and HF emissions from the melting furnace in the continuous filament glass fibre sector

Parameter	BAT-AEL	
	mg/Nm^3	kg/tonne melted glass (1)
Hydrogen chloride, expressed as HCl	< 10	< 0,05
Hydrogen fluoride, expressed as HF (2)	< 5 – 15	< 0,02 – 0,07

(1) The conversion factor reported in Table 2 ($4,5 \times 10^{-3}$) has been applied.
(2) The higher levels of the range are associated with the use of fluorine compounds in the batch formulation.

1.4.5. Metals from melting furnaces

36. BAT is to reduce metal emissions from the melting furnace by using one or a combination of the following techniques:

Technique (1)	Applicability
(i) Selection of raw materials for the batch formulation with a low content of metals	The technique is generally applicable within the constraints of the availability of raw materials
(ii) Applying a dry or semi-dry scrubbing, in combination with a filtration system	The technique is generally applicable
(iii) Applying wet scrubbing	The technique is generally applicable within technical constraints; i.e. need for a specific waste water treatment plant.

(1) A description of the techniques is given in Sections 1.10.5 and 1.10.6.

Table 26

BAT-AELs for metal emissions from the melting furnace in the continuous filament glass fibre sector

Parameter	BAT-AEL (1)	
	mg/Nm^3	kg/tonne melted glass (2)
Σ (As, Co, Ni, Cd, Se, Cr_{VI})	< 0,2 – 1	$< 0,9 - 4,5 \times 10^{-3}$
Σ (As, Co, Ni, Cd, Se, Cr_{VI}, Sb, Pb, Cr_{III}, Cu, Mn, V, Sn)	< 1 – 3	$< 4,5 - 13,5 \times 10^{-3}$

(1) The levels refer to the sum of metals present in the flue-gases in both solid and gaseous phases.
(2) The conversion factor reported in Table 2 ($4,5 \times 10^{-3}$) has been applied.

1.4.6. Emissions from downstream processes

37. BAT is to reduce emissions from downstream processes by using one or a combination of the following techniques:

Technique (1)	Applicability
(i) Wet scrubbing systems	The techniques are generally applicable for the treatment of waste gases from the forming process (application of the coating to the fibres) or secondary processes which involve the use of binder that must be cured or dried
(ii) Wet electrostatic precipitator	
(iii) Filtration system (bag filter)	The technique is generally applicable for the treatment of waste gases from cutting and milling operations of the products

(1) A description of the techniques is given in Sections 1.10.7 and 1.10.8.

Table 27

BAT-AELs for air emissions from downstream processes in the continuous filament glass fibre sector, when treated separately

Parameter	BAT-AEL
	mg/Nm^3
Emissions from forming and coating	
Dust	< 5 – 20
Formaldehyde	< 10
Ammonia	< 30
Total volatile organic compounds, expressed as C	< 20
Emissions from cutting and milling	
Dust	< 5 – 20

1.5. *BAT conclusions for domestic glass manufacturing*

Unless otherwise stated, the BAT conclusions presented in this section can be applied to all domestic glass manufacturing installations.

1.5.1. Dust emissions from melting furnaces

38. BAT is to reduce dust emissions from the waste gases of the melting furnace by using one or a combination of the following techniques:

Technique [1]	Applicability
(i) Reduction of the volatile components by raw material modifications. The formulation of the batch composition may contain very volatile components (e.g. boron, fluorides) which significantly contribute to the formation of dust emissions from the melting furnace	The technique is generally applicable within the constraints of the type of glass produced and the availability of substitute raw materials
(ii) 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
(iii) Oxy-fuel melting	The maximum environmental benefits are achieved for applications made at the time of a complete furnace rebuild
(iv) Filtration system: electrostatic precipitator or bag filter	The techniques are generally applicable
(v) Wet scrubbing system	The applicability is limited to specific cases, in particular to electric melting furnaces, where flue-gas volumes and dust emissions are generally low and related to carryover of the batch formulation

[1] A description of the techniques is given in Sections 1.10.5 and 1.10.7.

Table 28

BAT-AELs for dust emissions from the melting furnace in the domestic glass sector

Parameter	BAT-AEL	
	mg/Nm^3	kg/tonne melted glass (1)
Dust	< 10 – 20 (2)	< 0,03 – 0,06
	< 1 – 10 (3)	< 0,003 – 0,03

(1) A conversion factor of 3×10^{-3} has been applied (see Table 2). However, a case by case conversion factor may have to be applied for specific productions.
(2) Considerations concerning the economic viability for achieving the BAT-AELs in the case of furnaces with a capacity of < 80 t/d, producing soda-lime glass, are reported.
(3) This BAT-AEL applies to batch formulations containing significant amounts of constituents meeting the criteria as dangerous substances, in accordance with Regulation (EC) No 1272/2008 of the European Parliament and of the Council.

1.5.2. Nitrogen oxides (NO_X) from melting furnaces

39. BAT is to reduce NO_X emissions from the melting furnace by using one or a combination of the following techniques:

Technique (1)	Applicability
(i) Combustion modifications	
(a) 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
(b) Reduced combustion air temperature	Applicable only under installation-specific circumstances due to a lower furnace efficiency and higher fuel demand (i.e. use of recuperative furnaces in place of regenerative furnaces)
(c) Staged combustion: (f) Air staging (g) Fuel staging	Fuel staging is applicable to most conventional air/fuel furnaces. Air staging has very limited applicability due to its technical complexity
(d) Flue-gas recirculation	The applicability of this technique is limited to the use of special burners with automatic recirculation of the waste gas
(e) Low-NO_X burners	The technique is generally applicable. The achieved environmental benefits are generally lower for applications to cross-fired, gas-fired furnaces due to technical constraints and a lower degree of flexibility of the furnace. Full benefits are achieved at normal or complete furnace rebuild, when combined with optimum furnace design and geometry
(f) Fuel choice	The applicability is limited by the constraints associated with the availability of different types of fuel, which may be impacted by the energy policy of the Member State
(ii) Special furnace design	The applicability is limited to batch formulations that contain high levels of external cullet (> 70 %). The application requires a complete rebuild of the melting furnace. The shape of the furnace (long and narrow) may pose space restrictions

Technique (1)	Applicability
(iii) 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
(iv) Oxy-fuel melting	The maximum environmental benefits are achieved for applications at the time of a complete furnace rebuild

(1) A description of the techniques is given in Section 1.10.2.

Table 29

BAT-AELs for NO_X emissions from the melting furnace in the domestic glass sector

Parameter	BAT	BAT-AEL	
		mg/Nm^3	kg/tonne melted glass (1)
NO_x expressed as NO_2	Combustion modifications, special furnace designs	< 500 – 1 000	< 1,25 – 2,5
	Electric melting	< 100	< 0,3
	Oxy-fuel melting (2)	Not applicable	< 0,5 – 1,5

(1) A conversion factor of $2,5 \times 10^{-3}$ has been applied for combustion modifications and special furnace designs and a conversion factor of 3×10^{-3} has been applied for electric melting (see Table 2). However, a case-by-case conversion factor may have to be applied for specific productions.
(2) The achievable levels depend on the quality of the natural gas and oxygen available (nitrogen content).

40. When nitrates are used in the batch formulation, BAT is to reduce NO_X emissions by minimising the use of these raw materials, in combination with primary or secondary techniques.

The BAT-AELs are set out in Table 29.

If nitrates are used in the batch formulation for a limited number of short campaigns or for melting furnaces with a capacity < 100 t/day producing special types of soda-lime glasses (clear/ultra-clear glass or coloured glass using selenium) and other special glasses (i.e. borosilicate, glass ceramics, opal glass, crystal and lead crystal), the BAT-AELs are set out in Table 30.

Technique (1)	Applicability
Primary techniques:	
— Minimising the use of nitrates in the batch formulation The use of nitrates is applied for very high quality products, where a very colourless (clear) glass is required or special glasses are produced. Effective alternative materials are sulphates, arsenic oxides, cerium oxide	The substitution of nitrates in the batch formulation may be limited by the high costs and/or higher environmental impact of the alternative materials

(1) A description of the technique is given in Section 1.10.2.

Table 30

BAT-AELs for NO_X emissions from the melting furnace in the domestic glass sector, when nitrates are used in the batch formulation for a limited number of short campaigns or for melting furnaces with a capacity < 100 t/day producing special types of soda-lime glasses (clear/ultra-clear glass or coloured glass using selenium) and other special glasses (i.e. borosilicate, glass ceramics, opal glass, crystal and lead crystal

Parameter	Type of furnace	BAT-AEL	
		mg/Nm^3	kg/tonne melted glass
NO_X expressed as NO_2	Fuel/air conventional furnaces	< 500 – 1 500	< 1,25 – 3,75 [1]
	Electric melting	< 300 – 500	< 8 – 10

[1] The conversion factor reported in Table 2 for soda-lime glass ($2,5 \times 10^{-3}$) has been applied.

1.5.3. Sulphur oxides (SO_X) from melting furnaces

41. BAT is to reduce SO_X emissions from the melting furnace by using one or a combination of the following techniques:

Technique [1]	Applicability
(i) 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)
(ii) Use of low sulphur content fuels	The applicability may be limited by the constraints associated with the availability of low sulphur fuels, which may be impacted by the energy policy of the Member State
(iii) Dry or semi-dry scrubbing, in combination with a filtration system	The technique is generally applicable

[1] A description of the techniques is given in Section 1.10.3.

Table 31

BAT-AELs for SO_X emissions from the melting furnace in the domestic glass sector

Parameter	Fuel/melting technique	BAT-AEL	
		mg/Nm^3	kg/tonne melted glass [1]
SO_x expressed as SO_2	Natural gas	< 200 – 300	< 0,5 – 0,75
	Fuel oil [2]	< 1 000	< 2,5
	Electric melting	< 100	< 0,25

[1] A conversion factor of $2,5 \times 10^{-3}$ has been applied (see Table 2). However, a case-by-case conversion factor may have to be applied for specific productions.
[2] The levels are related to the use of 1 % sulphur fuel oil in combination with secondary abatement techniques.

1.5.4. Hydrogen chloride (HCl) and hydrogen fluoride (HF) from melting furnaces

42. BAT is to reduce HCl and HF emissions from the melting furnace by using one or a combination of the following techniques:

Technique [1]	Applicability
(i) Selection of raw materials for the batch formulation with a low content of chlorine and fluorine	The applicability may be limited by the constraints of the batch formulation for the type of glass produced at the installation and the availability of raw materials

Technique [1]	Applicability
(ii) Minimisation of the fluorine content in the batch formulation and optimisation of the fluorine mass balance The minimisation of fluorine emissions from the melting process may be achieved by minimising/reducing the quantity of fluorine compounds (e.g. fluorspar) used in the batch formulation to the minimum commensurate with the quality of the final product. Fluorine compounds are added to the batch formulation to give an opaque or cloudy appearance to the glass	The technique is generally applicable within the constraints of the quality requirements for the final product
(iii) Dry or semi-dry scrubbing, in combination with a filtration system	The technique is generally applicable
(iv) Wet scrubbing	The technique is generally applicable within technical constraints; i.e. need for a specific waste water treatment plant. High costs, waste water treatment aspects, including restrictions in the recycle of sludge or solid residues from the water treatment, may limit the applicability of this technique

(1) A description of the techniques is given in Sections 1.10.4 and 1.10.6.

Table 32

BAT-AELs for HCl and HF emissions from the melting furnace in the domestic glass sector

Parameter	BAT-AEL	
	mg/Nm^3	kg/tonne melted glass [1]
Hydrogen chloride, expressed as HCl [2] [3]	< 10 – 20	< 0,03 – 0,06
Hydrogen fluoride, expressed as HF [4]	< 1 – 5	< 0,003 – 0,015

(1) A conversion factor of 3×10^{-3} has been applied (see Table 2). However, a case-by-case conversion factor may have to be applied for specific productions.
(2) The lower levels are associated with the use of electric melting.
(3) In cases where KCl or NaCl are used as a refining agents, the BAT-AEL is < 30 mg/Nm^3 or < 0,09 kg/tonne melted glass.
(4) The lower levels are associated with the use of electric melting. The higher levels are associated with the production of opal glass, the recycling of filter dust or where high levels of external cullet are used in the batch formulation.

1.5.5. Metals from melting furnaces

43. BAT is to reduce metal emissions from the melting furnace by using one or a combination of the following techniques:

Technique [1]	Applicability
(i) Selection of raw materials for the batch formulation with a low content of metals	The applicability may be limited by the constraints imposed by the type of glass produced at the installation and the availability of raw materials
(ii) Minimising the use of metal compounds in the batch formulation, through a suitable selection of the raw materials where colouring and decolourising of glass is needed or where specific characteristics are conferred to the glass	For the production of crystal and lead crystal glasses the minimisation of metal compounds in the batch formulation is restricted by the limits defined in Directive 69/493/EEC which classifies the chemical composition of the final glass products.
(iii) Dry or semi-dry scrubbing, in combination with a filtration system	The technique is generally applicable

(1) A description of the techniques is given in Section 1.10.5.

Table 33

BAT-AELs for metal emissions from the melting furnace in the domestic glass sector with the exception of glasses where selenium is used for decolourising

Parameter	BAT-AEL (1)	
	mg/Nm^3	kg/tonne melted glass (2)
Σ (As, Co, Ni, Cd, Se, Cr_{VI})	< 0,2 – 1	< 0,6 – 3 × 10^{-3}
Σ (As, Co, Ni, Cd, Se, Cr_{VI}, Sb, Pb, Cr_{III}, Cu, Mn, V, Sn)	< 1 – 5	< 3 – 15 × 10^{-3}

(1) The levels refer to the sum of metals present in the flue-gases in both solid and gaseous phases.
(2) A conversion factor of 3 × 10^{-3} has been applied (see Table 2). However, a case-by-case conversion factor may have to be applied for specific productions.

44. When selenium compounds are used for decolourising the glass, BAT is to reduce selenium emissions from the melting furnace by using one or a combination of the following techniques

Technique (1)	Applicability
(i) Minimising the use of selenium compounds in the batch formulation, through a suitable selection of the raw materials	The applicability may be limited by the constraints imposed by the type of glass produced at the installation and the availability of raw materials
(ii) Dry or semi-dry scrubbing, in combination with a filtration system	The technique is generally applicable

(1) A description of the techniques is given in Section 1.10.5.

Table 34

BAT-AELs for selenium emissions from the melting furnace in the domestic glass sector when selenium compounds are used for decolourising the glass

Parameter	BAT-AEL (1)	
	mg/Nm^3	kg/tonne melted glass (2)
Selenium compounds, as Se	< 1	< 3 × 10^{-3}

(1) The values refer to the sum of selenium present in the flue-gases in both solid and gaseous phases.
(2) A conversion factor of 3 × 10^{-3} has been applied (see Table 2). However, a case-by-case conversion factor may have to be applied for specific productions.

45. When lead compounds are used for the manufacturing of lead crystal glass, BAT is to reduce lead emissions from the melting furnace by using one or a combination of the following techniques:

Technique (1)	Applicability
(i) 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
(ii) Bag filter	The technique is generally applicable
(iii) Electrostatic precipitator	
(iv) Dry or semi-dry scrubbing, in combination with a filtration system	

(1) A description of the technique is given in Sections 1.10.1 and 1.10.5.

Table 35

BAT-AELs for lead emissions from the melting furnace in the domestic glass sector when lead compounds are used for manufacturing lead crystal glass

Parameter	BAT-AEL (1)	
	mg/Nm^3	kg/tonne melted glass (2)
Lead compounds, expressed as Pb	< 0,5 – 1	$< 1 - 3 \times 10^{-3}$

(1) The values refer to the sum of lead present in the flue-gases in both solid and gaseous phases.
(2) A conversion factor of 3×10^{-3} has been applied (see Table 2). However, a case-by-case conversion factor may have to be applied for specific productions.

1.5.6. Emissions from downstream processes

46. For downstream dusty processes, BAT is to reduce emissions of dust and metals by using one or a combination of the following techniques:

Technique (1)	Applicability
(i) Performing dusty operations (e.g. cutting, grinding, polishing) under liquid	The techniques are generally applicable
(ii) Applying a bag filter system	

(1) A description of the techniques is given in Section 1.10.8.

Table 36

BAT-AELs for air emissions from dusty downstream processes in the domestic glass sector, when treated separately

Parameter	BAT-AEL
	mg/Nm^3
Dust	< 1 – 10
Σ (As, Co, Ni, Cd, Se, Cr_{VI}) (1)	< 1
Σ (As, Co, Ni, Cd, Se, Cr_{VI}, Sb, Pb, Cr_{III}, Cu, Mn, V, Sn) (1)	< 1 – 5
Lead compounds, expressed as Pb (2)	< 1 – 1,5

(1) The levels refer to the sum of metals present in the waste gas.
(2) The levels refer to downstream operations on lead crystal glass.

47. For acid polishing processes, BAT is to reduce HF emissions by using one or a combination of the following techniques:

Technique (1)	Applicability
(i) Minimising the losses of polishing product by ensuring a good sealing of the application system	The techniques are generally applicable
(ii) Applying a secondary technique, e.g. wet scrubbing.	

(1) A description of the techniques is given in Section 1.10.6.

Table 37

BAT-AELs for HF emissions from acid polishing processes in the domestic glass sector, when treated separately

Parameter	BAT-AEL
	mg/Nm^3
Hydrogen fluoride, expressed as HF	< 5

1.6. *BAT conclusions for special glass manufacturing*

Unless otherwise stated, the BAT conclusions presented in this section can be applied to all special glass manufacturing installations.

1.6.1. Dust emissions from melting furnaces

48. BAT is to reduce dust emissions from the waste gases of the melting furnace by using one or a combination of the following techniques:

Technique (1)	Applicability
(i) Reduction of the volatile components by raw material modifications The formulation of the batch composition may contain very volatile components (e.g. boron, fluorides) which represent the main constituents of dust emitted from the melting furnace	The technique is generally applicable within the constraints of the quality of the glass produced
(ii) 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
(iii) Filtration system: electrostatic precipitator or bag filter	The technique is generally applicable

(1) A description of the techniques is given in Section 1.10.1.

Table 38

BAT-AELs for dust emissions from the melting furnace in the special glass sector

Parameter	BAT-AEL	
	mg/Nm^3	kg/tonne melted glass (1)
Dust	< 10 – 20	< 0,03 – 0,13
	< 1 – 10 (2)	< 0,003 – 0,065

(1) The conversions factors of $2,5 \times 10^{-3}$ and $6,5 \times 10^{-3}$ have been used for the determination of the lower and upper value of the BAT-AELs range (see Table 2), with some values being approximated. However, a-case-by-case conversion factor needs to be applied, depending on the type of glass produced (see Table 2).

(2) The BAT-AELs apply to batch formulations containing significant amounts of constituents meeting the criteria as dangerous substances, in accordance with Regulation (EC) No 1272/2008.

1.6.2. Nitrogen oxides (NO_X) from melting furnaces

49. BAT is to reduce NO_X emissions from the melting furnace by using one or a combination of the following techniques:

I. primary techniques, such as:

Technique [1]	Applicability
(i) Combustion modifications	
(a) 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
(b) Reduced combustion air temperature	Applicable only under installation-specific circumstances due to a lower furnace efficiency and higher fuel demand (i.e. use of recuperative furnaces in place of regenerative furnaces)
(c) Staged combustion: — Air staging — Fuel staging	Fuel staging is applicable to most conventional air/fuel furnaces. Air staging has very limited applicability due to the technical complexity
(d) Flue-gas recirculation	The applicability of this technique is limited to the use of special burners with automatic recirculation of the waste gas
(e) Low-NO_X burners	The technique is generally applicable. The achieved environmental benefits are generally lower for applications to cross-fired, gas-fired furnaces due to technical constraints and a lower degree of flexibility of the furnace. Full benefits are achieved at normal or complete furnace rebuild, when combined with optimum furnace design and geometry
(f) Fuel choice	The applicability is limited by the constraints associated with the availability of different types of fuel, which may be impacted by the energy policy of the Member State
(ii) 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
(iii) Oxy-fuel melting	The maximum environmental benefits are achieved for applications at the time of a complete furnace rebuild

[1] A description of the techniques is given in Section 1.10.2.

II. secondary techniques, such as:

Technique [1]	Applicability
(i) Selective catalytic reduction (SCR)	The application may require an upgrade of the dust abatement system in order to guarantee a dust concentration of below 10 – 15 mg/Nm^3 and a desulphurisation system for the removal of SO_X emissions Due to the optimum operating temperature window, the applicability is limited to the use of electrostatic precipitators. In general, the technique is not used with a bag filter system because the low operating temperature, in the range of 180 – 200 °C, would require reheating of the waste gases. The implementation of the technique may require significant space availability

Technique (1)	Applicability
(ii) Selective non-catalytic reduction (SNCR)	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

(1) A description of the techniques is given in Section 1.10.2.

Table 39

BAT-AELs for NO_X emissions from the melting furnace in the special glass sector

Parameter	BAT	BAT-AEL	
		mg/Nm^3	kg/tonne melted glass (1)
NO_X expressed as NO_2	Combustion modifications	600 – 800	1,5 – 3,2
	Electric melting	< 100	< 0,25 – 0,4
	Oxy-fuel melting (2) (3)	Not applicable	< 1 – 3
	Secondary techniques	< 500	< 1 – 3

(1) The conversion factors of $2{,}5 \times 10^{-3}$ and 4×10^{-3} have been used for the determination of the lower and upper value of the BAT-AEL range (see Table 2), with some values being approximated. However, a case-by-case conversion factor needs to be applied based on the type of production (see Table 2).
(2) The higher values are related to a special production of borosilicate glass tubes for pharmaceutical use.
(3) The achievable levels depend on the quality of the natural gas and oxygen available (nitrogen content).

50. When nitrates are used in the batch formulation, BAT is to reduce NO_X emissions by minimising the use of these raw materials, in combination with either primary or secondary techniques

Technique (1)	Applicability
Primary techniques	
— minimising the use of nitrates in the batch formulation The use of nitrates is applied for very high quality products, where special characteristics of the glass are required. Effective alternative materials are sulphates, arsenic oxides, cerium oxide	The substitution of nitrates in the batch formulation may be limited by the high costs and/or higher environmental impact of the alternative materials

(1) A description of the technique is given in Section 1.10.2.

Table 40

BAT-AELs for NO_X emissions from the melting furnace in the special glass sector when nitrates are used in the batch formulation

Parameter	BAT	BAT-AEL (1)	
		mg/Nm^3	kg/tonne melted glass (2)
NO_X expressed as NO_2	Minimisation of nitrate input in the batch formulation combined with primary or secondary techniques	< 500 – 1 000	< 1 – 6

(1) The lower levels are associated with the use of electric melting.
(2) The conversion factors of $2{,}5 \times 10^{-3}$ and $6{,}5 \times 10^{-3}$ have been used for the determination of the lower and upper value of the BAT-AEL range respectively, with values being approximated. A case-by-case conversion factor may have to be applied based on the type of production (see Table 2).

1.6.3. Sulphur oxides (SO_X) from melting furnaces

51. BAT is to reduce SO_X emissions from the melting furnace by using one or a combination of the following techniques:

Technique [1]	Applicability
(i) Minimisation of the sulphur content in the batch formulation and optimisation of the sulphur balance	The technique is generally applicable within the constraints of quality requirements of the final glass product
(ii) Use of low sulphur content fuels	The applicability may be limited by the constraints associated with the availability of low sulphur fuels, which may be impacted by the energy policy of the Member State
(iii) Dry or semi-dry scrubbing, in combination with a filtration system	The technique is generally applicable

[1] A description of the techniques is given in Section 1.10.3.

Table 41

BAT-AELs for SO_X emissions from the melting furnace in the special glass sector

Parameter	Fuel/melting technique	BAT-AEL [1]	
		mg/Nm^3	kg/tonne melted glass [2]
SO_X expressed as SO_2	Natural gas, electric melting [3]	< 30 – 200	< 0,08 – 0,5
	Fuel oil [4]	500 – 800	1,25 – 2

[1] The ranges take into account the variable sulphur balances associated with the type of glass produced.
[2] The conversion factor of $2{,}5 \times 10^{-3}$ (see Table 2) has been used. However, a case-by-case conversion factor may have to be applied based on the type of production.
[3] The lower levels are associated with the use of electric melting and batch formulations without sulphates.
[4] The associated emission levels are related to the use of 1 % sulphur fuel oil in combination with secondary abatement techniques.

1.6.4. Hydrogen chloride (HCl) and hydrogen fluoride (HF) from melting furnaces

52. BAT is to reduce HCl and HF emissions from the melting furnace by using one or a combination of the following techniques:

Technique [1]	Applicability
(i) Selection of raw materials for the batch formulation with a low content of chlorine and fluorine	The applicability may be limited by the constraints of the batch formulation for the type of glass produced at the installation and the availability of raw materials
(ii) Minimisation of the fluorine and/or chlorine compounds in the batch formulation and optimisation of the fluorine and/or chlorine mass balance Fluorine compounds are used to confer particular characteristics to special glasses (i.e. opaque lighting glass, optical glass). Chlorine compounds may be used as fining agents for borosilicate glass production	The technique is generally applicable within the constraints of the quality requirements for the final product.
(iii) Dry or semi-dry scrubbing, in combination with a filtration system	The technique is generally applicable

[1] A description of the techniques is given in Section 1.10.4.

Table 42

BAT-AELs for HCl and HF emissions from the melting furnace in the special glass sector

Parameter	BAT-AEL	
	mg/Nm^3	kg/tonne melted glass (1)
Hydrogen chloride, expressed as HCl (2)	< 10 – 20	< 0,03 – 0,05
Hydrogen fluoride, expressed as HF	< 1 – 5	< 0,003 – 0,04 (3)

(1) The conversion factor of $2,5 \times 10^{-3}$ (see Table 2) has been used; with some values being approximated. A case-by-case conversion factor may have to be applied based on the type of production.
(2) The higher levels are associated with the use of materials containing chlorine in the batch formulation.
(3) The upper value of the range has been derived from specific reported data.

1.6.5. Metals from melting furnaces

53. BAT is to reduce metal emissions from the melting furnace by using one or a combination of the following techniques:

Technique (1)	Applicability
(i) Selection of raw materials for the batch formulation with a low content of metals	The applicability may be limited by the constraints imposed by the type of glass produced at the installation and the availability of raw materials
(ii) Minimising the use of metal compounds in the batch formulation, through a suitable selection of the raw materials where colouring and decolourising of glass is needed or where specific characteristics are conferred to the glass	The techniques are generally applicable
(iii) Dry or semi-dry scrubbing, in combination with a filtration system	

(1) A description of the techniques is given in Section 1.10.5.

Table 43

BAT-AELs for metal emissions from the melting furnace in the special glass sector

Parameter	BAT-AEL (1) (2)	
	mg/Nm^3	kg/tonne melted glass (3)
Σ (As, Co, Ni, Cd, Se, Cr_{VI})	< 0,1 – 1	$< 0,3 - 3 \times 10^{-3}$
Σ (As, Co, Ni, Cd, Se, Cr_{VI}, Sb, Pb, Cr_{III}, Cu, Mn, V, Sn)	< 1 – 5	$< 3 - 15 \times 10^{-3}$

(1) The levels refer to the sum of metals present in the flue-gases in both solid and gaseous phases.
(2) The lower levels are BAT-AELs when metal compounds are not intentionally used in the batch formulation.
(3) The conversion factor of $2,5 \times 10^{-3}$ (see Table 2) has been used, with some values indicated in the table having been approximated. A case-by-case conversion factor may have to be applied based on the type of production.

1.6.6. Emissions from downstream processes

54. For downstream dusty processes, BAT is to reduce emissions of dust and metals by using one or a combination of the following techniques:

Technique (1)	Applicability
(i) Performing dusty operations (e.g. cutting, grinding, polishing) under liquid	The techniques are generally applicable
(ii) Applying a bag filter system	

(1) A description of the techniques is given in Section 1.10.8.

Table 44

BAT-AELs for dust and metal emissions from downstream processes in the special glass sector, when treated separately

Parameter	BAT-AEL
	mg/Nm^3
Dust	1 – 10
Σ (As, Co, Ni, Cd, Se, Cr_{VI}) (1)	< 1
Σ (As, Co, Ni, Cd, Se, Cr_{VI}, Sb, Pb, Cr_{III}, Cu, Mn, V, Sn) (1)	< 1 – 5

(1) The levels refer to the sum of metals present in the waste gas.

55. For acid polishing processes, BAT is to reduce HF emissions by using one or a combination of the following techniques:

Technique (1)	Description
(i) Minimising the losses of polishing product by ensuring a good sealing of the application system	The techniques are generally applicable
(ii) Applying a secondary technique, e.g. wet scrubbing	

(1) A description of the techniques is given in Section 1.10.6.

Table 45

BAT-AELs for HF emissions from acid polishing processes in the special glass sector, when treated separately

Parameter	BAT-AEL
	mg/Nm^3
Hydrogen fluoride, expressed as HF	< 5

1.7. *BAT conclusions for mineral wool manufacturing*

Unless otherwise stated, the BAT conclusions presented in this section can be applied to all mineral wool manufacturing installations.

1.7.1. Dust emissions from melting furnaces

56. BAT is to reduce dust emissions from the waste gases of the melting furnace by applying an electrostatic precipitator or a bag filter system

Technique (1)	Applicability
Filtration system: electrostatic precipitator or bag filter	The technique is generally applicable. Electrostatic precipitators are not applicable to cupola furnaces for stone wool production, due to the risk of explosion from the ignition of carbon monoxide produced within the furnace

(1) A description of the techniques is given in Section 1.10.1.

Table 46

BAT-AELs for dust emissions from the melting furnace in the mineral wool sector

Parameter	BAT-AEL	
	mg/Nm^3	kg/tonne melted glass (1)
Dust	< 10 – 20	< 0,02 – 0,050

(1) The conversion factors of 2×10^{-3} and $2,5 \times 10^{-3}$ have been used for the determination of the lower and upper value of the BAT-AELs range (see Table 2), in order to cover both the production of glass wool and stone wool.

1.7.2. Nitrogen oxides (NO_X) from melting furnaces

57. BAT is to reduce NO_X emissions from the melting furnace by using one or a combination of the following techniques:

Technique [1]	Applicability
(i) Combustion modifications	
(a) 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
(b) Reduced combustion air temperature	Applicable only under installation-specific circumstances due to a lower furnace efficiency and higher fuel demand (i.e. use of recuperative furnaces in place of regenerative furnaces)
(c) Staged combustion: — Air staging — Fuel staging	Fuel staging is applicable to most conventional air/fuel furnaces. Air staging has very limited applicability due to the technical complexity
(d) Flue-gas recirculation	The applicability of this technique is limited to the use of special burners with automatic recirculation of the waste gas
(e) Low-NO_X burners	The technique is generally applicable. The achieved environmental benefits are generally lower for applications to cross-fired, gas-fired furnaces due to technical constraints and a lower degree of flexibility of the furnace. Full benefits are achieved at normal or complete furnace rebuild, when combined with optimum furnace design and geometry
(f) Fuel choice	The applicability is limited by the constraints associated with the availability of different types of fuel, which may be impacted by the energy policy of the Member State
(ii) 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
(iii) Oxy-fuel melting	The maximum environmental benefits are achieved for applications at the time of a complete furnace rebuild

(1) A description of the techniques is given in Section 1.10.2.

Table 47

BAT-AELs for NO_X emissions from the melting furnace in the mineral wool sector

Parameter	Product	Melting technique	BAT-AEL	
			mg/Nm^3	kg/tonne melted glass [1]
NO_X expressed as NO_2	Glass wool	Fuel/air and electric furnaces	< 200 – 500	< 0,4 – 1,0
		Oxy-fuel melting [2]	Not applicable	< 0,5
	Stone wool	All types of furnaces	< 400 – 500	< 1,0 – 1,25

(1) The conversion factors of 2×10^{-3} for glass wool and $2,5 \times 10^{-3}$ for stone wool have been used (see Table 2).
(2) The achievable levels depend on the quality of the natural gas and oxygen available (nitrogen content).

58. When nitrates are used in the batch formulation for glass wool production, BAT is to reduce NO_X emissions by using one or a combination of the following techniques:

Technique [1]	Applicability
(i) Minimising the use of nitrates in the batch formulation The use of nitrates is applied as an oxidising agent in batch formulations with high levels of external cullet to compensate for the presence of organic material contained in the cullet	The technique is generally applicable within the constraints of the quality requirements for the final product
(ii) Electric melting	The technique is generally applicable. The implementation of electric melting requires a complete furnace rebuild
(iii) Oxy-fuel melting	The technique is generally applicable. The maximum environmental benefits are achieved for applications made at the time of a complete furnace rebuild

[1] A description of the techniques is given in Section 1.10.2.

Table 48

BAT-AELs for NO_X emissions from the melting furnace in glass wool production when nitrates are used in the batch formulation

Parameter	BAT	BAT-AEL	
		mg/Nm^3	kg/tonne melted glass [1]
NO_X expressed as NO_2	Minimisation of nitrate input in the batch formulation, combined with primary techniques	< 500 – 700	< 1,0 – 1,4 [2]

[1] The conversion factor of 2×10^{-3} has been used (see Table 2).
[2] The lower levels of the ranges are associated with the application of oxy-fuel melting.

1.7.3. Sulphur oxides (SO_X) from melting furnaces

59. BAT is to reduce SO_X emissions from the melting furnace by using one or a combination of the following techniques:

Technique [1]	Applicability
(i) Minimisation of the sulphur content in the batch formulation and optimisation of the sulphur balance	In glass wool production, the technique is generally applicable within the constraints of the availability of low-sulphur raw materials, in particular external cullet. High levels of external cullet in the batch formulation limit the possibility of optimising the sulphur balance due to a variable sulphur content. In the stone wool production, the optimisation of the sulphur balance may require a trade-off approach between the removal of SO_X emissions from the flue-gases and the management of the solid waste, deriving from the treatment of the flue-gases (filter dust) and/or from the fiberising process, which may be recycled into the batch formulation (cement briquettes) or may need to be disposed of
(ii) Use of low sulphur content fuels	The applicability may be limited by the constraints associated with the availability of low sulphur fuels, which may be impacted by the energy policy of the Member State
(iii) Dry or semi-dry scrubbing, in combination with a filtration system	Electrostatic precipitators are not applicable to cupola furnaces for stone wool production (see BAT 56)
(iv) Use of wet scrubbing	The technique is generally applicable within technical constraints; i.e. need for a specific waste water treatment plant

[1] A description of the techniques is given in Sections 1.10.3 and 1.10.6.

Table 49

BAT-AELs for SO_X emissions from the melting furnace in the mineral wool sector

Parameter	Product/conditions	BAT-AEL	
		mg/Nm^3	kg/tonne melted glass (1)
SO_X expressed as SO_2	***Glass wool***		
	Gas-fired and electric furnaces (2)	< 50 – 150	< 0,1 – 0,3
	Stone wool		
	Gas-fired and electric furnaces	< 350	< 0,9
	Cupola furnaces, no briquettes or slag recycling (3)	< 400	< 1,0
	Cupola furnaces, with cement briquettes or slag recycling (4)	< 1 400	< 3,5

(1) The conversion factors of 2 × 10^{-3} for glass wool and 2,5 × 10^{-3} for stone wool have been used (see Table 2).
(2) The lower levels of the ranges are associated with the use of electric melting. The higher levels are associated with high levels of cullet recycling.
(3) The BAT-AEL is associated with conditions where the reduction of SO_X emissions has a high priority over a lower production of solid waste.
(4) When reduction of waste has a high priority over SO_X emissions, higher emission values may be expected. The achievable levels should be based on a sulphur balance.

1.7.4. Hydrogen chloride (HCl) and hydrogen fluoride (HF) from melting furnaces

60. BAT is to reduce HCl and HF emissions from the melting furnace by using one or a combination of the following techniques:

Technique (1)	Description
(i) Selection of raw materials for the batch formulation with a low content of chlorine and fluorine	The technique is generally applicable within the constraints of the batch formulation and the availability of raw materials
(ii) Dry or semi-dry scrubbing, in combination with a filtration system	Electrostatic precipitators are not applicable to cupola furnaces for stone wool production (see BAT 56)

(1) A description of the techniques is given in Section 1.10.4.

Table 50

BAT-AELs for HCl and HF emissions from the melting furnace in the mineral wool sector

Parameter	Product	BAT-AEL	
		mg/Nm^3	kg/tonne melted glass (1)
Hydrogen chloride, expressed as HCl	Glass wool	< 5 – 10	< 0,01 – 0,02
	Stone wool	< 10 – 30	< 0,025 – 0,075
Hydrogen fluoride, expressed as HF	All products	< 1 – 5	< 0,002 – 0,013 (2)

(1) The conversion factors of 2 × 10^{-3} for glass wool and 2,5 × 10^{-3} for stone wool have been used (see Table 2).
(2) The conversion factors of 2 × 10^{-3} and 2,5 × 10^{-3} have been used for the determination of the lower and upper values of the BAT-AELs range (see Table 2).

1.7.5. Hydrogen sulphide (H_2S) from stone wool melting furnaces

61. BAT is to reduce H_2S emissions from the melting furnace by applying a waste gas incineration system to oxidise hydrogen sulphide to SO_2

Technique (1)	Applicability
Waste gas incinerator system	The technique is generally applicable to stone wool cupola furnaces

(1) A description of the technique is given in Section 1.10.9.

Table 51

BAT-AELs for H_2S emissions from the melting furnace in stone wool production

Parameter	BAT-AEL	
	mg/Nm^3	kg/tonne melted glass (1)
Hydrogen sulphide, expressed as H_2S	< 2	< 0,005

(1) The conversion factor of $2,5 \times 10^{-3}$ for stone wool has been applied (see Table 2).

1.7.6. Metals from melting furnaces

62. BAT is to reduce metal emissions from the melting furnace by using one or a combination of the following techniques:

Technique (1)	Applicability
(i) Selection of raw materials for the batch formulation with a low content of metals	The technique is generally applicable within the constraints of the availability of raw materials. In glass wool production, the use of manganese in the batch formulation as an oxidising agent depends on the quantity and quality of external cullet employed in the batch formulation and may be minimised accordingly
(ii) Application of a filtration system	Electrostatic precipitators are not applicable to cupola furnaces for stone wool production (see BAT 56)

(1) A description of the techniques is given in Section 1.10.5.

Table 52

BAT-AELs for metal emissions from the melting furnace in the mineral wool sector

Parameter	BAT-AEL (1)	
	mg/Nm^3	kg/tonne melted glass (2)
Σ (As, Co, Ni, Cd, Se, Cr_{VI})	< 0,2 – 1 (3)	$< 0,4 - 2,5 \times 10^{-3}$
Σ (As, Co, Ni, Cd, Se, Cr_{VI}, Sb, Pb, Cr_{III}, Cu, Mn, V, Sn)	< 1 – 2 (3)	$< 2 - 5 \times 10^{-3}$

(1) The ranges refer to the sum of metals present in the flue-gases in both solid and gaseous phases.
(2) The conversion factors of 2×10^{-3} and $2,5 \times 10^{-3}$ have been used for the determination of the lower and upper values of the BAT-AELs range (see Table 2).
(3) Higher values are associated with the use of cupola furnaces for the production of stone wool.

1.7.7. Emissions from downstream processes

63. BAT is to reduce emissions from downstream processes by using one or a combination of the following techniques:

Technique [1]	Applicability
(i) Impact jets and cyclones The technique is based on the removal of particles and droplets from waste gases by impaction/impingement, as well as gaseous substances by partial absorption with water. Process water is normally used for impact jets. The recycling process water is filtered before it is reapplied	The technique is generally applicable to the mineral wool sector, in particular to glass wool processes for the treatment of emissions from the forming area (application of the coating to the fibres). Limited applicability to stone wool processes since it could adversely affect other abatement techniques being used.
(ii) Wet scrubbers	The technique is generally applicable for the treatment of waste gases from the forming process (application of the coating to the fibres) or for combined waste gases (forming plus curing)
(iii) Wet electrostatic precipitators	The technique is generally applicable for the treatment of waste gases from the forming process (application of the coating to the fibres), from curing ovens or for combined waste gases (forming plus curing)
(iv) Stone wool filters It consists of a steel or concrete structure in which stone wool slabs are mounted and act as a filter medium. The filtering medium needs to be cleaned or exchanged periodically. This filter is suitable for waste gases with a high moisture content and particulate matter with an adhesive nature	The applicability is mainly limited to stone wool processes for waste gases from the forming area and/or curing ovens
(v) Waste gas incineration	The technique is generally applicable for the treatment of waste gases from curing ovens, in particular in the stone wool processes. The application to combined waste gases (forming plus curing) is not economically viable because of the high volume, low concentration, low temperature of the waste gases

[1] A description of the techniques is given in Sections 1.10.7 and 1.10.9.

Table 53

BAT-AELs for air emissions from downstream processes in the mineral wool sector, when treated separately

Parameter	BAT-AEL	
	mg/Nm^3	kg/tonne finished product
Forming area – Combined forming and curing emissions-Combined forming, curing and cooling emissions		
Total particulate matter	< 20 – 50	—
Phenol	< 5 – 10	—
Formaldehyde	< 2 – 5	—
Ammonia	30 – 60	—

Parameter	BAT-AEL	
	mg/Nm^3	kg/tonne finished product
Amines	< 3	—
Total volatile organic compounds expressed as C	10 – 30	—
Curing oven emissions [1] [2]		
Total particulate matter	< 5 – 30	< 0,2
Phenol	< 2 – 5	< 0,03
Formaldehyde	< 2 – 5	< 0,03
Ammonia	< 20 – 60	< 0,4
Amines	< 2	< 0,01
Total volatile organic compounds expressed as C	< 10	< 0,065
NO_X, expressed as NO_2	< 100 – 200	< 1

(1) Emission levels expressed in kg/tonne of finished product are not affected by the thickness of the mineral wool mat produced nor by extreme concentration or dilution of the flue-gases. A conversion factor of $6,5 \times 10^{-3}$ has been used.
(2) If high density or high binder content mineral wools are produced, the emission levels associated with the techniques listed as BAT for the sector could be significantly higher than these BAT-AELs. If these types of products represent the majority of the production from a given installation, then consideration should be given to other techniques.

1.8. *BAT conclusions for high temperature insulation wools (HTIW) manufacturing*

Unless otherwise stated, the BAT conclusions presented in this section can be applied to all HTIW manufacturing installations.

1.8.1. Dust emissions from melting and downstream processes

64. BAT is to reduce dust emissions from the waste gases of the melting furnace by applying a filtration system.

Technique [1]	Applicability
The filtration system usually consists of a bag filter	The technique is generally applicable

(1) A description of the technique is given in Section 1.10.1.

Table 54

BAT-AELs for dust emissions from the melting furnace in the HTIW sector

Parameter	BAT	BAT-AEL
		mg/Nm^3
Dust	Flue-gas cleaning by filtration systems	< 5 – 20 [1]

(1) The values are associated with the use of a bag filter system.

65. For downstream dusty processes, BAT is to reduce emissions using one or a combination of the following techniques:

Technique [1]	Applicability
(i) Minimising the losses of product by ensuring a good sealing of the production line, where technically applicable. The potential sources of dust and fibre emissions are: — fiberisation and collection — mat formation (needling) — lubricant burn-off — cutting, trimming and packaging of the finished product A good construction, sealing and maintenance of the downstream processing systems are essential for minimising the losses of product into the air	The techniques are generally applicable
(ii) Cutting, trimming and packaging under vacuum, by applying an efficient extraction system in conjunction with a fabric filter. A negative pressure is applied to the workstation (i.e. cutting machine, cardboard box for packaging) in order to extract particulate and fibrous releases and convey it to a fabric filter	
(iii) Applying a fabric filter system [1] Waste gases from downstream operations (e.g. fiberising, mat formation, lubricant burn-off) are conveyed to a treatment system consisting of a bag filter	

[1] A description of the technique is given in Section 1.10.1.

Table 55

BAT-AELs from dusty downstream processes in the HTIW sector, when treated separately

Parameter	BAT-AEL
	mg/Nm^3
Dust [1]	1 – 5

[1] The lower level of the range is associated with emissions of aluminium silicate glass wool/refractory ceramic fibres (ASW/RCF).

1.8.2. Nitrogen oxides (NO_X) from melting and downstream processes

66. BAT is to reduce NO_X emissions from the lubricant burn-off oven by applying combustion control and/or modifications

Technique	Applicability
Combustion control and/or modifications Techniques to reduce the formation of thermal NO_X emissions include a control of the main combustion parameters: — air/fuel ratio (oxygen content in the reaction zone) — flame temperature — residence time in the high temperature zone. A good combustion control consists of generating those conditions which are least favourable for NO_X formation	The technique is generally applicable

Table 56

BAT-AELs for NO_X from the lubricant burn-off oven in the HTIW sector

Parameter	BAT	BAT-AEL
		mg/Nm^3
NO_X expressed as NO_2	Combustion control and/or modifications	100 – 200

1.8.3. Sulphur oxides (SO_X) from melting and downstream processes

67. BAT is to reduce SO_X emissions from the melting furnaces and downstream processes by using one or a combination of the following techniques:

Technique [1]	Applicability
(i) Selection of raw materials for the batch formulation with a low content of sulphur	The technique is generally applicable within the constraints of the availability of raw materials
(ii) Use of low sulphur content fuel	The applicability may be limited by the constraints associated with the availability of low sulphur fuels, which may be impacted by the energy policy of the Member State

[1] A description of the technique is given in Section 1.10.3.

Table 57

BAT-AELs for SO_X emissions from the melting furnaces and downstream processes in the HTIW sector

Parameter	BAT	BAT-AEL
		mg/Nm^3
SO_x expressed as SO_2	Primary techniques	< 50

1.8.4. Hydrogen chloride (HCl) and hydrogen fluoride (HF) from melting furnaces

68. BAT is to reduce HCl and HF emissions from the melting furnace by selecting raw materials for the batch formulation with a low content of chlorine and fluorine

Technique [1]	Applicability
Selection of raw materials for the batch formulation with a low content of chlorine and fluorine	The technique is generally applicable

[1] A description of the technique is given in Section 1.10.4.

Table 58

BAT-AELs for HCl and HF emissions from the melting furnace in the HTIW sector

Parameter	BAT-AEL
	mg/Nm^3
Hydrogen chloride, expressed as HCl	< 10
Hydrogen fluoride, expressed as HF	< 5

1.8.5. Metals from melting furnaces and downstream processes

69. BAT is to reduce metal emissions from the melting furnace and/or downstream processes by using one or a combination of the following techniques:

Technique [1]	Applicability
(i) Selection of raw materials for the batch formulation with a low content of metals	The techniques are generally applicable
(ii) Applying a filtration system	

[1] A description of the technique is given in Section 1.10.5.

Table 59

BAT-AELs for metal emissions from the melting furnace and/or downstream processes in the HTIW sector

Parameter	BAT-AEL [1]
	mg/Nm^3
Σ (As, Co, Ni, Cd, Se, Cr_{VI})	< 1
Σ (As, Co, Ni, Cd, Se, Cr_{VI}, Sb, Pb, Cr_{III}, Cu, Mn, V, Sn)	< 5

[1] The levels refer to the sum of metals present in the flue-gases in both solid and gaseous phases.

1.8.6. Volatile organic compounds from downstream processes

70. BAT is to reduce volatile organic compound (VOC) emissions from the lubricant burn-off oven by using one or a combination of the following techniques:

Technique [1]	Applicability
(i) Combustion control, including monitoring the associated emissions of CO. The technique consists of the control of combustion parameters (e.g. oxygen content in the reaction zone, flame temperature) in order to ensure a complete combustion of the organic components (i.e. polyethylene glycol) in the waste gas. The monitoring of carbon monoxide emissions allows for controlling the presence of uncombusted organic materials	The technique is generally applicable
(ii) Waste gas incineration	The economic viability may limit the applicability of these techniques because of low waste gas volumes and VOC concentrations
(iii) Wet scrubbers	

[1] A description of the techniques is given in Sections 1.10.6 and 1.10.9.

Table 60

BAT-AELs for VOC emissions from the lubricant burn-off oven in the HTIW sector, when treated separately

Parameter	BAT	BAT-AEL
		mg/Nm^3
Volatile organic compounds expressed as C	Primary and/or secondary techniques	10 – 20

1.9. *BAT conclusions for frits manufacturing*

Unless otherwise stated, the BAT conclusions presented in this section can be applied to all frits glass manufacturing installations.

1.9.1. Dust emissions from melting furnaces

71. BAT is to reduce dust emissions from the waste gases of the melting furnace by means of an electrostatic precipitator or a bag filter system.

Technique (1)	Applicability
Filtration system: electrostatic precipitator or bag filter	The technique is generally applicable

(1) A description of the technique is given in Section 1.10.1.

Table 61

BAT-AELs for dust emissions from the melting furnace in the frits sector

Parameter	BAT-AEL	
	mg/Nm^3	kg/tonne melted glass (1)
Dust	< 10 – 20	< 0,05 – 0,15

(1) The conversion factors of 5×10^{-3} and $7,5 \times 10^{-3}$ have been used for the determination of the lower and upper value of the BAT-AELs range (see Table 2). However, a case-by-case conversion factor may have to be applied based on the type of combustion.

1.9.2. Nitrogen oxides (NO_X) from melting furnaces

72. BAT is to reduce NO_X emissions from the melting furnace by using one or a combination of the following techniques:

Technique (1)	Applicability
(i) Minimising the use of nitrates in the batch formulation In the frits production, nitrates are used in the batch formulation of many products in order to obtain the required characteristics	The substitution of nitrates in the batch formulation may be limited by the high costs and/or higher environmental impact of the alternative materials and/or the quality requirements of the final product
(ii) Reduction of the parasitic air entering the furnace The technique consists of preventing the ingress of air into the furnace by sealing the burner blocks, the batch material feeder and any other opening of the melting furnace	The technique is generally applicable
(iii) Combustion modifications	
(a) 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
(b) Reduced combustion air temperature	Applicable only under installation-specific circumstances due to a lower furnace efficiency and higher fuel demand
(c) Staged combustion: — Air staging — Fuel staging	Fuel staging is applicable to most conventional air/fuel furnaces. Air staging has very limited applicability due to its technical complexity

Technique [1]	Applicability
(d) Flue-gas recirculation	The applicability of this technique is limited to the use of special burners with automatic recirculation of the waste gas
(e) Low-NO_X burners	The technique is generally applicable. Full benefits are achieved at normal or complete furnace rebuild, when combined with optimum furnace design and geometry
(f) Fuel choice	The applicability is limited by the constraints associated with the availability of different types of fuel, which may be impacted by the energy policy of the Member State
(iv) Oxy-fuel melting	The maximum environmental benefits are achieved for applications at the time of a complete furnace rebuild

[1] A description of the technique is given in Section 1.10.2.

Table 62

BAT-AELs for NO_X emissions from the melting furnace in the frits glass sector

Parameter	BAT	Operating conditions	BAT-AEL [1]	
			mg/Nm^3	kg/tonne melted glass [2]
NO_X expressed as NO_2	Primary techniques	Oxy-fuel firing, without nitrates [3]	Not applicable	< 2,5 – 5
		Oxy-fuel firing, with use of nitrates	Not applicable	5 – 10
		Fuel/air, fuel/oxygen-enriched air combustion, without nitrates	500 – 1 000	2,5 – 7,5
		Fuel/air, fuel/oxygen-enriched air combustion, with use of nitrates	< 1 600	< 12

[1] The ranges take into account the combination of flue-gases from furnaces applying different melting techniques and producing a variety of frit types, with or without nitrates in the batch formulations, which may be conveyed to a single stack, precluding the possibility of characterising each applied melting technique and the different products.
[2] The conversion factors of 5×10^{-3} and $7,5 \times 10^{-3}$ have been used for the determination of the lower and higher values of the range. However, a case-by-case conversion factor may have to be applied based on the type of combustion (see Table 2).
[3] The achievable levels depend on the quality of the natural gas and oxygen available (nitrogen content).

1.9.3. Sulphur oxides (SO_X) from melting furnaces

73. BAT is to control SO_X emissions from the melting furnace by using one or a combination of the following techniques:

Technique [1]	Applicability
(i) Selection of raw materials for the batch formulation with a low content of sulphur	The technique is generally applicable within the constraints of the availability of raw materials
(ii) Dry or semi-dry scrubbing, in combination with a filtration system	The technique is generally applicable
(iii) Use of low sulphur content fuels	The applicability may be limited by the constraints associated with the availability of low sulphur fuels, which may be impacted by the energy policy of the Member State

[1] A description of the techniques is given in Section 1.10.3.

Table 63

BAT-AELs for SO_X emissions from the melting furnace in the frits sector

Parameter	BAT-AEL	
	mg/Nm³	kg/tonne melted glass [1]
SO_X, expressed as SO_2	< 50 – 200	< 0,25 – 1,5

[1] The conversion factors of 5×10^{-3} and $7,5 \times 10^{-3}$ have been used; however, the values indicated in the table may have been approximated. A case-by-case conversion factor may have to be applied based on the type of combustion (see Table 2).

1.9.4. Hydrogen chloride (HCl) and hydrogen fluoride (HF) from melting furnaces

74. BAT is to reduce HCl and HF emissions from the melting furnace by using one or a combination of the following techniques:

Technique [1]	Applicability
(i) Selection of raw materials for the batch formulation with a low content of chlorine and fluorine	The technique is generally applicable within the constraints of the batch formulation and the availability of raw materials
(ii) Minimisation of the fluorine compounds in the batch formulation when used to ensure the quality of the final product Fluorine compounds are used to confer particular characteristics to the frits (i.e. thermal and chemical resistance)	The minimisation or substitution of fluorine compounds with alternative materials is limited by quality requirements of the product
(iii) Dry or semi-dry scrubbing, in combination with a filtration system	The technique is generally applicable

[1] A description of the techniques is given in Section 1.10.4.

Table 64

BAT-AELs for HCl and HF emissions from the melting furnace in the frits sector

Parameter	BAT-AEL	
	mg/Nm³	kg/tonne melted glass [1]
Hydrogen chloride, expressed as HCl	< 10	< 0,05
Hydrogen fluoride, expressed as HF	< 5	< 0,03

[1] The conversion factor of 5×10^{-3} has been used with some values being approximated. A case-by-case conversion factor may have to be applied based on the type of combustion (see Table 2).

1.9.5. Metals from melting furnaces

75. BAT is to reduce metal emissions from the melting furnace by using one or a combination of the following techniques:

Technique [1]	Applicability
(i) Selection of raw materials for the batch formulation with a low content of metals	The technique is generally applicable within the constraints of the type of frit produced at the installation and the availability of raw materials

Technique [1]	Applicability
(ii) Minimising of the use of metal compounds in the batch formulation, where colouring is required or other specific characteristics are conferred to the frit	The techniques are generally applicable
(iii) Dry or semi-dry scrubbing, in combination with a filtration system	

(1) A description of the techniques is given in Section 1.10.5.

Table 65

BAT-AELs for metal emissions from the melting furnace in the frits sector

Parameter	BAT-AEL [1]	
	mg/Nm^3	kg/tonne melted glass [2]
Σ (As, Co, Ni, Cd, Se, Cr_{VI})	< 1	< 7,5 × 10^{-3}
Σ (As, Co, Ni, Cd, Se, Cr_{VI}, Sb, Pb, Cr_{III}, Cu, Mn, V, Sn)	< 5	< 37 × 10^{-3}

(1) The levels refer to the sum of metals present in the flue-gases in both solid and gaseous phases.
(2) The conversion factor of 7,5 × 10^{-3} has been used. A case-by-case conversion factor may have to be applied based on the type of combustion (see Table 2).

1.9.6. Emissions from downstream processes

76. For downstream dusty processes, BAT is to reduce emissions by using one or a combination of the following techniques:

Technique [1]	Applicability
(i) Applying wet milling techniques The technique consists of grinding the frit to the desired particle size distribution with sufficient liquid to form a slurry. The process is generally carried out in alumina ball mills with water	The techniques are generally applicable
(ii) Operating dry milling and dry product packaging under an efficient extraction system in conjunction with a fabric filter A negative pressure is applied to the milling equipment or to the work station where packaging is carried out in order to convey dust emissions to a fabric filter	
(iii) Applying a filtration system	

(1) A description of the techniques is given in Section 1.10.1.

Table 66

BAT-AELs for air emissions from downstream processes in the frits sector, when treated separately

Parameter	BAT-AEL
	mg/Nm^3
Dust	5 – 10
Σ (As, Co, Ni, Cd, Se, Cr_{VI})	< 1 [1]
Σ (As, Co, Ni, Cd, Se, Cr_{VI}, Sb, Pb, Cr_{III}, Cu, Mn, V, Sn)	< 5 [1]

(1) The levels refer to the sum of metals present in the waste gas.

Glossary

1.10. *Description of techniques*

1.10.1. Dust emissions

Technique	Description
Electrostatic precipitator	Electrostatic precipitators operate such that particles are charged and separated under the influence of an electrical field. Electrostatic precipitators are capable of operating over a wide range of conditions
Bag filter	Bag filters are constructed from porous woven or felted fabric through which gases are flowed to remove particles. The use of a bag filter requires a fabric material selection adequate to the characteristics of the waste gases and the maximum operating temperature
Reduction of the volatile components by raw material modifications	The formulation of batch compositions might contain very volatile components (e.g. boron compounds) which could be minimised or substituted for reducing dust emissions mainly generated by volatilisation phenomena
Electric melting	The technique consists of a melting furnace where the energy is provided by resistive heating. In the cold-top furnaces (where the electrodes are generally inserted at the bottom of the furnace) the batch blanket covers the surface of the melt with a consequent, significant reduction of the volatilisation of batch components (i.e. lead compounds)

1.10.2. NO_X emissions

Technique	Description
Combustion modifications	
(i) Reduction of air/fuel ratio	The technique is mainly based on the following features: — minimisation of air leakages into the furnace — careful control of air used for combustion — modified design of the furnace combustion chamber
(ii) Reduced combustion air temperature	The use of recuperative furnaces, in place of regenerative furnaces, results in a reduced air preheat temperature and, consequently, a lower flame temperature. However, this is associated with a lower furnace efficiency (lower specific pull), lower fuel efficiency and higher fuel demand, resulting in potentially higher emissions (kg/tonne of glass)
(iii) Staged combustion	— Air staging – involves substoichiometric firing and the addition of the remaining air or oxygen into the furnace to complete combustion. — Fuel staging – a low impulse primary flame is developed in the port neck (10 % of total energy); a secondary flame covers the root of the primary flame reducing its core temperature
(iv) Flue-gas recirculation	Implies the reinjection of waste gas from the furnace into the flame to reduce the oxygen content and therefore the temperature of the flame. The use of special burners is based on internal recirculation of combustion gases which cool the root of the flames and reduce the oxygen content in the hottest part of the flames
(v) Low-NO_X burners	The technique is based on the principles of reducing peak flame temperatures, delaying but completing the combustion and increasing the heat transfer (increased emissivity of the flame). It may be associated with a modified design of the furnace combustion chamber

Technique	Description
(vi) Fuel choice	In general, oil-fired furnaces show lower NO_X emissions than gas-fired furnaces due to better thermal emissivity and lower flame temperatures
Special furnace design	Recuperative type furnace that integrates various features, allowing for lower flame temperatures. The main features are: — specific type of burners (number and positioning) — modified geometry of the furnace (height and size) — two-stage raw material preheating with waste gases passing over the raw materials entering the furnace and an external cullet preheater downstream of the recuperator used for preheating the combustion air
Electric melting	The technique consists of a melting furnace where the energy is provided by resistive heating. The main features are: — electrodes are generally inserted at the bottom of the furnace (cold-top) — nitrates are often required in the batch composition of cold-top electric furnaces to provide the necessary oxidising conditions for a stable, safe and efficient manufacturing process
Oxy-fuel melting	The technique involves the replacement of the combustion air with oxygen (> 90 % purity), with consequent elimination/reduction of thermal NO_X formation from nitrogen entering the furnace. The residual nitrogen content in the furnace depends on the purity of the oxygen supplied, on the quality of the fuel (% N_2 in natural gas) and on the potential air inlet
Chemical reduction by fuel	The technique is based on the injection of fossil fuel to the waste gas with chemical reduction of NO_X to N_2 through a series of reactions. In the 3R process, the fuel (natural gas or oil) is injected at the regenerator entrance. The technology is designed for use in regenerative furnaces
Selective catalytic reduction (SCR)	The technique is based on the reduction of NO_X to nitrogen in a catalytic bed by reaction with ammonia (in general aqueous solution) at an optimum operating temperature of around 300 – 450 °C. One or two layers of catalyst may be applied. A higher NO_X reduction is achieved with the use of higher amounts of catalyst (two layers)
Selective non-catalytic reduction (SNCR)	The technique is based on the reduction of NO_X to nitrogen by reaction with ammonia or urea at a high temperature. The operating temperature window must be maintained between 900 and 1 050 °C
Minimising the use of nitrates in the batch formulation	The minimisation of nitrates is used to reduce NO_X emissions deriving from the decomposition of these raw materials when applied as an oxidising agent for very high quality products where a very colourless (clear) glass is required or for other glasses to provide the required characteristics. The following options may be applied: — Reduce the presence of nitrates in the batch formulation to the minimum commensurate with the product and melting requirements. — Substitute nitrates with alternative materials. Effective alternatives are sulphates, arsenic oxides, cerium oxide. — Apply process modifications (e.g. special oxidising combustion conditions)

1.10.3. SO_X emissions

Technique	Description
Dry or semi-dry scrubbing, in combination with a filtration system	Dry powder or a suspension/solution of alkaline reagent are introduced and dispersed in the waste gas stream. The material reacts with the sulphur gaseous species to form a solid which has to be removed by filtration (bag filter or electrostatic precipitator). In general, the use of a reaction tower improves the removal efficiency of the scrubbing system
Minimisation of the sulphur content in the batch formulation and optimisation of the sulphur balance	The minimisation of sulphur content in the batch formulation is applied to reduce SO_X emissions deriving from the decomposition of sulphur-containing raw materials (in general, sulphates) used as fining agents. The effective reduction of SO_X emissions depends on the retention of sulphur compounds in the glass, which may vary significantly depending on the glass type, and on the optimisation of the sulphur balance
Use of low sulphur content fuels	The use of natural gas or low sulphur fuel oil is applied to reduce the amount of SO_X emissions deriving from the oxidation of sulphur contained in the fuel during combustion

1.10.4. HCl, HF emissions

Technique	Description
Selection of raw materials for the batch formulation with a low content of chlorine and fluorine	The technique consists of a careful selection of raw materials that may contain chlorides and fluorides as impurities (e.g. synthetic soda ash, dolomite, external cullet, recycled filter dust) in order to reduce at source HCl and HF emissions which arise from the decomposition of these materials during the melting process
Minimisation of the fluorine and/or chlorine compounds in the batch formulation and optimisation of the fluorine and/or chlorine mass balance	The minimisation of fluorine and/or chlorine emissions from the melting process may be achieved by minimising/reducing the quantity of these substances used in the batch formulation to the minimum commensurate with the quality of the final product. Fluorine compounds (e.g. fluorspar, cryolite, fluorsilicate) are used to confer particular characteristics to special glasses (e.g. opaque glass, optical glass). Chlorine compounds may be used as fining agents
Dry or semi-dry scrubbing, in combination with a filtration system	Dry powder or a suspension/solution of alkaline reagent are introduced and dispersed in the waste gas stream. The material reacts with the gaseous chlorides and fluorides to form a solid which has to be removed by filtration (electrostatic precipitator or bag filter)

1.10.5. Metal emissions

Technique	Description
Selection of raw materials for the batch formulation with a low content of metals	The technique consists of a careful selection of batch materials that may contain metals as impurities (e.g. external cullet), in order to reduce at source metal emissions which arise from the decomposition of these materials during the melting process
Minimising the use of metal compounds in the batch formulation, where colouring and decolourising of glass is needed, subject to consumer glass quality requirements	The minimisation of metal emissions from the melting process may be achieved as follows: — minimising the quantity of metal compounds in the batch formulation (e.g. iron, chromium, cobalt, copper, manganese compounds) in the production of coloured glasses — minimising the quantity of selenium compounds and cerium oxide used as decolourising agents for the production of clear glass

Technique	Description
Minimising the use of selenium compounds in the batch formulation, through a suitable selection of the raw materials	The minimisation of selenium emissions from the melting process may be achieved by: — minimising/reducing the quantity of selenium in the batch formulation to the minimum commensurate with the product requirements — selecting selenium raw materials with a lower volatility, in order to reduce the volatilisation phenomena during the melting process
Application of a filtration system	Dust abatement systems (bag filter and electrostatic precipitator) can reduce both dust and metal emissions since the emissions to air of metals from glass melting processes are largely contained in particulate form. However, for some metals presenting extremely volatile compounds (e.g. selenium) the removal efficiency may vary significantly with the filtration temperature
Dry or semi-dry scrubbing, in combination with a filtration system	Gaseous metals can be substantially reduced by the use of a dry or semi-dry scrubbing technique with an alkaline reagent. The alkaline reagent reacts with the gaseous species to form a solid which has to be removed by filtration (bag filter or electrostatic precipitator)

1.10.6. Combined gaseous emissions (e.g. SO_X, HCl, HF, boron compounds)

Wet scrubbing	In the wet scrubbing process, gaseous compounds are dissolved in a suitable liquid (water or alkaline solution). Downstream of the wet scrubber, the flue-gases are saturated with water and a separation of the droplets is required before discharging the flue-gases. The resulting liquid has to be treated by a waste water process and the insoluble matter is collected by sedimentation or filtration

1.10.7. Combined emissions (solid + gaseous)

Technique	Description
Wet scrubbing	In a wet scrubbing process (by a suitable liquid: water or alkaline solution), the simultaneous removal of solid and gaseous compounds may be achieved. The design criteria for particulate or gas removal are different; therefore, the design is often a compromise between the two options. The resulting liquid has to be treated by a waste water process and the insoluble matter (solid emissions and products from chemical reactions) is collected by sedimentation or filtration. In the mineral wool and continuous filament glass fibre sector, the most common systems applied are: — packed bed scrubbers with impact jets upstream — venturi scrubbers
Wet electrostatic precipitator	The technique consists of an electrostatic precipitator in which the collected material is removed from the plates of the collectors by flushing with a suitable liquid, usually water. Some mechanism is usually installed to remove water droplets before discharge of the waste gas (demister or a last dry field)

1.10.8. Emissions from cutting, grinding, polishing operations

Technique	Description
Performing dusty operations (e.g. cutting, grinding, polishing) under liquid	Water is generally used as a coolant for cutting, grinding and polishing operations and for preventing dust emissions. An extraction system equipped with a mist eliminator may be necessary

Technique	Description
Applying a bag filter system	The use of bag filters is suitable for the reduction of both dust and metal emissions since metals from downstream processes are largely contained in particulate form
Minimising the losses of polishing product by ensuring a good sealing of the application system	Acid polishing is performed by immersion of the glass articles in a polishing bath of hydrofluoric and sulphuric acids. The release of fumes may be minimised by a good design and maintenance of the application system in order to minimise losses
Applying a secondary technique, e.g. wet scrubbing	Wet scrubbing with water is used for the treatment of waste gases, due to the acidic nature of the emissions and the high solubility of the gaseous pollutants to be removed

1.10.9. H_2S, VOC emissions

Waste gas incineration	The technique consists of an afterburner system which oxidises the hydrogen sulphide (generated by strong reducing conditions in the melting furnace) to sulphur dioxide and carbon monoxide to carbon dioxide. Volatile organic compounds are thermally incinerated with consequent oxidation to carbon dioxide, water and other combustion products (e.g. NO_X, SO_X)

COMMISSION IMPLEMENTING DECISION

of 28 February 2012

establishing the best available techniques (BAT) conclusions under Directive 2010/75/EU of the European Parliament and of the Council on industrial emissions for iron and steel production

(notified under document C(2012) 903)

(Text with EEA relevance)

(2012/135/EU)

THE EUROPEAN COMMISSION,

Having regard to the Treaty on the Functioning of the European Union,

Having regard to Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control) [1], and in particular Article 13(5) thereof,

Whereas:

(1) Article 13(1) of Directive 2010/75/EU requires the Commission to organise an exchange of information on industrial emissions between it and Member States, the industries concerned and non-governmental organisations promoting environmental protection in order to facilitate the drawing up of best available techniques (BAT) reference documents as defined in Article 3(11) of that Directive.

(2) In accordance with Article 13(2) of Directive 2010/75/EU, the exchange of information is to address the performance of installations and techniques in terms of emissions, expressed as short- and long-term averages, where appropriate, and the associated reference conditions, consumption and nature of raw materials, water consumption, use of energy and generation of waste and the techniques used, associated monitoring, cross-media effects, economic and technical viability and developments therein and also the best available techniques and emerging techniques identified after considering the issues mentioned in points (a) and (b) of Article 13(2) of that Directive.

(3) ‘BAT conclusions’ as defined in Article 3(12) of Directive 2010/75/EU are the key element of BAT reference documents and lay down the conclusions on best available techniques, their description, information to assess their applicability, the emission levels associated with the best available techniques, associated monitoring, associated consumption levels and, where appropriate, relevant site remediation measures.

(4) In accordance with Article 14(3) of Directive 2010/75/EU, BAT conclusions are to be the reference for setting the permit conditions for installations covered by Chapter 2 of that Directive.

(5) Article 15(3) of Directive 2010/75/EU requires the competent authority to set emission limit values that ensure that, under normal operating conditions, emissions do not exceed the emission levels associated with the best available techniques as laid down in the decisions on BAT conclusions referred to in Article 13(5) of that Directive.

(6) Article 15(4) of Directive 2010/75 provides for derogations from the requirement laid down in Article 15(3) only where the costs associated with the achievement of emissions levels disproportionately outweigh the environmental benefits due to the geographical location, the local environmental conditions or the technical characteristics of the installation concerned.

(7) Article 16(1) of Directive 2010/75/EU provides that the monitoring requirements in the permit referred to in point (c) of Article 14(1) are to be based on the conclusions on monitoring as described in the BAT conclusions.

(8) In accordance with Article 21(3) of Directive 2010/75/EU, within four years of publication of decisions on BAT conclusions, the competent authority is to reconsider and, if necessary, update all the permit conditions and ensure that the installation complies with those permit conditions.

(9) Commission Decision of 16 May 2011 establishing a forum for the exchange of information pursuant to Article 13 of the Directive 2010/75/EU on industrial emissions [2] established a forum composed of representatives of Member States, the industries concerned and non-governmental organisations promoting environmental protection.

[1] OJ L 334, 17.12.2010, p. 17.

[2] OJ C 146, 17.5.2011, p. 3.

(10) In accordance with Article 13(4) of Directive 2010/75/EU, the Commission obtained the opinion [1] of that forum on the proposed content of the BAT reference document for iron and steel production on 13 September 2011 and made it publicly available.

(11) The measures provided for in this Decision are in accordance with the opinion of the Committee established by Article 75(1) of Directive 2010/75/EU,

HAS ADOPTED THIS DECISION:

Article 1

The BAT conclusions for iron and steel production are set out in the Annex to this Decision.

Article 2

This Decision is addressed to the Member States.

Done at Brussels, 28 February 2012.

For the Commission
Janez POTOČNIK
Member of the Commission

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(1) http://circa.europa.eu/Public/irc/env/ied/library?l=/ied_art_13_forum/opinions_article

ANNEX

BAT CONCLUSIONS FOR IRON AND STEEL PRODUCTION

SCOPE

These BAT conclusions concern the following activities specified in Annex I to Directive 2010/75/EU, namely:

— activity 1.3: coke production

— activity 2.1: metal ore (including sulphide ore) roasting and sintering

— activity 2.2: production of pig iron or steel (primary or secondary fusion) including continuous casting, with a capacity exceeding 2,5 tonnes per hour.

In particular, the BAT conclusions cover the following processes:

— the loading, unloading and handling of bulk raw materials

— the blending and mixing of raw materials

— the sintering and pelletisation of iron ore

— the production of coke from coking coal

— the production of hot metal by the blast furnace route, including slag processing

— the production and refining of steel using the basic oxygen process, including upstream ladle desulphurisation, downstream ladle metallurgy and slag processing

— the production of steel by electric arc furnaces, including downstream ladle metallurgy and slag processing

— continuous casting (thin slab/thin strip and direct sheet casting (near-shape))

These BAT conclusions do not address the following activities:

— production of lime in kilns, covered by the Cement, Lime and Magnesium Oxide Manufacturing Industries BREF (CLM)

— the treatment of dusts to recover non-ferrous metals (e.g. electric arc furnace dust) and the production of ferroalloys, covered by the Non-Ferrous Metals Industries BREF (NFM)

— sulphuric acid plants in coke ovens, covered by the Large Volume Inorganic Chemicals-Ammonia, Acids and Fertilisers Industries (LVIC-AAF BREF).

Other reference documents which are of relevance for the activities covered by these BAT conclusions are the following:

Reference documents	Activity
Large Combustion Plants BREF (LCP)	Combustion plants with a rated thermal input of 50 MW or more
Ferrous Metals Processing Industry BREF (FMP)	Downstream processes like rolling, pickling, coating, etc.
	Continuous casting to the thin slab/thin strip and direct sheet casting (near-shape)

Reference documents	Activity
Emissions from Storage BREF (EFS)	Storage and handling
Industrial Cooling Systems BREF (ICS)	Cooling systems
General Principles of Monitoring (MON)	Emissions and consumptions monitoring
Energy Efficiency BREF (ENE)	General energy efficiency
Economic and Cross-Media Effects (ECM)	Economic and cross-media effects of techniques

The techniques listed and described in these BAT conclusions are neither prescriptive nor exhaustive. Other techniques may be used that ensure at least an equivalent level of environmental protection.

GENERAL CONSIDERATIONS

The environmental performance levels associated with BAT are expressed as ranges, rather than as single values. A range may reflect the differences within a given type of installation (e.g. differences in the grade/purity and quality of the final product, differences in design, construction, size and capacity of the installation) that result in variations in the environmental performances achieved when applying BAT

EXPRESSION OF EMISSION LEVELS ASSOCIATED WITH THE BEST AVAILABLE TECHNIQUES (BAT-AELs)

In these BAT conclusions, BAT-AELs for air emissions are expressed as either:

— mass of emitted substances per volume of waste gas under standard conditions (273,15 K, 101,3 kPa), after deduction of water vapour content, expressed in the units g/Nm^3, mg/Nm^3, $\mu g/Nm^3$ or ng/Nm^3; or

— mass of emitted substances per unit of mass of products generated or processed (consumption or emission factors), expressed in the units kg/t, g/t, mg/t or μg/t.

and BAT-AELs for emissions to water are expressed as:

— mass of emitted substances per volume of waste water, expressed in the units g/l, mg/l or μg/l.

DEFINITIONS

For the purposes of these BAT conclusions:

— 'new plant' means: a plant introduced on the site of the installation following the publication of these BAT conclusions or a complete replacement of a plant on the existing foundations of the installation following the publication of these BAT conclusions

— 'existing plant' means: a plant which is not a new plant

— 'NO_X' means: the sum of nitrogen oxide (NO) and nitrogen dioxide (NO_2) expressed as NO_2

— 'SO_X' means: the sum of sulphur dioxide (SO_2) and sulphur trioxide (SO_3) expressed as SO_2

— 'HCl' means: all gaseous chlorides expressed as HCl

— 'HF' means: all gaseous fluorides expressed as HF

1.1. *General BAT Conclusions*

Unless otherwise stated, the BAT conclusions presented in this section are generally applicable.

The process specific BAT included in the Sections 1.2 – 1.7 apply in addition to the general BAT mentioned in this Section.

1.1.1. Environmental management systems

1. BAT is to implement and adhere to an environmental management system (EMS) that incorporates all of the following features:

I. commitment of management, including senior management;

II. definition of an environmental policy that includes continuous improvement for the installation by the management;

III. planning and establishing the necessary procedures, objectives and targets, in conjunction with financial planning and investment;

IV. implementation of the procedures paying particular attention to:

(i) structure and responsibility

(ii) training, awareness and competence

(iii) communication

(iv) employee involvement

(v) documentation

(vi) efficient process control

(vii) maintenance programmes

(viii) emergency preparedness and response

(ix) safeguarding compliance with environmental legislation;

V. checking performance and taking corrective action, paying particular attention to:

(i) monitoring and measurement (see also the Reference Document on the General Principles of Monitoring)

(ii) corrective and preventive action

(iii) maintenance of records

(iv) independent (where practicable) internal and external auditing in order to determine whether or not the EMS conforms to planned arrangements and has been properly implemented and maintained;

VI. review of the EMS and its continuing suitability, adequacy and effectiveness by senior management;

VII. following the development of cleaner technologies;

VIII. consideration for the environmental impacts from the eventual decommissioning of the installation at the stage of designing a new plant, and throughout its operating life;

IX. application of sectoral benchmarking on a regular basis.

Applicability

The scope (e.g. level of details) and nature of the EMS (e.g. standardised or non-standardised) will generally be related to the nature, scale and complexity of the installation, and the range of environmental impacts it may have.

1.1.2. Energy management

2. BAT is to reduce thermal energy consumption by using a combination of the following techniques:

I. improved and optimised systems to achieve smooth and stable processing, operating close to the process parameter set points by using

(i) process control optimisation including computer-based automatic control systems

(ii) modern, gravimetric solid fuel feed systems

(iii) preheating, to the greatest extent possible, considering the existing process configuration.

II. recovering excess heat from processes, especially from their cooling zones

III. an optimised steam and heat management

IV. applying process integrated reuse of sensible heat as much as possible.

In the context of energy management, see the Energy Efficiency BREF (ENE).

Description of BAT I.i

The following items are important for integrated steelworks in order to improve the overall energy efficiency:

— optimising energy consumption

— online monitoring for the most important energy flows and combustion processes at the site including the monitoring of all gas flares in order to prevent energy losses, enabling instant maintenance and achieving an undisrupted production process

— reporting and analysing tools to check the average energy consumption of each process

— defining specific energy consumption levels for relevant processes and comparing them on a long-term basis

— carrying out energy audits as defined in the Energy Efficiency BREF, e.g. to identify cost-effective energy savings opportunities.

Description of BAT II – IV

Process integrated techniques used to improve energy efficiency in steel manufacturing by improved heat recovery include:

— combined heat and power production with recovery of waste heat by heat exchangers and distribution either to other parts of the steelworks or to a district heating network

— the installation of steam boilers or adequate systems in large reheating furnaces (furnaces can cover a part of the steam demand)

— preheating of the combustion air in furnaces and other burning systems to save fuel, taking into consideration adverse effects, i.e. an increase of nitrogen oxides in the off-gas

— the insulation of steam pipes and hot water pipes

— recovery of heat from products, e.g. sinter

— where steel needs to be cooled, the use of both heat pumps and solar panels

— the use of flue-gas boilers in furnaces with high temperatures

— the oxygen evaporation and compressor cooling to exchange energy across standard heat exchangers

— the use of top recovery turbines to convert the kinetic energy of the gas produced in the blast furnace into electric power.

Applicability of BAT II – IV

Combined heat and power generation is applicable for all iron and steel plants close to urban areas with a suitable heat demand. The specific energy consumption depends on the scope of the process, the product quality and the type of installation (e.g. the amount of vacuum treatment at the basic oxygen furnace (BOF), annealing temperature, thickness of products, etc.).

3. BAT is to reduce primary energy consumption by optimisation of energy flows and optimised utilisation of the extracted process gases such as coke oven gas, blast furnace gas and basic oxygen gas.

Description

Process integrated techniques to improve energy efficiency in an integrated steelworks by optimising process gas utilisation include:

— the use of gas holders for all by-product gases or other adequate systems for short-term storage and pressure holding facilities

— increasing pressure in the gas grid if there are energy losses in the flares – in order to utilise more process gases with the resulting increase in the utilisation rate

— gas enrichment with process gases and different calorific values for different consumers

— heating fire furnaces with process gas

— use of a computer-controlled calorific value control system

— recording and using coke and flue-gas temperatures

— adequate dimensioning of the capacity of the energy recovery installations for the process gases, in particular with regard to the variability of process gases.

Applicability

The specific energy consumption depends on the scope of the process, the product quality and the type of installation (e.g. the amount of vacuum treatment at the BOF, annealing temperature, thickness of products, etc.).

4. BAT is to use desulphurised and dedusted surplus coke oven gas and dedusted blast furnace gas and basic oxygen gas (mixed or separate) in boilers or in combined heat and power plants to generate steam, electricity and/or heat using surplus waste heat for internal or external heating networks, if there is a demand from a third party.

Applicability

The cooperation and agreement of a third party may not be within the control of the operator, and therefore may not be within the scope of the permit.

5. BAT is to minimise electrical energy consumption by using one or a combination of the following techniques:

I. power management systems

II. grinding, pumping, ventilation and conveying equipment and other electricity-based equipment with high energy efficiency.

Applicability

Frequency controlled pumps cannot be used where the reliability of the pumps is of essential importance for the safety of the process.

1.1.3. Material management

6. BAT is to optimise the management and control of internal material flows in order to prevent pollution, prevent deterioration, provide adequate input quality, allow reuse and recycling and to improve the process efficiency and optimisation of the metal yield.

Description

Appropriate storage and handling of input materials and production residues can help to minimise the airborne dust emissions from stockyards and conveyor belts, including transfer points, and to avoid soil, groundwater and runoff water pollution (see also BAT 11).

The application of an adequate management of integrated steelworks and residues, including wastes, from other installations and sectors allows for a maximised internal and/or external use as raw materials (see also BAT 8, 9 and 10).

Material management includes the controlled disposal of small parts of the overall quantity of residues from an integrated steelworks which have no economic use.

7. In order to achieve low emission levels for relevant pollutants, BAT is to select appropriate scrap qualities and other raw materials. Regarding scrap, BAT is to undertake an appropriate inspection for visible contaminants which might contain heavy metals, in particular mercury, or might lead to the formation of polychlorinated dibenzodioxins/furans (PCDD/F) and polychlorinated biphenyls (PCB).

To improve the use of scrap, the following techniques can be used individually or in combination:

— specification of acceptance criteria suited to the production profile in purchase orders of scrap

— having a good knowledge of scrap composition by closely monitoring the origin of the scrap; in exceptional cases, a melt test might help characterise the composition of the scrap

— having adequate reception facilities and check deliveries

— having procedures to exclude scrap that is not suitable for use in the installation

— storing the scrap according to different criteria (e.g. size, alloys, degree of cleanliness); storing of scrap with potential release of contaminants to the soil on impermeable surfaces with a drainage and collection system; using a roof which can reduce the need for such a system

— putting together the scrap load for the different melts taking into account the knowledge of composition in order to use the most suitable scrap for the steel grade to be produced (this is essential in some cases to avoid the presence of undesired elements and in other cases to take advantage of alloy elements which are present in the scrap and needed for the steel grade to be produced)

— prompt return of all internally-generated scrap to the scrapyard for recycling

— having an operation and management plan

— scrap sorting to minimise the risk of including hazardous or non-ferrous contaminants, particularly polychlorinated biphenyls (PCB) and oil or grease. This is normally done by the scrap supplier but the operator inspects all scrap loads in sealed containers for safety reasons. Therefore, at the same time, it is possible to check, as far as practicable, for contaminants. Evaluation of the small quantities of plastic (e.g. as plastic coated components) may be required

— radioactivity control according to the United Nations Economic Commission for Europe (UNECE) Expert Group framework of recommendations

— implementation of the mandatory removal of components which contain mercury from End-of-Life Vehicles and Waste Electrical and Electronic Equipment (WEEE) by the scrap processors can be improved by:

— fixing the absence of mercury in scrap purchase contracts

— refusal of scrap which contains visible electronic components and assemblies.

Applicability

The selection and sorting of scrap might not be entirely within the control of the operator.

1.1.4. Management of process residues such as by-products and waste

8. BAT for solid residues is to use integrated techniques and operational techniques for waste minimisation by internal use or by application of specialised recycling processes (internally or externally).

Description

Techniques for the recycling of iron-rich residues include specialised recycling techniques such as the OxyCup® shaft furnace, the DK process, smelting reduction processes or cold bonded pelletting/briquetting as well as techniques for production residues mentioned in Sections 9.2 – 9.7.

Applicability

As the mentioned processes may be carried out by a third party, the recycling itself may not be within the control of the operator of the iron and steel plant, and therefore may not be within the scope of the permit.

9. BAT is to maximise external use or recycling for solid residues which cannot be used or recycled according to BAT 8, wherever this is possible and in line with waste regulations. BAT is to manage in a controlled manner residues which can neither be avoided nor recycled.

10. BAT is to use the best operational and maintenance practices for the collection, handling, storage and transport of all solid residues and for the hooding of transfer points to avoid emissions to air and water.

1.1.5. Diffuse dust emissions from materials storage, handling and transport of raw materials and (intermediate) products

11. BAT is to prevent or reduce diffuse dust emissions from materials storage, handling and transport by using one or a combination of the techniques mentioned below.

If abatement techniques are used, BAT is to optimise the capture efficiency and subsequent cleaning through appropriate techniques such as those mentioned below. Preference is given to the collection of the dust emissions nearest to the source.

I. General techniques include:

— the setting up within the EMS of the steelworks of an associated diffuse dust action plan;

— consideration of temporary cessation of certain operations where they are identified as a source of PM_{10} causing a high ambient reading; in order to do this, it will be necessary to have sufficient PM_{10} monitors, with associated wind direction and strength monitoring, to be able to triangulate and identify key sources of fine dust.

II. Techniques for the prevention of dust releases during the handling and transport of bulk raw materials include:

— orientation of long stockpiles in the direction of the prevailing wind

— installing wind barriers or using natural terrain to provide shelter

— controlling the moisture content of the material delivered

— careful attention to procedures to avoid the unnecessary handling of materials and long unenclosed drops

— adequate containment on conveyors and in hoppers, etc.

— the use of dust-suppressing water sprays, with additives such as latex, where appropriate

— rigorous maintenance standards for equipment

— high standards of housekeeping, in particular the cleaning and damping of roads

— the use of mobile and stationary vacuum cleaning equipment

— dust suppression or dust extraction and the use of a bag filter cleaning plant to abate sources of significant dust generation

— the application of emissions-reduced sweeping cars for carrying out the routine cleaning of hard surfaced roads.

III. Techniques for materials delivery, storage and reclamation activities include:

— total enclosure of unloading hoppers in a building equipped with filtered air extraction for dusty materials, or hoppers should be fitted with dust baffles and the unloading grids coupled to a dust extraction and cleaning system

— limiting the drop heights if possible to a maximum of 0,5 m

— the use of water sprays (preferably using recycled water) for dust suppression

— where necessary, the fitting of storage bins with filter units to control dust

— the use of totally enclosed devices for reclamation from bins

— where necessary, the storage of scrap in covered, and hard surfaced areas to reduce the risk of ground contamination (using just in time delivery to minimise the size of the yard and hence emissions)

— minimisation of the disturbance of stockpiles

— restriction of the height and a controlling of the general shape of stockpiles

— the use of in-building or in-vessel storage, rather than external stockpiles, if the scale of storage is appropriate

— the creation of windbreaks by natural terrain, banks of earth or the planting of long grass and evergreen trees in open areas to capture and absorb dust without suffering long-term harm

— hydro-seeding of waste tips and slag heaps

— implementation of a greening of the site by covering unused areas with top soil and planting grass, shrubs and other ground covering vegetation

— the moistening of the surface using durable dust-binding substances

— the covering of the surface with tarpaulins or coating (e.g. latex) stockpiles

— the application of storage with retaining walls to reduce the exposed surface

— when necessary, a measure could be to include impermeable surfaces with concrete and drainage.

IV. Where fuel and raw materials are delivered by sea and dust releases could be significant, some techniques include:

— use by operators of self-discharge vessels or enclosed continuous unloaders. Otherwise, dust generated by grab-type ship unloaders should be minimised through a combination of ensuring adequate moisture content of the material is delivered, by minimising drop heights and by using water sprays or fine water fogs at the mouth of the ship unloader hopper

— avoiding seawater in spraying ores or fluxes as this results in a fouling of sinter plant electrostatic precipitators with sodium chloride. Additional chlorine input in the raw materials may also lead to rising emissions (e.g. of polychlorinated dibenzodioxins/furans (PCDD/F)) and hamper filter dust recirculation

— storage of powdered carbon, lime and calcium carbide in sealed silos and conveying them pneumatically or storing and transferring them in sealed bags.

V. Train or truck unloading techniques include:

— if necessary due to dust emission formation, use of dedicated unloading equipment with a generally enclosed design.

VI. For highly drift-sensitive materials which may lead to significant dust release, some techniques include:

— use of transfer points, vibrating screens, crushers, hoppers and the like, which may be totally enclosed and extracted to a bag filter plant

— use of central or local vacuum cleaning systems rather than washing down for the removal of spillage, since the effects are restricted to one medium and the recycling of spilt material is simplified.

VII. Techniques for the handling and processing of slag include:

— keeping stockpiles of slag granulate damp for slag handling and processing since dried blast furnace slag and steel slag can give rise to dust

— use of enclosed slag-crushing equipment fitted with efficient extraction and bag filters to reduce dust emissions.

VIII. Techniques for handling scrap include:

— providing scrap storage under cover and/or on concrete floors to minimise dust lift-off caused by vehicle movements

IX. Techniques to consider during material transport include:

— the minimisation of points of access from public highways

— the employment of wheel-cleaning equipment to prevent the carryover of mud and dust onto public roads

— the application of hard surfaces to the transport roads (concrete or asphalt) to minimise the generation of dust clouds during materials transport and the cleaning of roads

— the restriction of vehicles to designated routes by fences, ditches or banks of recycled slag

— the damping of dusty routes by water sprays, e.g. at slag-handling operations

— ensuring that transport vehicles are not overfull, so as to prevent any spillage

— ensuring that transport vehicles are sheeted to cover the material carried

— the minimisation of numbers of transfers

— use of closed or enclosed conveyors

— use of tubular conveyors, where possible, to minimise material losses by changes of direction across sites usually provided by the discharge of materials from one belt onto another

— good practice techniques for molten metal transfer and ladle handling

— dedusting of conveyor transfer points.

1.1.6. Water and waste water management

12. BAT for waste water management is to prevent, collect and separate waste water types, maximising internal recycling and using an adequate treatment for each final flow. This includes techniques utilising, e.g. oil interceptors, filtration or sedimentation. In this context, the following techniques can be used where the prerequisites mentioned are present:

— avoiding the use of potable water for production lines

— increasing the number and/or capacity of water circulating systems when building new plants or modernising/revamping existing plants

— centralising the distribution of incoming fresh water

— using the water in cascades until single parameters reach their legal or technical limits

— using the water in other plants if only single parameters of the water are affected and further usage is possible

— keeping treated and untreated waste water separated; by this measure it is possible to dispose of waste water in different ways at a reasonable cost

— using rainwater whenever possible.

Applicability

The water management in an integrated steelworks will primarily be constrained by the availability and quality of fresh water and local legal requirements. In existing plants the existing configuration of the water circuits may limit applicability.

1.1.7. Monitoring

13. BAT is to measure or assess all relevant parameters necessary to steer the processes from control rooms by means of modern computer-based systems in order to adjust continuously and to optimise the processes online, to ensure stable and smooth processing, thus increasing energy efficiency and maximising the yield and improving maintenance practices.

14. BAT is to measure the stack emissions of pollutants from the main emission sources from all processes included in the Sections 1.2 – 1.7 whenever BAT-AELs are given and in process gas-fired power plants in iron and steel works.

BAT is to use continuous measurements at least for:

— primary emissions of dust, nitrogen oxides (NO_X) and sulphur dioxide (SO_2) from sinter strands

— nitrogen oxides (NO_X) and sulphur dioxide (SO_2) emissions from induration strands of pelletisation plants

— dust emissions from blast furnace cast houses

— secondary emissions of dust from basic oxygen furnaces

— emissions of nitrogen oxides (NO_X) from power plants

— dust emissions from large electric arc furnaces.

For other emissions, BAT is to consider using continuous emission monitoring depending on the mass flow and emission characteristics.

15. For relevant emission sources not mentioned in BAT 14, BAT is to measure the emissions of pollutants from all processes included in the Sections 1.2 – 1.7 and from process gas-fired power plants within iron and steel works as well as all relevant process gas components/pollutants periodically and discontinuously. This includes the discontinuous monitoring of process gases, stack emissions, polychlorinated dibenzodioxins/furans (PCDD/F) and monitoring the discharge of waste water, but excludes diffuse emissions (see BAT 16).

Description (relevant for BAT 14 and 15)

The monitoring of process gases provides information about the composition of process gases and about indirect emissions from the combustion of process gases, such as emissions of dust, heavy metals and SO_x.

Stack emissions can be measured by regular, periodic discontinuous measurements at relevant channelled emission sources over a sufficiently long period, to obtain representative emission values.

For monitoring the discharge of waste water a great variety of standardised procedures exist for sampling and analyzing water and waste water, including:

— a random sample which refers to a single sample taken from a waste water flow

— a composite sample, which refers to a sample taken continuously over a given period, or a sample consisting of several samples taken either continuously or discontinuously over a given period and blended

— a qualified random sample shall refer to a composite sample of at least five random samples taken over a maximum period of two hours at intervals of no less than two minutes, and blended.

Monitoring should be done according to the relevant EN or ISO standards. If EN or ISO standards are not available, national or other international standards should be used that ensure the provision of data of an equivalent scientific quality.

16. BAT is to determine the order of magnitude of diffuse emissions from relevant sources by the methods mentioned below. Whenever possible, direct measurement methods are preferred over indirect methods or evaluations based on calculations with emission factors.

— Direct measurement methods where the emissions are measured at the source itself. In this case, concentrations and mass streams can be measured or determined.

— Indirect measurement methods where the emission determination takes place at a certain distance from the source; a direct measurement of concentrations and mass stream is not possible.

— Calculation with emission factors.

Description

Direct or quasi-direct measurement

Examples for direct measurements are measurements in wind tunnels, with hoods or other methods like quasi-emissions measurements on the roof of an industrial installation. For the latter case, the wind velocity and the area of the roofline vent are measured and a flow rate is calculated. The cross-section of the measurement plane of the roofline vent is subdivided into sectors of identical surface area (grid measurement).

Indirect measurements

Examples of indirect measurements include the use of tracer gases, reverse dispersion modelling (RDM) methods and the mass balance method applying light detection and ranging (LIDAR).

Calculation of emissions with emission factors

Guidelines using emission factors for the estimation of diffuse dust emissions from storage and handling of bulk materials and for the suspension of dust from roadways due to traffic movements are:

— VDI 3790 Part 3

— US EPA AP 42

1.1.8. Decommissioning

17. BAT is to prevent pollution upon decommissioning by using necessary techniques as listed below.

Design considerations for end-of-life plant decommissioning:

I. giving consideration to the environmental impact from the eventual decommissioning of the installation at the stage of designing a new plant, as forethought makes decommissioning easier, cleaner and cheaper

II. decommissioning poses environmental risks for the contamination of land (and groundwater) and generates large quantities of solid waste; preventive techniques are process-specific but general considerations may include:

(i) avoiding underground structures

(ii) incorporating features that facilitate dismantling

(iii) choosing surface finishes that are easily decontaminated

(iv) using an equipment configuration that minimises trapped chemicals and facilitates drain-down or cleaning

(v) designing flexible, self-contained units that enable phased closure

(vi) using biodegradable and recyclable materials where possible.

1.1.9. Noise

18. BAT is to reduce noise emissions from relevant sources in the iron and steel manufacturing processes by using one or more of the following techniques depending on and according to local conditions:

— implementation of a noise-reduction strategy

— enclosure of the noisy operations/units

— vibration insulation of operations/units

— internal and external lining made of impact-absorbent material

— soundproofing buildings to shelter any noisy operations involving material transformation equipment

— building noise protection walls, e.g. the construction of buildings or natural barriers, such as growing trees and bushes between the protected area and the noisy activity

— outlet silencers on exhaust stacks

— lagging ducts and final blowers which are situated in soundproof buildings

— closing doors and windows of covered areas.

1.2. *BAT Conclusions For Sinter Plants*

Unless otherwise stated, the BAT conclusions presented in this section can be applied to all sinter plants.

Air emissions

19. BAT for blending/mixing is to prevent or reduce diffuse dust emissions by agglomerating fine materials by adjusting the moisture content (see also BAT 11).

20. BAT for primary emissions from sinter plants is to reduce dust emissions from the sinter strand waste gas by means of a bag filter.

BAT for primary emissions for existing plants is to reduce dust emissions from the sinter strand waste gas by using advanced electrostatic precipitators when bag filters are not applicable.

The BAT-associated emission level for dust is < 1 – 15 mg/Nm^3 for the bag filter and < 20 – 40 mg/Nm^3 for the advanced electrostatic precipitator (which should be designed and operated to achieve these values), both determined as a daily mean value.

Bag Filter

Description

Bag filters used in sinter plants are usually applied downstream of an existing electrostatic precipitator or cyclone but can also be operated as a standalone device.

Applicability

For existing plants requirements such as space for a downstream installation to the electrostatic precipitator can be relevant. Special regard should be given to the age and the performance of the existing electrostatic precipitator.

Advanced electrostatic precipitator

Description

Advanced electrostatic precipitators are characterised by one or a combination of the following features:

— good process control

— additional electrical fields

— adapted strength of the electric field

— adapted moisture content

— conditioning with additives

— higher or variably pulsed voltages

— rapid reaction voltage

— high energy pulse superimposition

— moving electrodes

— enlarging the electrode plate distance or other features which improves the abatement efficiency.

21. BAT for primary emissions from sinter strands is to prevent or reduce mercury emissions by selecting raw materials with a low mercury content (see BAT 7) or to treat waste gases in combination with activated carbon or activated lignite coke injection.

The BAT-associated emissions level for mercury is < 0,03 – 0,05 mg/Nm^3, as the average over the sampling period (discontinuous measurement, spot samples for at least half an hour).

22. BAT for primary emissions from sinter strands is to reduce sulphur oxide (SO_X) emissions by using one or a combination of the following techniques:

I. lowering the sulphur input by using coke breeze with a low sulphur content

II. lowering the sulphur input by minimisation of coke breeze consumption

III. lowering the sulphur input by using iron ore with a low sulphur content

IV. injection of adequate adsorption agents into the waste gas duct of the sinter strand before dedusting by bag filter (see BAT 20)

V. wet desulphurisation or regenerative activated carbon (RAC) process (with particular consideration for the prerequisites for application).

The BAT-associated emission level for sulphur oxides (SO_X) using BAT I – IV is < 350 – 500 mg/Nm^3, expressed as sulphur dioxide (SO_2) and determined as a daily mean value, the lower value being associated with BAT IV.

The BAT-associated emission level for sulphur oxides (SO_X) using BAT V is < 100 mg/Nm^3, expressed as sulphur dioxide (SO_2) and determined as a daily mean value.

Description of the *RAC process* mentioned under BAT V

Dry desulphurisation techniques are based on an adsorption of SO_2 by activated carbon. When the SO_2-laden activated carbon is regenerated, the process is called regenerated activated carbon (RAC). In this case, a high quality, expensive activated carbon type may be used and sulphuric acid (H_2SO_4) is yielded as a by-product. The bed is regenerated either with water or thermally. In some cases, for 'fine-tuning' downstream of an existing desulphurisation unit, lignite-based activated carbon is used. In this case, the SO_2-laden activated carbon is usually incinerated under controlled conditions.

The RAC system can be developed as a single-stage or a two-stage process.

In the single-stage process, the waste gases are led through a bed of activated carbon and pollutants are adsorbed by the activated carbon. Additionally, NO_X removal occurs when ammonia (NH_3) is injected into the gas stream before the catalyst bed.

In the two-stage process, the waste gases are led through two beds of activated carbon. Ammonia can be injected before the bed to reduce NO_X emissions.

Applicability of techniques mentioned under BAT V

Wet desulphurisation: The requirements of space may be of significance and may restrict the applicability. High investment and operational costs and significant cross-media effects such as slurry generation and disposal and additional waste water treatment measures, have to be taken into account. This technique is not used in Europe at the time of writing, but might be an option where environmental quality standards are unlikely to be met through the application of other techniques.

RAC: Dust abatement should be installed prior to the RAC process to reduce the inlet dust concentration. Generally the layout of the plant and space requirements are important factors when considering this technique, but especially for a site with more than one sinter strand.

High investment and operational costs, in particular when high quality, expensive, activated carbon types may be used and a sulphuric acid plant is needed, have to be taken into account. This technique is not used in Europe at the time of writing, but might be an option in new plants targeting SO_X, NO_X, dust and PCDD/F simultaneously and in circumstances where environmental quality standards are unlikely to be met through the application of other techniques.

23. BAT for primary emissions from sinter strands is to reduce total nitrogen oxides (NO_X) emissions by using one or a combination of the following techniques:

I. process integrated measures which can include:

(i) waste gas recirculation

(ii) other primary measures, such as the use of anthracite or the use of low-NO_X burners for ignition

II. end-of-pipe techniques which can include

(i) the regenerative activated carbon (RAC) process

(ii) selective catalytic reduction (SCR).

The BAT-associated emission level for nitrogen oxides (NO_X) using process integrated measures is < 500 mg/Nm^3, expressed as nitrogen dioxide (NO_2) and determined as a daily mean value.

The BAT-associated emission level for nitrogen oxides (NO_X) using RAC is < 250 mg/Nm^3 and using SCR it is < 120 mg/Nm^3, expressed as nitrogen dioxide (NO_2), related to an oxygen content of 15 % and determined as daily mean values.

Description of *waste gas recirculation* under BAT I.i

In the partial recycling of waste gas, some portions of the sinter waste gas are recirculated to the sintering process. Partial recycling of waste gas from the whole strand was primarily developed to reduce waste gas flow and thus the mass emissions of major pollutants. Additionally it can lead to a decrease in energy consumption. The application of waste gas recirculation requires special efforts to ensure that the sinter quality and productivity are not affected negatively. Special attention needs to be paid to carbon monoxide (CO) in the recirculated waste gas in order to prevent carbon monoxide poisoning of employees. Various processes have been developed such as:

— partial recycling of waste gas from the whole strand

— recycling of waste gas from the end sinter strand combined with heat exchange

— recycling of waste gas from part of the end sinter strand and use of waste gas from the sinter cooler

— recycling of parts of waste gas to other parts of the sinter strand.

Applicability of BAT I.i

The applicability of this technique is site specific. Accompanying measures to ensure that sinter quality (cold mechanical strength) and strand productivity are not negatively affected must be considered. Depending on local conditions, these can be relatively minor and easy to implement or, on the contrary, they can be of a more fundamental nature and may be costly and difficult to introduce. In any case, the operating conditions of the strand should be reviewed when this technique is introduced.

In existing plants, it may not be possible to install a partial recycling of waste gas due to space restrictions.

Important considerations in determining the applicability of this technique include:

— initial configuration of the strand (e.g. dual or single wind-box ducts, space available for new equipment and, when required, lengthening of the strand)

— initial design of the existing equipment (e.g. fans, gas cleaning and sinter screening and cooling devices)

— initial operating conditions (e.g. raw materials, layer height, suction pressure, percentage of quick lime in the mix, specific flow rate, percentage of in-plant reverts returned in the feed)

— existing performance in terms of productivity and solid fuel consumption

— basicity index of the sinter and composition of the burden at the blast furnace (e.g. percentage of sinter versus pellet in the burden, iron content of these components).

Applicability of *other primary measures* under BAT I.ii

The use of anthracite depends on the availability of anthracites with a lower nitrogen content compared to coke breeze.

Description and applicability of the *RAC process* under BAT II.i see BAT 22.

Applicability of the *SCR* process under BAT II.ii

SCR can be applied within a high dust system, a low dust system and as a clean gas system. Until now, only clean gas systems (after dedusting and desulphurisation) have been applied at sinter plants. It is essential that the gas is low in dust (< 40 mg dust/Nm^3) and heavy metals, because they can make the surface of the catalyst ineffective. Additionally, desulphurisation prior to the catalyst might be required. Another prerequisite is a minimum off-gas temperature of about 300 °C. This requires an energy input.

The high investment and operational costs, the need for catalyst revitalisation, NH_3 consumption and slip, the accumulation of explosive ammonium nitrate (NH_4NO_3), the formation of corrosive SO_3 and the additional energy required for reheating which can reduce the possibilities for recovery of sensible heat from the sinter process, all may constrain the applicability. This technique might be an option where environmental quality standards are unlikely to be met through the application of other techniques.

24. BAT for primary emissions from sinter strands is to prevent and/or reduce emissions of polychlorinated dibenzodioxins/furans (PCDD/F) and polychlorinated biphenyls (PCB) by using one or a combination of the following techniques:

I. avoidance of raw materials which contain polychlorinated dibenzodioxins/furans (PCDD/F) and polychlorinated biphenyls (PCB) or their precursors as much as possible (see BAT 7)

II. suppression of polychlorinated dibenzodioxins/furans (PCDD/F) formation by addition of nitrogen compounds

III. waste gas recirculation (see BAT 23 for description and applicability).

25. BAT for primary emissions from sinter strands is to reduce emissions of polychlorinated dibenzodioxins/furans (PCDD/F) and polychlorinated biphenyls (PCB) by the injection of adequate adsorption agents into the waste gas duct of the sinter strand before dedusting with a bag filter or advanced electrostatic precipitators when bag filters are not applicable (see BAT 20).

The BAT- associated emission level for polychlorinated dibenzodioxins/furans (PCDD/F) is < 0,05 – 0,2 ng I-TEQ/Nm^3 for the bag filter and < 0,2 – 0,4 ng-I-TEQ/Nm^3 for the advanced electrostatic precipitator, both determined for a 6 – 8 hour random sample under steady-state conditions.

26. BAT for secondary emissions from sinter strand discharge, sinter crushing, cooling, screening and conveyor transfer points is to prevent dust emissions and/or to achieve an efficient extraction and subsequently to reduce dust emissions by using a combination of the following techniques:

I. hooding and/or enclosure

II. an electrostatic precipitator or a bag filter.

The BAT-associated emission level for dust is < 10 mg/Nm^3 for the bag filter and < 30 mg/Nm^3 for the electrostatic precipitator, both determined as a daily mean value.

Water and waste water

27. BAT is to minimise water consumption in sinter plants by recycling cooling water as much as possible unless once-through cooling systems are used.

28. BAT is to treat the effluent water from sinter plants where rinsing water is used or where a wet waste gas treatment system is applied, with the exception of cooling water prior to discharge by using a combination of the following techniques:

I. heavy metal precipitation

II. neutralisation

III. sand filtration.

The BAT-associated emission levels, based on a qualified random sample or a 24-hour composite sample, are:

— suspended solids	< 30 mg/l
— chemical oxygen demand (COD [1])	< 100 mg/l
— heavy metals	< 0,1 mg/l

(sum of arsenic (As), cadmium (Cd), chromium (Cr), copper (Cu), mercury (Hg), nickel (Ni), lead (Pb), and zinc (Zn)).

Production residues

29. BAT is to prevent waste generation within sinter plants by using one or a combination of the following techniques (see BAT 8):

I. selective on-site recycling of residues back to the sinter process by excluding heavy metals, alkali or chloride-enriched fine dust fractions (e.g. the dust from the last electrostatic precipitator field)

II. external recycling whenever on-site recycling is hampered.

BAT is to manage in a controlled manner sinter plant process residues which can neither be avoided nor recycled.

30. BAT is to recycle residues that may contain oil, such as dust, sludge and mill scale which contain iron and carbon from the sinter strand and other processes in the integrated steelworks, as much as possible back to the sinter strand, taking into account the respective oil content.

[1] In some cases, TOC is measured instead of COD (in order to avoid $HgCl_2$ used in the analysis for COD). The correlation between COD and TOC should be elaborated for each sinter plant case by case. The COD/TOC ratio may vary approximately between two and four.

31. BAT is to lower the hydrocarbon content of the sinter feed by appropriate selection and pretreatment of the recycled process residues.

In all cases, the oil content of the recycled process residues should be < 0,5 % and the content of the sinter feed < 0,1 %.

Description

The input of hydrocarbons can be minimised, especially by the reduction of the oil input. Oil enters the sinter feed mainly by addition of mill scale. The oil content of mill scales can vary significantly, depending on their origin.

Techniques to minimise oil input via dusts and mill scale include the following:

— limiting input of oil by segregating and then selecting only those dusts and mill scale with a low oil content

— the use of 'good housekeeping' techniques in the rolling mills can result in a substantial reduction in the contaminant oil content of mill scale

— de-oiling of mill scale by:

  — heating the mill scale to approximately 800 °C, the oil hydrocarbons are volatilised and clean mill scale is yielded; the volatilised hydrocarbons can be combusted.

  — extracting oil from the mill scale using a solvent.

Energy

32. BAT is to reduce thermal energy consumption within sinter plants by using one or a combination of the following techniques:

I. recovering sensible heat from the sinter cooler waste gas

II. recovering sensible heat, if feasible, from the sintering grate waste gas

III. maximising the recirculation of waste gases to use sensible heat (see BAT 23 for description and applicability).

Description

Two kinds of potentially reusable waste energies are discharged from the sinter plants:

— the sensible heat from the waste gases from the sintering machines

— the sensible heat of the cooling air from the sinter cooler.

Partial waste gas recirculation is a special case of heat recovery from waste gases from sintering machines and is dealt with in BAT 23. The sensible heat is transferred directly back to the sinter bed by the hot recirculated gases. At the time of writing (2010), this is the only practical method of recovering heat from the waste gases.

The sensible heat in the hot air from the sinter cooler can be recovered by one or more of the following ways:

— steam generation in a waste heat boiler for use in the iron and steel works

— hot water generation for district heating

— preheating combustion air in the ignition hood of the sinter plant

— preheating the sinter raw mix

— use of the sinter cooler gases in a waste gas recirculation system.

Applicability

At some plants, the existing configuration may make costs of heat recovery from the sinter waste gases or sinter cooler waste gas very high.

The recovery of heat from the waste gases by means of a heat exchanger would lead to unacceptable condensation and corrosion problems.

1.3. *BAT Conclusions For Pelletisation Plants*

Unless otherwise stated, the BAT conclusions presented in this section can be applied to all pelletisation plants.

Air emissions

33. BAT is to reduce the dust emissions in the waste gases from

— the raw materials pre-treatment, drying, grinding, wetting, mixing and the balling;

— from the induration strand; and

— from the pellet handling and screening

by using one or a combination of the following techniques:

I. an electrostatic precipitator

II. a bag filter

III. a wet scrubber

The BAT-associated emission level for dust is < 20 mg/Nm^3 for the crushing, grinding and drying and $< 10 - 15$ mg/Nm^3 for all other process steps or in cases where all waste gases are treated together, all determined as daily mean values.

34. BAT is to reduce the sulphur oxides (SO_X), hydrogen chloride (HCl) and hydrogen fluoride (HF) emissions from the induration strand waste gas by using one of the following techniques:

I. a wet scrubber

II. semi-dry absorption with a subsequent dedusting system

The BAT-associated emission levels, determined as daily mean values, for these compounds are:

— sulphur oxides (SO_X), expressed as sulphur dioxide (SO_2)	$< 30 - 50$ mg/Nm^3
— hydrogen fluoride (HF)	$< 1 - 3$ mg/Nm^3
— hydrogen chloride (HCl)	$< 1 - 3$ mg/Nm^3.

35. BAT is to reduce NO_X emissions from the drying and grinding section and induration strand waste gases by applying process-integrated techniques.

Description

Plant design through tailor-made solutions should be optimised for low nitrogen oxides (NO_X) emissions from all firing sections. The reduction of the formation of thermal NO_X can be achieved by lowering the (peak) temperature in the burners and reducing the excess oxygen in the combustion air. Additionally, lower NO_X emissions can be achieved by a combination of low energy use and low nitrogen content in the fuel (coal and oil).

36. BAT for existing plants is to reduce NO_X emissions from the drying and grinding section and induration strand waste gases by applying one of the following techniques:

I. selective catalytic reduction (SCR) as an end-of-pipe technique

II. any other technique with a NO_X reduction efficiency of at least 80 %.

Applicability

For existing plants, both straight grate and grate kiln systems, it is difficult to obtain the operating conditions necessary to suit an SCR reactor. Due to high costs, these end-of-pipe techniques should only be considered in circumstances where environmental quality standards are otherwise not likely to be met.

37. BAT for new plants is to reduce NO_X emissions from the drying and grinding section and induration strand waste gases by applying selective catalytic reduction (SCR) as an end-of-pipe technique.

Water and waste water

38. BAT for pelletisation plants is to minimise the water consumption and discharge of scrubbing, wet rinsing and cooling water and reuse it as much as possible.

39. BAT for pelletisation plants is to treat the effluent water prior to discharge by using a combination of the following techniques:

I. neutralisation

II. flocculation

III. sedimentation

IV. sand filtration

V. heavy metal precipitation.

The BAT-associated emission levels, based on a qualified random sample or a 24-hour composite sample, are:

— suspended solids	< 50 mg/l
— chemical oxygen demand (COD [1])	< 160 mg/l
— Kjeldahl nitrogen	< 45 mg/l
— heavy metals	< 0,55 mg/l

(sum of arsenic (As), cadmium (Cd), chromium (Cr), copper (Cu), mercury (Hg), nickel (Ni), lead (Pb), zinc (Zn)).

Production residues

40. BAT is to prevent waste generation from pelletisation plants by effective on-site recycling or the reuse of residues (i.e. undersized green and heat-treated pellets)

BAT is to manage in a controlled manner pellet plant process residues, i.e. sludge from waste water treatment, which can neither be avoided nor recycled.

Energy

41. BAT is to reduce/minimise thermal energy consumption in pelletisation plants by using one or a combination of the following techniques:

I. process integrated reuse of sensible heat as far as possible from the different sections of the induration strand

II. using surplus waste heat for internal or external heating networks if there is demand from a third party.

(1) In some cases, TOC is measured instead of COD (in order to avoid $HgCl_2$ used in the analysis for COD). The correlation between COD and TOC should be elaborated for each pelletisation plant case by case. The COD/TOC ratio may vary approximately between two and four.

Description

Hot air from the primary cooling section can be used as secondary combustion air in the firing section. In turn, the heat from the firing section can be used in the drying section of the induration strand. Heat from the secondary cooling section can also be used in the drying section.

Excess heat from the cooling section can be used in the drying chambers of the drying and grinding unit. The hot air is transported through an insulated pipeline called a 'hot air recirculation duct'.

Applicability

Recovery of sensible heat is a process integrated part of pelletisation plants. The 'hot air recirculation duct' can be applied at existing plants with a comparable design and a sufficient supply of sensible heat.

The cooperation and agreement of a third party may not be within the control of the operator, and therefore may not be within the scope of the permit.

1.4. *BAT Conclusions For Coke Oven Plants*

Unless otherwise stated, the BAT conclusions presented in this section can be applied to all coke oven plants.

Air emissions

42. BAT for coal grinding plants (coal preparation including crushing, grinding, pulverising and screening) is to prevent or reduce dust emissions by using one or a combination of the following techniques:

I. building and/or device enclosure (crusher, pulveriser, sieves) and

II. efficient extraction and use of a subsequent dry dedusting systems.

The BAT-associated emission level for dust is < 10 – 20 mg/Nm^3, as the average over the sampling period (discontinuous measurement, spot samples for at least half an hour).

43. BAT for storage and handling of pulverised coal is to prevent or reduce diffuse dust emissions by using one or a combination of the following techniques:

I. storing pulverised materials in bunkers and warehouses

II. using closed or enclosed conveyors

III. minimising the drop heights depending on the plant size and construction

IV. reducing emissions from charging of the coal tower and the charging car

V. using efficient extraction and subsequent dedusting.

When using BAT V, the BAT-associated emission level for dust is < 10 – 20 mg/Nm^3, as the average over the sampling period (discontinuous measurement, spot samples for at least half an hour).

44. BAT is to charge coke oven chambers with emission-reduced charging systems.

Description

From an integrated point of view, 'smokeless' charging or sequential charging with double ascension pipes or jumper pipes are the preferred types, because all gases and dust are treated as part of the coke oven gas treatment.

If, however, the gases are extracted and treated outside the coke oven, charging with a land-based treatment of the extracted gases is the preferred method. Treatment should consist of an efficient extraction of the emissions with subsequent combustion to reduce organic compounds and the use of a bag filter to reduce particulates.

The BAT-associated emission level for dust from coal charging systems with land-based treatment of extracted gases is < 5 g/t coke equivalent to < 50 mg/Nm^3, as the average over the sampling period (discontinuous measurement, spot samples for at least half an hour).

The duration associated with BAT of visible emissions from charging is < 30 seconds per charge as a monthly average using a monitoring method described in BAT 46.

45. BAT for coking is to extract the coke oven gas (COG) during coking as much as possible.

46. BAT for coke plants is to reduce the emissions through achieving continuous undisrupted coke production by using the following techniques:

I. extensive maintenance of oven chambers, oven doors and frame seals, ascension pipes, charging holes and other equipment (a systematic programme should be carried out by specially-trained detection and maintenance personnel)

II. avoiding strong temperature fluctuations

III. comprehensive observation and monitoring of the coke oven

IV. cleaning of doors, frame seals, charging holes, lids and ascension pipes after handling (applicable at new and, in some cases, existing plants)

V. maintaining a free gas-flow in the coke ovens

VI. adequate pressure regulation during coking and application of spring-loaded flexible sealing doors or knife-edged doors (in cases of ovens ≤ 5 m high and in good working order)

VII. using water-sealed ascension pipes to reduce visible emissions from the whole apparatus which provides a passage from the coke oven battery to the collecting main, gooseneck and stationary jumper pipes

VIII. luting charging hole lids with a clay suspension (or other suitable sealing material), to reduce visible emissions from all holes

IX. ensuring complete coking (avoiding green coke pushes) by application of adequate techniques

X. installing larger coke oven chambers (applicable to new plants or in some cases of a complete replacement of the plant on the old foundations)

XI. where possible, using variable pressure regulation to oven chambers during coking (applicable to new plants and can be an option for existing plants; the possibility of installing this technique in existing plants should be assessed carefully and is subject to the individual situation of every plant).

The percentage of visible emissions from all doors associated with BAT is < 5 – 10 %.

The percentage of visible emissions for all source types associated with BAT VII and BAT VIII is < 1 %.

The percentages are related to the frequency of any leaks compared to the total number of doors, ascension pipes or charging hole lids as a monthly average using a monitoring method as described below.

For the estimation of diffuse emissions from coke ovens the following methods are in use:

— the EPA 303 method

— the DMT (Deutsche Montan Technologie GmbH) methodology

— the methodology developed by BCRA (British Carbonisation Research Association).

— the methodology applied in the Netherlands, based on counting visible leaks of the ascension pipes and charging holes, while excluding visible emissions due to normal operations (coal charging, coke pushing).

47. BAT for the gas treatment plant is to minimise fugitive gaseous emissions by using the following techniques:

I. minimising the number of flanges by welding piping connections wherever possible

II. using appropriate sealings for flanges and valves

III. using gas-tight pumps (e.g. magnetic pumps)

IV. avoiding emissions from pressure valves in storage tanks by:

— connecting the valve outlet to the coke oven gas (COG) collecting main or

— collecting the gases and subsequent combustion.

Applicability

The techniques can be applied to both new and existing plants. In new plants, a gas tight design might be easier to achieve than in existing plants.

48. BAT is to reduce the sulphur content of the coke oven gas (COG) by using one of the following techniques:

I. desulphurisation by absorption systems

II. wet oxidative desulphurisation.

The residual hydrogen sulphide (H_2S) concentrations associated with BAT, determined as daily mean averages, are < 300 – 1 000 mg/Nm^3 in the case of using BAT I (the higher values being associated with higher ambient temperature and the lower values being associated with lower ambient temperature) and < 10 mg/Nm^3 in the case of using BAT II.

49. BAT for the coke oven underfiring is to reduce the emissions by using the following techniques:

I. preventing leakage between the oven chamber and the heating chamber by means of regular coke oven operation

II. repairing leakage between the oven chamber and the heating chamber (only applicable to existing plants)

III. incorporating low-nitrogen oxides (NO_X) techniques in the construction of new batteries, such as staged combustion and the use of thinner bricks and refractory with a better thermal conductivity (only applicable to new plants)

IV. using desulphurised coke oven gas (COG) process gases.

The BAT-associated emission levels, determined as daily mean values and relating to an oxygen content of 5 % are:

— sulphur oxides (SO_X), expressed as sulphur dioxide (SO_2) < 200 – 500 mg/Nm^3

— dust < 1 – 20 mg/Nm^3 [1]

— nitrogen oxides (NO_X), expressed as nitrogen dioxide (NO_2) < 350 – 500 mg/Nm^3 for new or substantially revamped plants (less than 10 years old) and 500 – 650 mg/Nm^3 for older plants with well maintained batteries and incorporated low- nitrogen oxides (NO_X) techniques.

50. BAT for coke pushing is to reduce dust emissions by using the following techniques:

I. extraction by means of an integrated coke transfer machine equipped with a hood

II. using land-based extraction gas treatment with a bag filter or other abatement systems

III. using a one point or a mobile quenching car.

The BAT-associated emission level for dust from coke pushing is < 10 mg/Nm^3 in the case of bag filters and of < 20 mg/Nm^3 in other cases, determined as the average over the sampling period (discontinuous measurement, spot samples for at least half an hour).

Applicability

At existing plants, lack of space may constrain the applicability.

[1] The lower end of the range has been defined based on the performance of one specific plant achieved under real operating conditions by the BAT obtaining the best environmental performance.

51. BAT for coke quenching is to reduce dust emissions by using one of the following techniques:

I. using coke dry quenching (CDQ) with the recovery of sensible heat and the removal of dust from charging, handling and screening operations by means of a bag filter

II. using emission-minimised conventional wet quenching

III. using coke stabilisation quenching (CSQ).

The BAT-associated emission levels for dust, determined as the average over the sampling period, are:

— < 20 mg/Nm^3 in case of coke dry quenching

— < 25 g/t coke in case of emission minimised conventional wet quenching (1)

— < 10 g/t coke in case of coke stabilisation quenching (2).

Description of BAT I

For the continuous operation of coke dry quenching plants, there are two options. In one case, the coke dry quenching unit comprises two to up to four chambers. One unit is always on stand by. Hence no wet quenching is necessary but the coke dry quenching unit needs an excess capacity against the coke oven plant with high costs. In the other case, an additional wet quenching system is necessary.

In case of modifying a wet quenching plant to a dry quenching plant, the existing wet quenching system can be retained for this purpose. Such a coke dry quenching unit has no excess processing capacity against the coke oven plant.

Applicability of BAT II

Existing quenching towers can be equipped with emissions reduction baffles. A minimum tower height of at least 30 m is necessary in order to ensure sufficient draught conditions.

Applicability of BAT III

As the system is larger than that necessary for conventional quenching, lack of space at the plant may be a constraint.

52. BAT for coke grading and handling is to prevent or reduce dust emissions by using the following techniques in combination:

I. use of building or device enclosures

II. efficient extraction and subsequent dry dedusting.

The BAT-associated emission level for dust is < 10 mg/Nm^3, determined as the average over the sampling period (discontinuous measurement, spot samples for at least half an hour).

Water and waste water

53. BAT is to minimise and reuse quenching water as much as possible.

54. BAT is to avoid the reuse of process water with a significant organic load (like raw coke oven waste water, waste water with a high content of hydrocarbons, etc.) as quenching water.

55. BAT is to pretreat waste water from the coking process and coke oven gas (COG) cleaning prior to discharge to a waste water treatment plant by using one or a combination of the following techniques:

I. using efficient tar and polycyclic aromatic hydrocarbons (PAH) removal by using flocculation and subsequent flotation, sedimentation and filtration individually or in combination

II. using efficient ammonia stripping by using alkaline and steam.

(1) This level is based on the use of the non-isokinetic Mohrhauer method (former VDI 2303)
(2) This level is based on the use of an isokinetic sampling method according to VDI 2066

56. BAT for pretreated waste water from the coking process and coke oven gas (COG) cleaning is to use biological waste water treatment with integrated denitrification/nitrification stages.

The BAT-associated emission levels, based on a qualified random sample or a 24-hour composite sample and referring only to single coke oven water treatment plants, are:

— chemical oxygen demand (COD [1])	< 220 mg/l
— biological oxygen demand for 5 days (BOD_5)	< 20 mg/l
— sulphides, easily released [2]	< 0,1 mg/l
— thiocyanate (SCN^-)	< 4 mg/l
— cyanide (CN^-), easily released [3]	< 0,1 mg/l
— polycyclic aromatic hydrocarbons (PAH) (sum of Fluoranthene, Benzo[b]fluoranthene, Benzo[k]fluoranthene, Benzo[a]pyrene, Indeno[1,2,3-cd]pyrene and Benzo[g,h,i]perylene)	< 0,05 mg/l
— phenols	< 0,5 mg/l
— sum of ammonia-nitrogen (NH_4^+-N), nitrate-nitrogen (NO_3^--N) and nitrite-nitrogen (NO_2^--N)	< 15 – 50 mg/l.

Regarding the sum of ammonia-nitrogen (NH_4^+-N), nitrate-nitrogen (NO_3^--N) and nitrite-nitrogen (NO_2^--N), values of < 35 mg/l are usually associated with the application of advanced biological waste water treatment plants with predenitrification/nitrification and post-denitrification.

Production residues

57. BAT is to recycle production residues such as tar from the coal water and still effluent, and surplus activated sludge from the waste water treatment plant back to the coal feed of the coke oven plant.

Energy

58. BAT is to use the extracted coke oven gas (COG) as a fuel or reducing agent or for the production of chemicals.

1.5. *BAT Conclusions For Blast Furnaces*

Unless otherwise stated, the BAT conclusions presented in this section can be applied to all blast furnaces.

Air emissions

59. BAT for displaced air during loading from the storage bunkers of the coal injection unit is to capture dust emissions and perform subsequent dry dedusting.

The BAT-associated emission level for dust is < 20 mg/Nm^3, determined as the average over the sampling period (discontinuous measurement, spot samples for at least half an hour).

60. BAT for burden preparation (mixing, blending) and conveying is to minimise dust emissions and, where relevant, extraction with subsequent dedusting by means of an electrostatic precipitator or bag filter.

(1) In some cases, TOC is measured instead of COD (in order to avoid $HgCl_2$ used in the analysis for COD). The correlation between COD and TOC should be elaborated for each coke oven plant case by case. The COD/TOC ratio may vary approximately between two and four.
(2) This level is based on the use of the DIN 38405 D 27 or any other national or international standard that ensures the provision of data of an equivalent scientific quality.
(3) This level is based on the use of the DIN 38405 D 13-2 or any other national or international standard that ensures the provision of data of an equivalent scientific quality.

61. BAT for casting house (tap holes, runners, torpedo ladles charging points, skimmers) is to prevent or reduce diffuse dust emissions by using the following techniques:

I. covering the runners

II. optimising the capture efficiency for diffuse dust emissions and fumes with subsequent off-gas cleaning by means of an electrostatic precipitator or bag filter

III. fume suppression using nitrogen while tapping, where applicable and where no collecting and dedusting system for tapping emissions is installed.

When using BAT II, the BAT-associated emission level for dust is < 1 – 15 mg/Nm^3, determined as a daily mean value.

62. BAT is to use tar-free runner linings.

63. BAT is to minimise the release of blast furnace gas during charging by using one or a combination of the following techniques:

I. bell-less top with primary and secondary equalising

II. gas or ventilation recovery system

III. use of blast furnace gas to pressurise the top bunkers.

Applicability of BAT II

Applicable for new plants. Applicable for existing plants only where the furnace has a bell-less charging system. It is not applicable to plants where gases other than blast furnace gas (e.g. nitrogen) are used to pressurise the furnace top bunkers.

64. BAT is to reduce dust emissions from the blast furnace gas by using one or a combination of the following techniques:

I. using dry prededusting devices such as:

(i) deflectors

(ii) dust catchers

(iii) cyclones

(iv) electrostatic precipitators.

II. subsequent dust abatement such as:

(i) hurdle-type scrubbers

(ii) venturi scrubbers

(iii) annular gap scrubbers

(iv) wet electrostatic precipitators

(v) disintegrators.

For cleaned blast furnace (BF) gas, the residual dust concentration associated with BAT is < 10 mg/Nm^3, determined as the average over the sampling period (discontinuous measurement, spot samples for at least half an hour).

65. BAT for hot blast stoves is to reduce emissions by using desulphurised and dedusted surplus coke oven gas, dedusted blast furnace gas, dedusted basic oxygen furnace gas and natural gas, individually or in combination.

The BAT-associated emission levels, determined as daily mean values related to an oxygen content of 3 %, are:

— sulphur oxides (SO_x) expressed as sulphur dioxide (SO_2) < 200 mg/Nm^3

— dust < 10 mg/Nm^3

— nitrogen oxides (NO_x), expressed as nitrogen dioxide (NO_2) < 100 mg/Nm^3.

Water and waste water

66. BAT for water consumption and discharge from blast furnace gas treatment is to minimise and to reuse scrubbing water as much as possible, e.g. for slag granulation, if necessary after treatment with a gravel-bed filter.

67. BAT for treating waste water from blast furnace gas treatment is to use flocculation (coagulation) and sedimentation and the reduction of easily released cyanide, if necessary.

The BAT-associated emission levels, based on a qualified random sample or a 24-hour composite sample, are:

— suspended solids	< 30 mg/l
— iron	< 5 mg/l
— lead	< 0,5 mg/l
— zinc	< 2 mg/l
— cyanide (CN^-), easily released [1]	< 0,4 mg/l.

Production residues

68. BAT is to prevent waste generation from blast furnaces by using one or a combination of the following techniques:

I. appropriate collection and storage to facilitate a specific treatment

II. on-site recycling of coarse dust from the blast furnace (BF) gas treatment and dust from the cast house dedusting, with due regard for the effect of emissions from the plant where it is recycled

III. hydrocyclonage of sludge with subsequent on-site recycling of the coarse fraction (applicable whenever wet dedusting is applied and where the zinc content distribution in the different grain sizes allows a reasonable separation)

IV. slag treatment, preferably by means of granulation (where market conditions allow for it), for the external use of slag (e.g. in the cement industry or for road construction).

BAT is to manage in a controlled manner blast furnace process residues which can neither be avoided nor recycled.

69. BAT for minimising slag treatment emissions is to condense fume if odour reduction is required.

Resource management

70. BAT for resource management of blast furnaces is to reduce coke consumption by directly injected reducing agents, such as pulverised coal, oil, heavy oil, tar, oil residues, coke oven gas (COG), natural gas and wastes such as metallic residues, used oils and emulsions, oily residues, fats and waste plastics individually or in combination.

Applicability

Coal injection: The method is applicable to all blast furnaces equipped with pulverised coal injection and oxygen enrichment.

Gas injection: Tuyère injection of coke oven gas (COG) is highly dependent upon the availability of the gas that may be effectively used elsewhere in the integrated steelworks.

(1) This level is based on the use of the DIN 38405 D 13-2 or any other national or international standard that ensures the provision of data of an equivalent scientific quality.

Plastic injection: It should be noted that this technique is highly dependent on the local circumstances and market conditions. Plastics can contain Cl and heavy metals like Hg, Cd, Pb and Zn. Depending on the composition of the wastes used (e.g. shredder light fraction), the amount of Hg, Cr, Cu, Ni and Mo in the BF gas may increase.

Direct injection of used oils, fats and emulsions as reducing agents and of solid iron residues: The continuous operation of this system is reliant on the logistical concept of delivery and the storage of residues. Also, the conveying technology applied is of particular importance for a successful operation.

Energy

71. BAT is to maintain a smooth, continuous operation of the blast furnace at a steady state to minimise releases and to reduce the likelihood of burden slips.

72. BAT is to use the extracted blast furnace gas as a fuel.

73. BAT is to recover the energy of top blast furnace gas pressure where sufficient top gas pressure and low alkali concentrations are present.

Applicability

Top gas pressure recovery can be applied at new plants and in some circumstances at existing plants, albeit with more difficulties and additional costs. Fundamental to the application of this technique is an adequate top gas pressure in excess of 1.5 bar gauge.

At new plants, the top gas turbine and the blast furnace (BF) gas cleaning facility can be adapted to each other in order to achieve a high efficiency of both scrubbing and energy recovery.

74. BAT is to preheat the hot blast stove fuel gases or combustion air using the waste gas of the hot blast stove and to optimise the hot blast stove combustion process.

Description

For optimisation of the energy efficiency of the hot stove, one or a combination of the following techniques can be applied:

— the use of a computer-aided hot stove operation

— preheating of the fuel or combustion air in conjunction with insulation of the cold blast line and waste gas flue

— use of more suitable burners to improve combustion

— rapid oxygen measurement and subsequent adaptation of combustion conditions.

Applicability

The applicability of fuel preheating depends on the efficiency of the stoves as this determines the waste gas temperature (e.g. at waste gas temperatures below 250 °C, heat recovery may not be a technically or economically viable option).

The implementation of computer-aided control could require the construction of a fourth stove in the case of blast furnaces with three stoves (if possible) in order to maximise benefits.

1.6. *BAT Conclusions For Basic Oxygen Steelmaking And Casting*

Unless otherwise stated, the BAT conclusions presented in this section can be applied to all basic oxygen steelmaking and casting.

Air emissions

75. BAT for basic oxygen furnace (BOF) gas recovery by suppressed combustion is to extract the BOF gas during blowing as much as possible and to clean it by using the following techniques in combination:

I. use of a suppressed combustion process

II. prededusting to remove coarse dust by means of dry separation techniques (e.g. deflector, cyclone) or wet separators

III. dust abatement by means of:

(i) dry dedusting (e.g. electrostatic precipitator) for new and existing plants

(ii) wet dedusting (e.g. wet electrostatic precipitator or scrubber) for existing plants.

The residual dust concentrations associated with BAT, after buffering the BOF gas, are:

— 10 – 30 mg/Nm^3 for BAT III.i

— < 50 mg/Nm^3 for BAT III.ii.

76. BAT for basic oxygen furnace (BOF) gas recovery during oxygen blowing in the case of full combustion is to reduce dust emissions by using one of the following techniques:

I. dry dedusting (e.g. ESP or bag filter) for new and existing plants

II. wet dedusting (e.g. wet ESP or scrubber) for existing plants.

The BAT-associated emission levels for dust, determined as the average over the sampling period (discontinuous measurement, spot samples for at least half an hour), are:

— 10 – 30 mg/Nm^3 for BAT I

— < 50 mg/Nm^3 for BAT II.

77. BAT is to minimise dust emissions from the oxygen lance hole by using one or a combination of the following techniques:

I. covering the lance hole during oxygen blowing

II. inert gas or steam injection into the lance hole to dissipate the dust

III. use of other alternative sealing designs combined with lance cleaning devices.

78. BAT for secondary dedusting, including the emissions from the following processes:

— reladling of hot metal from the torpedo ladle (or hot metal mixer) to the charging ladle

— hot metal pretreatment (i.e. the preheating of vessels, desulphurisation, dephosphorisation, deslagging, hot metal transfer processes and weighing)

— BOF-related processes like the preheating of vessels, slopping during oxygen blowing, hot metal and scrap charging, tapping of liquid steel and slag from BOF and

— secondary metallurgy and continuous casting,

is to minimise dust emissions by means of process integrated techniques, such as general techniques to prevent or control diffuse or fugitive emissions, and by using appropriate enclosures and hoods with efficient extraction and a subsequent off-gas cleaning by means of a bag filter or an ESP.

The overall average dust collection efficiency associated with BAT is > 90 %

The BAT-associated emission level for dust, as a daily mean value, for all dedusted off-gases is < 1 – 15 mg/Nm^3 in the case of bag filters and < 20 mg/Nm^3 in the case of electrostatic precipitators.

If the emissions from hot metal pretreatment and the secondary metallurgy are treated separately, the BAT-associated emission level for dust, as a daily mean value, is < 1 – 10 mg/Nm^3 for bag filters and < 20 mg/Nm^3 for electrostatic precipitators.

Description

General techniques to prevent diffuse and fugitive emissions from the relevant BOF process secondary sources include:

— independent capture and use of dedusting devices for each subprocess in the BOF shop

— correct management of the desulphurisation installation to prevent air emissions

— total enclosure of the desulphurisation installation

— maintaining the lid on when the hot metal ladle is not in use and the cleaning of hot metal ladles and removal of skulls on a regular basis or alternatively apply a roof extraction system

— maintaining the hot metal ladle in front of the converter for approximately two minutes after putting the hot metal into the converter if a roof extraction system is not applied

— computer control and optimisation of the steelmaking process, e.g. so that slopping (i.e. when the slag foams to such an extent that it flows out of the vessel) is prevented or reduced

— reduction of slopping during tapping by limiting elements that cause slopping and the use of anti-slopping agents

— closure of doors from the room around the converter during oxygen blowing

— continuous camera observation of the roof for visible emission

— the use of a roof extraction system.

Applicability

In existing plants, the design of the plant may restrict the possibilities for proper evacuation.

79. BAT for on-site slag processing is to reduce dust emissions by using one or a combination of the following techniques:

I. efficient extraction of the slag crusher and screening devices with subsequent off-gas cleaning, if relevant

II. transport of untreated slag by shovel loaders

III. extraction or wetting of conveyor transfer points for broken material

IV. wetting of slag storage heaps

V. use of water fogs when broken slag is loaded.

The BAT-associated emission level for dust in the case of using BAT I is < 10 – 20 mg/Nm^3, determined as the average over the sampling period (discontinuous measurement, spot samples for at least half an hour).

Water and waste water

80. BAT is to prevent or reduce water use and waste water emissions from primary dedusting of basic oxygen furnace (BOF) gas by using one of the following techniques as set out in BAT 75 and BAT 76:

— dry dedusting of basic oxygen furnace (BOF) gas;

— minimising scrubbing water and reusing it as much as possible(e.g. for slag granulation) in case wet dedusting is applied.

81. BAT is to minimise the waste water discharge from continuous casting by using the following techniques in combination:

I. the removal of solids by flocculation, sedimentation and/or filtration

II. the removal of oil in skimming tanks or any other effective device

III. the recirculation of cooling water and water from vacuum generation as much as possible.

The BAT-associated emission levels, based on a qualified random sample or a 24-hour composite sample, for waste water from continuous casting machines are:

— suspended solids < 20 mg/l

— iron < 5 mg/l

— zinc < 2 mg/l

— nickel < 0,5 mg/l

— total chromium < 0,5 mg/l

— total hydrocarbons < 5 mg/l.

Production residues

82. BAT is to prevent waste generation by using one or a combination of the following techniques (see BAT 8):

I. appropriate collection and storage to facilitate a specific treatment

II. on-site recycling of dust from basic oxygen furnace (BOF) gas treatment, dust from secondary dedusting and mill scale from continuous casting back to the steelmaking processes with due regard for the effect of emissions from the plant where they are recycled

III. on-site recycling of BOF slag and BOF slag fines in various applications

IV. slag treatment where market conditions allow for the external use of slag (e.g. as an aggregate in materials or for construction)

V. use of filter dusts and sludge for external recovery of iron and non-ferrous metals such as zinc in the non-ferrous metals industry

VI. use of a settling tank for sludge with the subsequent recycling of the coarse fraction in the sinter/blast furnace or cement industry when grain size distribution allows for a reasonable separation.

Applicability of BAT V

Dust hot briquetting and recycling with recovery of high zinc concentrated pellets for external reuse is applicable when a dry electrostatic precipitation is used to clean the BOF gas. Recovery of zinc by briquetting is not applicable in wet dedusting systems because of unstable sedimentation in the settling tanks caused by the formation of hydrogen (from a reaction of metallic zinc and water). Due to these safety reasons, the zinc content in the sludge should be limited to 8 – 10 %.

BAT is to manage in a controlled manner basic oxygen furnace process residues which can neither be avoided nor recycled.

Energy

83. BAT is to collect, clean and buffer BOF gas for subsequent use as a fuel.

Applicability

In some cases, it may not be economically feasible or, with regard to appropriate energy management, not feasible to recover the BOF gas by suppressed combustion. In these cases, the BOF gas may be combusted with the generation of steam. The kind of combustion (full or suppressed combustion) depends on local energy management.

84. BAT is to reduce energy consumption by using ladle-lid systems.

Applicability

The lids can be very heavy as they are made out of refractory bricks and therefore the capacity of the cranes and the design of the whole building may constrain the applicability in existing plants. There are different technical designs for implementing the system into the particular conditions of a steel plant.

85. BAT is to optimise the process and reduce energy consumption by using a direct tapping process after blowing.

Description

Direct tapping normally requires expensive facilities like sub-lance or DROP IN sensor-systems to tap without waiting for a chemical analysis of the samples taken (direct tapping). Alternatively, a new technique has been developed to achieve direct tapping without such facilities. This technique requires a lot of experience and developmental work. In practice, the carbon is directly blown down to 0,04 % and simultaneously the bath temperature decreases to a reasonably low target. Before tapping, both the temperature and oxygen activity are measured for further actions.

Applicability

A suitable hot metal analyser and slag stopping facilities are required and the availability of a ladle furnace facilitates implementation of the technique.

86. BAT is to reduce energy consumption by using continuous near net shape strip casting, if the quality and the product mix of the produced steel grades justify it.

Description

Near net shape strip casting means the continuous casting of steel to strips with thicknesses of less than 15 mm. The casting process is combined with the direct hot rolling, cooling and coiling of the strips without an intermediate reheating furnace used for conventional casting techniques, e.g. continuous casting of slabs or thin slabs. Therefore, strip casting represents a technique for producing flat steel strips of different widths and thicknesses of less than 2 mm.

Applicability

The applicability depends on the produced steel grades (e.g. heavy plates cannot be produced with this process) and on the product portfolio (product mix) of the individual steel plant. In existing plants, the applicability may be constrained by the layout and the available space as e.g. retrofitting with a strip caster requires approximately 100 m in length.

1.7. *BAT Conclusions For Electric Arc Furnace Steelmaking And Casting*

Unless otherwise stated, the BAT conclusions presented in this section can be applied to all electric arc furnace steelmaking and casting.

Air emissions

87. BAT for the electric arc furnace (EAF) process is to prevent mercury emissions by avoiding, as much as possible, raw materials and auxiliaries which contain mercury (see BAT 6 and 7).

88. BAT for the electric arc furnace (EAF) primary and secondary dedusting (including scrap preheating, charging, melting, tapping, ladle furnace and secondary metallurgy) is to achieve an efficient extraction of all emission sources by using one of the techniques listed below and to use subsequent dedusting by means of a bag filter:

I. a combination of direct off-gas extraction (4th or 2nd hole) and hood systems

II. direct gas extraction and doghouse systems

III. direct gas extraction and total building evacuation (low-capacity electric arc furnaces (EAF) may not require direct gas extraction to achieve the same extraction efficiency).

The overall average collection efficiency associated with BAT is > 98 %.

The BAT-associated emission level for dust is < 5 mg/Nm^3, determined as a daily mean value.

The BAT-associated emission level for mercury is < 0,05 mg/Nm^3, determined as the average over the sampling period (discontinuous measurement, spot samples for at least four hours).

89. BAT for the electric arc furnace (EAF) primary and secondary dedusting (including scrap preheating, charging, melting, tapping, ladle furnace and secondary metallurgy) is to prevent and reduce polychlorinated dibenzodioxins/furans (PCDD/F) and polychlorinated biphenyls (PCB) emissions by avoiding, as much as possible, raw materials which contain PCDD/F and PCB or their precursors (see BAT 6 and 7) and using one or a combination of the following techniques, in conjunction with an appropriate dust removal system:

I. appropriate post-combustion

II. appropriate rapid quenching

III. injection of adequate adsorption agents into the duct before dedusting.

The BAT-associated emission level for polychlorinated dibenzodioxins/furans (PCDD/F) is < 0,1 ng I-TEQ/Nm^3, based on a 6 – 8 hour random sample during steady-state conditions. In some cases, the BAT-associated emission level can be achieved with primary measures only.

Applicability of BAT I

In existing plants, circumstances like available space, given off-gas duct system, etc. need to be taken into consideration for assessing the applicability.

90. BAT for on-site slag processing is to reduce dust emissions by using one or a combination of the following techniques:

I. efficient extraction of the slag crusher and screening devices with subsequent off-gas cleaning, if relevant

II. transport of untreated slag by shovel loaders

III. extraction or wetting of conveyor transfer points for broken material

IV. wetting of slag storage heaps

V. use of water fogs when broken slag is loaded.

In the case of using BAT I, the BAT-associated emission level for dust is < 10 – 20 mg/Nm^3, determined as the average over the sampling period (discontinuous measurement, spot samples for at least half an hour).

Water and waste water

91. BAT is to minimise the water consumption from the electric arc furnace (EAF) process by the use of closed loop water cooling systems for the cooling of furnace devices as much as possible unless once-through cooling systems are used.

92. BAT is to minimise the waste water discharge from continuous casting by using the following techniques in combination:

I. the removal of solids by flocculation, sedimentation and/or filtration

II. the removal of oil in skimming tanks or in any other effective device

III. the recirculation of cooling water and water from vacuum generation as much as possible.

The BAT-associated emission levels, for waste water from continuous casting machines, based on a qualified random sample or a 24-hour composite sample, are:

— suspended solids	< 20 mg/l
— iron	< 5 mg/l
— zinc	< 2 mg/l
— nickel	< 0,5 mg/l
— total chromium	< 0,5 mg/l
— total hydrocarbons	< 5 mg/l

Production residues

93. BAT is to prevent waste generation by using one or a combination of the following techniques:

I. appropriate collection and storage to facilitate a specific treatment

II. recovery and on-site recycling of refractory materials from the different processes and use internally, i.e. for the substitution of dolomite, magnesite and lime

III. use of filter dusts for the external recovery of non-ferrous metals such as zinc in the non-ferrous metals industry, if necessary, after the enrichment of filter dusts by recirculation to the electric arc furnace (EAF)

IV. separation of scale from continuous casting in the water treatment process and recovery with subsequent recycling, e.g. in the sinter/blast furnace or cement industry

V. external use of refractory materials and slag from the electric arc furnace (EAF) process as a secondary raw material where market conditions allow for it.

BAT is to manage in a controlled manner EAF process residues which can neither be avoided nor recycled.

Applicability

The external use or recycling of production residues as mentioned under BAT III – V depend on the cooperation and agreement of a third party which may not be within the control of the operator, and therefore may not be within the scope of the permit.

Energy

94. BAT is to reduce energy consumption by using continuous near net shape strip casting, if the quality and the product mix of the produced steel grades justify it.

Description

Near net shape strip casting means the continuous casting of steel to strips with thicknesses of less than 15 mm. The casting process is combined with the direct hot rolling, cooling and coiling of the strips without an intermediate reheating furnace used for conventional casting techniques, e.g. continuous casting of slabs or thin slabs. Therefore, strip casting represents a technique for producing flat steel strips of different widths and thicknesses of less than 2 mm.

Applicability

The applicability depends on the produced steel grades (e.g. heavy plates cannot be produced with this process) and on the product portfolio (product mix) of the individual steel plant. In existing plants, the applicability may be constrained by the layout and the available space as e.g. retrofitting with a strip caster requires approximately 100 m in length.

Noise

95. BAT is to reduce noise emissions from electric arc furnace (EAF) installations and processes generating high sound energies by using a combination of the following constructional and operational techniques depending on and according to local conditions (in addition to using the techniques listed in BAT 18):

I. construct the electric arc furnace (EAF) building in such a way as to absorb noise from mechanical shocks resulting from the operation of the furnace

II. construct and install cranes destined to transport the charging baskets to prevent mechanical shocks

III. special use of acoustical insulation of the inside walls and roofs to prevent the airborne noise of the electric arc furnace (EAF) building

IV. separation of the furnace and the outside wall to reduce the structure-borne noise from the electric arc furnace (EAF) building

V. housing of processes generating high sound energies (i.e. electric arc furnace (EAF) and decarburisation units) within the main building.

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