7.13 Man-made fibres production

7.13.1 Coverage

The sector production of man-made mineral fibres includes installations for the manufacture of continuous filament glass fibre, of mineral wool and of high temperature insulation glass wools with a melting capacity exceeding 20 tonnes per day. Mineral wool refers to glass wool and stone wool insulating materials, i.e., randomly interlaced masses of fibre that are bound by a resin based binder.[1][2]

7.13.2 Emission sources

Several production steps and environmental issues of the sector "production of man-made fibres" are the same as for the sector "glass production", so the following represents additional information to the basic production technologies, BAT etc. of the "glass production" sector.

Continuous Filament Glass Fibre is produced using recuperative or oxy-fuel fired furnaces. The glass flows from the furnace to the forehearths where is passes through bushings on the base. The glass is drawn through the brushing tips to form continuous filaments. The filaments are drawn together and pass over a roller or belt, which applies an aqueous coating to each filament. The coated filaments are gathered together into bundles (strands) for further processing.

Glass wool furnaces are usually electric melters, gas fired recuperative furnaces, or oxy-fuel furnaces. Glass flows along a forehearth and through single orifice bushings into rotary centrifugal spinners. Fiberising is by centrifugal action with attenuation by hot flame gases. An aqueous phenolic resin solution is sprayed onto the fibres. The resin-coated fibre is drawn under suction onto a moving conveyor and then passes through an oven to dry and cure the product.

Stone wool is usually produced with a coke fired hot blast cupola. The molten material gathers in the bottom of the furnace and flows out along the spinning machine. Air is used to attenuate the fibres and to direct them onto the collection belts, An aqueous phenolic resin solution is prayed onto the fibres by a series of spray nozzles. The remainder of the process is essentially as for glass wool.

Ceramic fibre is produced using electric furnaces. The melt is fiberised either by high-speed wheels or high pressure air jet, and the fibres are drawn onto a collection belt. The product can either be baled at this point or processed into blanket to be baled as product or needle felted.

Mineral wool
In the mineral wool sector, mainly recuperative and electrical furnaces are used, beside also oxy-gas-fired furnaces for glass wool production.
As in the glass industry, the main environmental issues are emissions to air (fossil fuelled furnaces and high-temperature oxidation of atmospheric nitrogen lead to emissions of SO_2, NO_X, CO_2 and Dust) and energy consumption.
In addition to the emissions found in the glass manufacturing sector, two further important emission sources exist: the forming area (application of binder to the fibres) and the curing oven (drying and curing of binder). In the forming area, dust, phenol, formaldehyde and ammonia are emitted, in the curing oven volatile binder components, breakdown products and combustion products are emitted.
For the production of high temperature insulation glass wools, only electrically heated furnaces are used. Thus only dust emissions are relevant and to a minor extent some organic compounds. [2] [3]

7.13.3 BAT, Associated Emission Levels (AEL)

7.13.3.1 SO2

In **stone wool production**, important sources of SO_2 emissions (in addition to coke) are the use of blast furnace slag and cement bond briquettes in the batch. The availability of low sulphur coke and slag are restricted by the limited supply within economical transport distances. Slag can normally be eliminated from most batches (except for examples white fibre for specific applications). Using cement bond waste briquettes involves a balance between waste minimisation and SO_2 emission reduction. [2]

For **continuous filament glass fibres**, BAT is considered to be the use of secondary abatement for dust with dry or semi-dry acid gas scrubbing where appropriate. The upper parts of the range correspond to dust recycling (otherwise lower values are expected). [2]

For **glass wool** production, SO_2 emissions are often low without any specific abatement equipment, as almost all furnaces are electrically or gas heated and very low levels of sulphate are used. If oil-fired furnaces are used, acid gas scrubbing will usually be necessary to protect dust abatement equipment. [2]

For **stone wool** production, the given BAT values correspond to a situation, where priority is given to the recycling of process wastes. Where these values are not reached, acid gas scrubbing may represent BAT (dry scrubbing likely to be most cost effective). [2]

Table 1: SO_2 emission levels associated with BAT for furnaces in fibres production [2]

Emission source	**BAT associated emission levels[1] mg/Nm³ (kg/tonne)**		**Comments**
	gas-firing	oil-firing	
Continuous filament glass fibre	< 200; (0.9)	500 – 1000 (2.25-4.5)	If sulphates in batch, gas-firing could be up to 800 (3.6). For oil-firing, upper end of range relates to dust recycling.
Glass wool	generally < 50 (0.1)	300 – 1000 (0.6-2.0)	Generally low sulphate glass.
Stone wool (coke fired) with waste minimisation and recycling as priority.	< 600 (1.5) < 1100 (2.7) < 1400 (3.4)		(a) Stone charge (b) 45 % cement bound briquettes (c) Cement briquettes inc. filter dust
Stone wool (coke fired) with SO_2 reduction as priority.	< 200 (0.5) < 350 (0.8) < 400 (1.0)		(a) Stone charge (b) 45 % cement bound briquettes (c) Cement briquettes inc. filter dust
Ceramic fibre (electric melting)	< 0.5 kg/tonne melt		Electric furnaces only, concentration will be case specific.

[1] The BAT associated emission levels are based on a daily average, standard conditions and represents a typical load situation. For peak load, start up and shut down periods, as well as for operational problems of the flue gas cleaning systems, short-term peak values, which could be higher, have to be regarded.^

For combustion gases: dry, 8 % oxygen by volume (continuous melters), 13 % oxygen by volume (discontinuous melters). For oxy-fuel fired systems the expression of the emissions corrected to 8 % oxygen is of little value, and emissions from these systems should be discussed in terms of mass.

7.13.3.2 NOx

For **continuous filament glass fibres**, BAT is considered likely to be oxy-fuel melting, however this is no firm conclusion. SCR is considered unlikely to be applicable in the near future due to fears of borate condensation in the catalyst. When using oxycombustion, special care has to be taken with regard to energy efficiency so as not to reduce the NO_X emission abatement potential.

For **glass wool production**, BAT for NO_X is considered to be oxy-firing or predominantly electrical melting, conventional firing combined with primary or secondary measures may also be judged BAT if emissions within the ranges are achieved.

Stone wool cupolas do not generally give rise to substantial NO_X emissions, however where tank furnaces are used, the NO_X BAT levels correspond to the one of glass wool production. [2]

Table 2: NO_X emission levels associated with BAT for furnaces in fibres production [2]

Emission source	BAT associated emission levels[1] mg/Nm³ or (kg/tonne)	Comments
Continuous filament glass fibre, oxycombustion	(0.5-1.5)	
Continuous filament glass fibre, other than oxycombustion	500-700	Sector in a transition period concerning NO_X control, emissions generally higher than 1000 mg/Nm³ (4.5 kg/tonne), with conventional combustion 800 mg/Nm³ (3.6 kg/tonne) possible
Glass wool	500-700 (0.5-1.4)	
Stone wool	(0.5)	For tank furnaces: see level for glass wool
Ceramic fibre	(<0.1-0.5)	

[1] The BAT associated emission levels are based on a daily average, standard conditions and represents a typical load situation. For peak load, start up and shut down periods, as well as for operational problems of the flue gas cleaning systems, short-term peak values, which could be higher, have to be regarded.

For combustion gases: dry, 8 % oxygen by volume (continuous melters), 13 % oxygen by volume (discontinuous melters). For oxy-fuel fired systems the expression of the emissions corrected to 8 % oxygen is of little value, and emissions from these systems should be discussed in terms of mass.

7.13.3.3 Dust

Many statements from the section on glass manufacturing can be transferred to the production of man-made fibres, for example that oxy-fuel burners can reduce waste gas volume and flue dust production by 60%. End-of-pipe prevention and control techniques to reduce dust emission commonly include the installation of electrostatic precipitators (ESP) reducing the emissions to 30 mg/m3 and fabric (baghouse) filters reducing the emissions below 10 mg/m^3. [1]

For **continuous filament glass fibres**, BAT for dust is the use of an electrostatic precipitator or bag filter operating, where appropriate, in conjunction with a dry or semi-dry acid gas scrubbing system. For this sector, cooling the waste gas and the positioning of the abatement system are very important for optimising efficiency. If existing equipment can achieve emission levels of 50 mg/Nm³, costs of replacement prior to the next rebuild could be disproportionate to the advantages gained. [2]

For **mineral wool (glass and stone wool)** production, the use of an electrostatic precipitator or bag filter is considered BAT, while acid gas scrubbing systems are not considered necessary due to prevalence of electric or gas heating). For downstream processes, the use of either a wet electrostatic scrubber, a packed bed scrubber, or a stone wool filter (stone wool processes only) is considered BAT.

In the **glass wool production**, the cooling of the waste gas and the positioning of the abatement system are very important for optimising the efficiency. If existing equipment can achieve emission levels of 50 mg/Nm^3, costs of replacement prior to the next rebuild could be disproportionate to the advantages gained.

For **ceramic fibre** production, electric melting with a bag filter system is considered BAT. [1]

Table 3: Dust emission levels associated with BAT for furnaces in fibres production [2]

<table>
<tr><th>Emission source</th><th>BAT associated emission levels[1]
mg/Nm^3 or (kg/tonne)</th><th>Comments</th></tr>
<tr><td>Continuous filament glass fibre</td><td>5-30; (<0.14)</td><td>Electrostatic precipitator or bag filter (plus dry or semi-dry acid gas scrubber where appropriate)
If existing equipment achieves 50 mg/Nm^3, costs of major modifications prior to rebuild may be disproportionate</td></tr>
<tr><td>Glass wool</td><td rowspan="2">5-30 (<0.1)</td><td rowspan="2">Electrostatic precipitator or bag filter.
If existing equipment achieves 50 mg/Nm^3, costs of major modifications prior to rebuild may be disproportionate</td></tr>
<tr><td>Stone wool</td></tr>
<tr><td>Downstream operations of mineral wool plants</td><td>20-50
5-30</td><td>combined forming and curing
curing ovens for stone wool</td></tr>
<tr><td>Ceramic fibres</td><td><10</td><td></td></tr>
<tr><td colspan="3">[1] The BAT associated emission levels are based on a daily average, standard conditions and represents a typical load situation. For peak load, start up and shut down periods, as well as for operational problems of the flue gas cleaning systems, short-term peak values, which could be higher, have to be regarded.

For combustion gases: dry, 8 % oxygen by volume (continuous melters), 13 % oxygen by volume (discontinuous melters). For oxy-fuel fired systems the expression of the emissions corrected to 8 % oxygen is of little value, and emissions from these systems should be discussed in terms of mass.</td></tr>
</table>

7.13.3.4 VOC

In the production of man-made mineral fibres, VOC emissions can be reduced by switching to low organic solvent containing binding agents and/or by VOC adsorption and incineration.

For **stone wool** processes, BAT is considered the use of a thermal incineration unit to reduce curing oven emissions.

Table 4 shows emission levels achievable by switching from conventional to reformulated binding agents and by destructing the emissions generated in the forming and the curing steps (catalytic incineration or adsorption preceded by precipitation of dust). [1]

Table 4: VOC emission levels associated with BAT for fibres production [2]

Emission Source	BAT associated emission levels[1] mg/Nm^3 or (kg/tonne)	Comments
Glass wool	10-50 [1] (0.12) [4]	forming area and combined forming and curing emissions
Stone wool	< 10	curing ovens: Thermal incineration unit considered BAT
Ceramic fibre	10-20	

[1] The BAT associated emission levels are based on a daily average, standard conditions and represents a typical load situation. For peak load, start up and shut down periods, as well as for operational problems of the flue gas cleaning systems, short-term peak values, which could be higher, have to be regarded.

7.13.3.5 Cross Media Effects

For all mentioned emission reduction and abatement techniques, the cross-media transfer of pollutants and the full range of environmental effects and improvements should be considered. For example additional energy consumption and increased quantities of waste or wastewater residuals may result from individual efforts for pollutant prevention, reduction, or removal.

7.13.4 Emerging techniques

An emerging technology is the Plasma Melter, which makes use of the electrical conductivity of molten glass and operates with negligible dust emissions. It is however not expected to be a viable technique for melting within the foreseeable future.

7.13.5 Cost data for emission reduction technologies

For general cost data for abatement techniques see section 7-12 (glass production).

Table 5: Cost data for abatement techniques (only fibres production) [1]

Abatement Technique	Typical Flow Rate Nm³/h	NO_X mg/Nm³ or (kg/tonne)	Dust mg/Nm³ or (kg/tonne)	VOC mg/Nm³ or (kg/tonne)	Investment for new process M€	Investment for existing process M€	Operating Cost M€/a
Impact scrubber + cyclone	150000-300000	-	50 (1.8)	30 (1.8)	1.3±30 %	1.6±40 %	0.1±0.02
Impact scrubber + cyclone +WEP	150000-300000	-	20 (1.2)	30 (1.8)	3.8±30 %	4.6±40 %	0.12±0.02
Impact scrubber + cyclone +PBS	150000-300000	-	50 (1.8)	25 (1.8)	3.5±30 %	4.2±40 %	0.21±0.02
Stone wool slab filter	150000-250000	-	20 (0.7)	25 (1.0)	1.3±30 %	1.5±30 %	0.2±0.1
Incinerator	150000-300000	200(3) (0.6)	20 (0.1)	10 (0.04)	1.3±40 %	1.6±30 %	0.2±0.1
Stack	150000-300000				0.7±40 %	0.8±40 %	-

7.13.6 References used in chapter 7.13

1 UNECE 2006. Draft background document: Assessment of technological developments: Best Available Techniques (BAT) and limit values. Submitted to the Task Force on Heavy Metals of UNECE CLTRAP

2 European Commission. 2001: “Integrated Pollution Prevention and Control (IPPC) Reference Document on Best Available Techniques in the Glass Manufacturing Industry.” http://eippcb.jrc.es/pages/FActivities.htm

3 UNECE. 2003. Background document on the sector of glass industry. Geneva (available on the EGTEI website: http://www.citepa.org/forums/egtei/egtei_index.htm)

4 Old version of the guidance document

General References:

US Environmental Protection Agency (US EPA). 1995. “AP-42 Section 11.15, Glass Manufacturing.” Washington, DC.

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Technical background documents for the actualisation and assessment of UN/ECE protocols related to the abatement of the transboundary Transport of nitrogen oxides from stationary sources, DFIU, 1999.