

Annex 1: Comments to Synopsis sheets

1. Glass industry

Specific Dutch situation

The existing reference-installations in the synopsis-sheet are applicable to only a very limited number of Dutch glass-plants (and probably other EU glass plants). In fact there are so many different glass-products (7 sub-sectors), furnace-dimensions (from 1 to >500 tonnes), emission-patterns, cost-curves, abatement-technologies, lifetime of furnaces (5-15 years), energy-consumption etc. that, by designing one or a few reference-installations, no justice is done to the diversity of the sector. An impression of this diversity can be obtained from the IPPC-reference-document on Best Available Techniques in the Glass Manufacturing Industry (2000):

<http://eippcb.jrc.es>.

Considering the fact that the Dutch glass-industry is, though very diverse, also a small sector in the Netherlands, the development of a broader range of reference-installations can only be made at a European level. Nevertheless, it is possible to define a single Dutch reference-installation that incorporates average values of emissions, furnace-dimensions, lifetime, efficiency of technologies etc of the most occurring situations in the Netherlands.

Such a reference installation would be a soda-lime-silica glass furnace with 285 tons molten glass per day fired with natural gas and preheated air using regenerators; Lifetime 10 years, instead of 8 (table 4.1 of synopsis sheet).

This reference installation can represent about 70% of the Dutch Glass-industry. The other 30% of the Dutch glass industry is very diverse, using different glass-compositions, types and sizes of furnaces, and having higher emissions, higher abatement-costs, less possible abatement-technologies etc.

Below, specific investment, fixed and variable operating costs of the 285 [t/d] reference installation are summarised. Though, the costs are given as Greenfield-situation, although hardly ever a real Greenfield-plant is built in the sector at these days. Real costs will probably be much higher.

Table 1, (Table 4.1 of synopsis sheet): Reference Installation for the Dutch glass industry

Reference Code	Technique	Fuel	Capacity [t/d]	Lifetime [a]	Plant factor [h/a]
...	Average capacity installation	Natural gas	285	10	8,760

Table 2, (Table 4.2.1.1 of synopsis sheet): Abatement Measures for dust (Dutch case, 285 tons glass melt /day)

Secondary Measure Code	Description	Lifetime (a)	Emission factor TSP (mg/Nm ³)	Emission factor TSP (g/t of glass melted)	Emission factor PM10 (mg/Nm ³)	Emission factor PM2.5 (mg/Nm ³)
00	None	-	225	450	225	225
01	Deduster	10	10	20	10	10

Table 3, (Table 4.2.1.2 of synopsis sheet): Investments and Operating costs for dust (Dutch case, 285 tons glass melt /day)

Description	Investment (k€)	Fixed Operating costs (%/a)	Variable Operating costs (€/t)	Total Operating costs (€/t)	Cost per tonne TSP abated (€/t)	Cost per tonne of glass melted (€/t)
None	-	-	-	-	-	-
Deduster and scrubber	1700 ²	12	1.85			

- Including scrubber (filter 1100 -1300 k€ & filter 400-500 k€, including additional costs for dust & SO₂ monitoring)
- The costs are higher for existing installations often requiring extra provisions due to limited space. (For existing installations, capital costs may be 30 % higher)

Table 4, (Table 4.2.2.1 of synopsis sheet): NO_x abatement measures for Dutch reference installation

Description	Efficiency (%)	Emission factor (mg/Nm ³)	Emission factor (kg/t of glass)
None	-	2500	5
Primary technologies	55	1100	2.2
Primary + DENO _x	80	500	1
Oxy-Gas firing	80		1

Table 5, (Table 4.2.2.2 of synopsis sheet): Investments and operating costs for NO_x abatement measures

Description	Investment (k€)	Fixed Operating costs (%/a)	Variable Operating costs (€/t)	Total Operating costs (€/t)	Cost per tonne of NO _x abated (€/t)	Cost per tonne of glass melted (€/t)
None	-	-	-	-	-	-
Primary technologies	250	12	0.20			
Secondary technologies ¹	1100 ²	12	1.25	2		
Oxy-gas firing ³	-	-	6 – 8	6 – 8		

Table 6, (Table 4.2.3.1 of synopsis sheet) SO₂ abatement measures for Dutch reference installation

Measure Code	Abatement technique	Efficiency (%)	Emission factor (mg/Nm ³)	Emission factor (kg/t)
Reference Installation ...				
00	-	-	600	1.2
01	Dry scrubber 30-35%	33	400	0.8

In the following paragraphs, general comments to the synopsis sheet, also applicable for the other European countries are given.

¹ The costs of secondary DeNO_x measures can be even significantly higher in case the existing filter system is not compatible with the required temperature level for the DeNO_x (in case of SCR) installation. Extra heating of flue gas after baghouse filter to achieve the required DeNO_x temperatures will also cause extra CO₂ emissions and may raise energy-consumption considerably. Other techniques for DeNO_x may also lead to extra energy consumption and CO₂ emissions.

² The costs are higher for existing installations, often requiring extra provisions due to limited space. For existing installations, capital costs may be 30% higher.

³ The costs of oxy-firing are notoriously difficult to predict. Investment costs cannot be given as an accurate number. The extra costs for oxygen firing may be as high as 15-20 Euros/ton molten glass in some situations (depends on type of original furnace, glass, oxygen consumption and oxygen price level (very volatile!)).

Reference Installations

Add reference installation 03, natural gas, 285 [t/d] or adapt RI 01 to new given values (see Table 1 in this Annex).

Redefine name 'plant factor' (table 4.1) into (number of) operational hours per year.

Dust abatement techniques

Adapt values of table 4.2.1.1 of synopsis sheet to values given in Table 2 of this Annex.

The cost of a 'deduster' varies between 1000 and 1250 k€. Table 4.2.1.2 mentions 900 k€ investment, but it is not said for which year this cost applies, nor on which way this cost is updated to the other reference years.

Table 3 in this Annex gives the costs of a combined Dust and SO₂ abatement technique.

NO_x abatement techniques

It is not clear if the abatement measures described apply for installation using NG or HFO as fuel. These techniques will probably have different (unabated) emission factors depending on the considered fuel. According to table 4.2.2.1 of synopsis sheet, are they independent of the used fuel.

If the abatement measures described apply for HFO, an extra measure should be included incorporating fuel change (from HFO to NG).

Under "primary technologies" (table 4.2.2.1 of synopsis sheet) are understood: the use of special burners, control of oxygen excess, modification in burner port and combustion chamber design, and control of flame characteristics. For these measurements, an efficiency of 55% (50% to 60%) is more accurate than the 65% mentioned in the synopsis sheet.

Instead of Primary + Secondary measures (table 4.2.2.1 of synopsis sheet), introduce two measures: Primary+DeNO_x and Oxy-gas firing. See Table 4 in this Annex. Respective costs of these techniques are given in Table 5 of this Annex.

SO₂ abatement techniques

According to the BAT document on glass manufacturing (IPPC 2001), SO₂ abatement techniques with a dry scrubber achieve efficiencies <50% (table 4.22). The Dutch industry experiences efficiencies a mean value of 33% for this technique, values varying between 30% and 50%. The value of table 4.2.3.1 of synopsis sheet should be adapted, because it gives the impression that a high efficiency can be achieved at the given costs. Conclusion: Adapt values of measure code 01 according to Table 6 in this Annex.

Table 3 in this Annex gives the costs of a combined Dust and SO₂ abatement technique.

Abatement measures for reference installation 02 should include fuel change, from HFO to NG. The costs of this measure are not equal to zero. The actual version of the synopsis sheet does not allow calculating the emission reduction and/or related costs of this measure.

Country specific data

It is not mentioned for which year the country specific costs must be given. It is also not clear on which way these costs will be deduced for the 'standard' year 2000, if the known costs are known for other year than 2000.

It is not clear in which way the correction factor is used, which parameters are changed by this factor. Is $ProdCap = Fc \times MeltCap$ or the other way around?

Specific unabated emission data may vary $\pm 10\%$ with respect to the default mean data provided in the synopsis sheet. The Dutch data varies much larger than the allowed 10%, mainly due to the big variety in glass-composition and types of furnaces and manufacturing-processes. Conclusion: different default data should be incorporated. See next table for Dutch unabated emission factors.

Table 7, (Table 5.5 of synopsis sheet): Unabated emission factors [kg/ t glass melted]

Pollutants	Default data mean	Dutch reference
EF NO _x	8.12	5
EF PM _{TSP}	0.725	0.45 (up to 2 for special glass)
EF PM ₁₀	0.725	0.45 (up to 2 for special glass)
EF PM _{2.5}	0.725	0.45 (up to 2 for special glass)
Reference installation the Netherlands		
EF SO ₂	1.74	1.2

Table A.2 of synopsis sheet (Annex, page 11) requests the energy value of the natural gas consumption in the whole glass sector [PJ]. It is not clear if this natural gas use concerns only the furnaces or the total natural gas usage, also for the other processes. This should be clarified.

2. Cement industry

Reference Installations

A capacity of 1100 [t/d] is rather low for a reference installation. A more representative value would be 2800 [t/d]. The Dutch industry does not have the costs of emission abatement techniques for a reference installation of this magnitude.

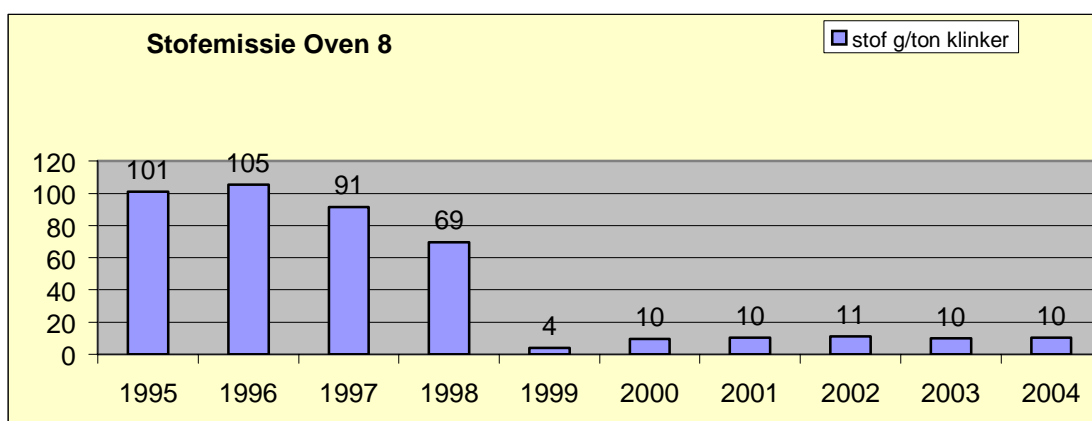
Redefine name 'plant factor' (table 4.1) into (number of) operational hours per year.

Dust abatement techniques

The given lifetime of a deduster (measure code 01 of Dust abatement techniques) is rather low. A lifetime of 20 to 25 years is more realistic.

The emission factor of 46 [g/t clinker] is very high (table 4.2.1.1). Dutch dust emissions of the cement industry show an emission factor of approximately 10 [g/t clinker] when an electronic filter is used, see figure.

Figure 1. Dust emissions of cement industry, for one of the ovens using electrostatic precipitators (ESP) in the Netherlands.

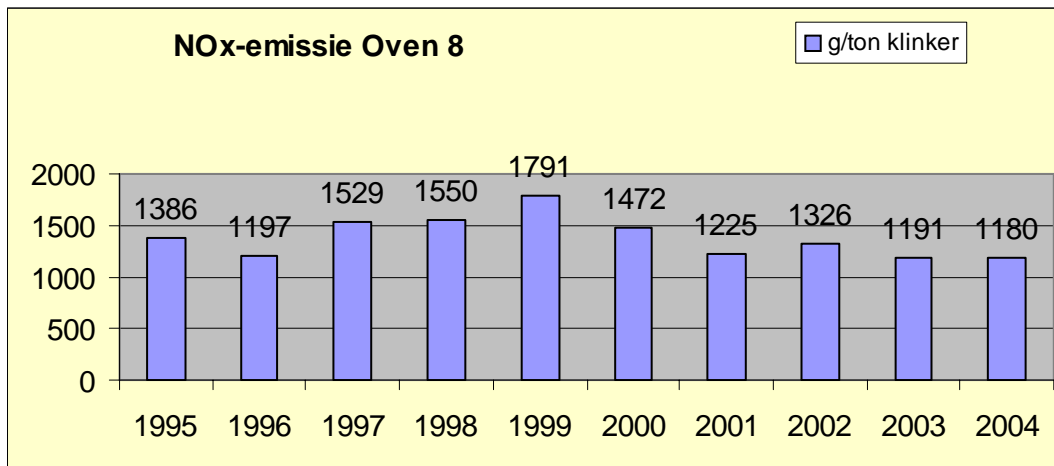


The variable operating costs are given as a fixed amount of 0.346 [€/t]. It is not clear if this is the case of France only or these costs are applicable for the reference installation of 1100 [t/d]. If this is not a fixed amount, then the equation behind should be added to the document.

NO_x abatement techniques

The value of the emission factor for NO_x using primary and secondary technologies (code 02 of table 4.2.2.1) 920 [g/t] is rather low. A value of 1200 [g/t] would be more realistic. Please see values of figure 2.

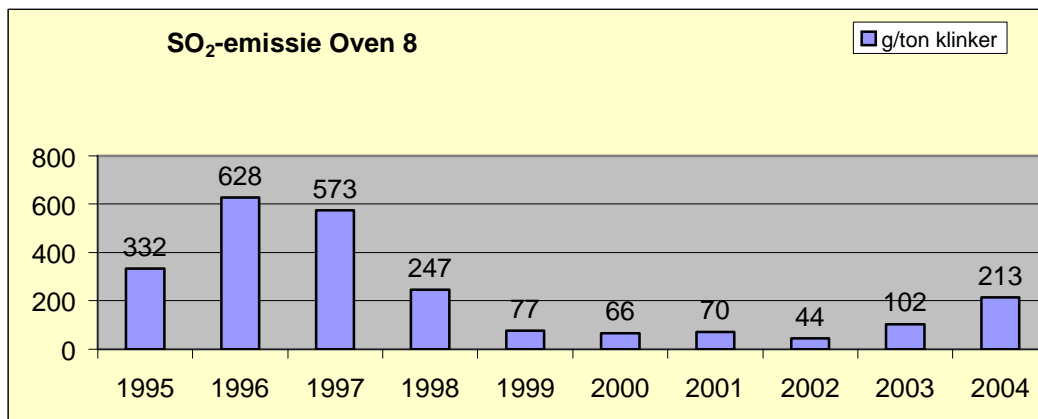
Figure 2. NO_x emissions of cement industry, for one of the cement ovens used in the Netherlands.



SO₂ abatement techniques

The Dutch cement industry has data about the emissions per ton clinker. See Figure 3. Since 1999 specific abatement techniques are used within this oven. The value of year 2004, 213 [g/t], is explained by the experts as a natural deviation due to the quality of the raw material used. It is not clear if that's a fact or that it indicates deterioration of the used technique. EGTEI document mentions <400 [g/t]. A value of 100 [g/t] as abated emission factor seems more realistic.

Figure 3. SO₂ emissions of cement industry, for one of the cement ovens used in the Netherlands.



Country specific data

It is not mentioned for which year the country specific costs must be given. It is also not clear on which way these costs will be deduced for the 'standard' year 2000, if the known costs are known for other year than 2000.

It is not clear in which way the correction factor is used, which parameters are changed by this factor, nor why a correction factor is needed. The emission factors are given for a determined cement production (or for a cement production capacity, it doesn't matter). If the cement production is given, the related emissions are calculated without using a correction factor in between. In the synopsis sheet it is assumed that an installation will run at 80% of its capacity (or other value if given by the experts). What is the reason of asking the production capacity plus a correction factor instead of the real cement production?

Table 5.3 asks for level of activity of 3 different types of reference installations, while only one type is defined in table 4.1.

3. Petroleum industry: Combustion processes

General remarks

There are different kinds of "Heavy Fuel Oils". As long as this 'fuel' is not defined, all emission factors and costs of emission abatement are not valid. The differences between 'fuel oils' encountered are: the percentage S, N and ash present, and the different fuel viscosities.

The document speaks also of "gas". Especially in refineries, not natural gas but '(washed) refinery gas' is used. Depending of the type of refinery gas used, different quantities of S, H₂, methane, ethane, propane and butane concentrations are encountered.

The presence of the named components into the fuel used will determine the emissions of SO₂, NO_x and PM from refineries. This is also valid for VOC emissions. It seems that the differentiation of the fuels into "HFO" and "Gas" only does not give a correct representation of the expected emissions from the combustion process. In the Netherlands, emissions from refineries are regulated through the 'Directive for Emission requirements from Heating Installations - Environment Administration' (Besluit Emissie-eisen Stookinstallaties – BEES), where emission ceilings are regulated depending on the fuel considered and process temperature used.

According to the Dutch experts, there is also a large difference between boilers (steam producers) and fired heaters (producing other than steam) with respect to emission factors.

For the reasons mentioned above, the emission factors mentioned in the synopsis sheet have not been assessed.

Reference Installations

Both reference installations defined consider a thermal power capacity of 50 [MW_{th}]. Within refineries present in the Netherlands, large combustion plants, above 100 [MW_{th}] and even 200 [MW_{th}] are present. It is not clear on which way costs related to 50 [MW_{th}] combustion units will be up scaled to combustion units of 100 [MW_{th}] or more.

Dust abatement techniques

Table 4.2.1.1 mentions for reference installation 1 an upper level TSP emission factor of 1000 [mg/Nm³] as a mean value. This value is, according to Dutch experts, unrealistic high. De realistic upper limit depends on the fuel considered and type steam atomisation process considered. Shell Global Solutions mentions a value of even less than 200 [mg/Nm³] as a mean value for HFO in combination with steam atomising at large boilers.

Table 4.2.1.1 mentions for reference installation 2 a TSP emission factor of 5 [mg/Nm³] as a mean value. This factor is applicable for Natural Gas, which is not used in refineries. Washed refinery gas will have a higher emission factor than 5 [mg/Nm³]. Value depends on gas type considered, see general remarks.

There are no abatement measures mentioned: both measures mentioned for reference installations based on HFO fuels Gas fuel are of the type 'uncontrolled'. Fuel switch (HFO to Gas) is in fact an abatement technique that should be included, because there are costs involved when fuel switch is applied. Because fuel switch is performed to a reference installation, the related costs and emission reductions should be considered together for PM, NO_x and SO₂.

NO_x abatement techniques

Table 4.2.2.1 show unrealistic efficiencies for all NO_x abatement techniques.

Efficiency of LOw-NO_x boilers is far too high. This can be shown using the experience of Exxon refinery in the Netherlands, with a boiler of 107 MW_{th}. The boiler was provided with a low-NO_x burner in 2002, after a study of 5 years (1997 – 2002).

Fuel: Refinery gas, sometimes complemented with natural gas (reference installation 02).

NO_x-emissions uncontrolled: 300-320 [mg/Nm³], 3% O₂ dry

NO_x-emissions after placement of low-NO_x burner: 204 [mg/Nm³], 3% O₂ dry

Efficiency of abatement technique $(320-204)/320 = 0.3625 = 36.25\%$

Investments: ~1.0 million Euro's

Cost per tonne of NO_x abated: ~3,500 [€/t]

From this example, it seems that not only the efficiency of the abatement technique is overestimated in EGTEI's document, but also that the uncontrolled as well as the abated emission factors are underestimated.

According to Dutch experts from the petroleum industry, the proposed high efficiency for the SNCR of 60% is not realistic. Note that SNCR is not applied to fired heaters, but only to boilers.

Although the BAT document mentions efficiencies between 85% and 90%, in practice about 80% is achieved. Moreover, due to maintenance issues, the SCR is out of service approximately 1000 hours a year. The real process efficiency amounts ~71% instead of the 85% proposed. Another possibility of incorporating this discrepancy is adding the number of operating hours per year as a factor.

Fuel switch should also be mentioned as abatement technique. Because fuel switch is performed to a reference installation, the related costs and emission reductions should be considered together for PM, NO_x and SO₂.

SO₂ abatement techniques

Table 4.2.3.1 indicates that uncontrolled SO₂ emissions for reference installation 01 amounts 3,400 [mg/Nm³]. The Large Combustion Plants Directive (Directive 2001/80/EC), applicable to combustion plants equal or greater than 50 MW, imposes that for European Member States a maximum emission factor of maximum 1,700 [mg/Nm³] are allowed for plants up to 300 MW. This emission level should be included in table 4.2.3.1.

Table 4.2.3.2 mentions that there are no costs involved when switching from HFO to gas is performed as an abatement measure. This is not correct. Extra costs are due to piping or piping volume change (more capacity) to the refinery, gas station including measuring systems, piping from gas station to boilers or fired heaters, change of burners, and under some circumstances even the change of the complete boiler. The Netherlands Petroleum Industry Association estimates that the investment costs for medium size combustion plants within refineries could rise to approximately 25 M€.

4. Petroleum industry: Fluid Catalytic Cracking Unit

Comments to the synopsis sheet on FCC units is similar to the synopsis sheet "Combustion processes":

- A definition of HFO is required;
- "Gas" means "refinery gas" and not "natural gas", all emission factor must be related to this gas type;
- Fuel switch is an abatement measure that does not cost "zero".

No other specific comments have been given to this synopsis sheet.

5. Petroleum industry: Sulphur Recovery Unit

General remarks

Claus reactors are not applied in refineries as stand-alone units: more equipment is required.

Reference Installations

According to Shell Global Solutions refineries in the Netherlands, it is not clear if the mentioned value of 33,333 [t/yr] of reference installation 01, reflects the amount of sulphur or the amount of hydrogen sulphide (H₂S). Shell remembers that during the preparation of EGTEI's work, a sulphur production case was discussed. The amount Shell gave to the experts was related to H₂S and not to sulphur only.

The plant size range of reference installation 01 produces 33,333 tons of sulphur per year (according to Shell, this number is applicable to H₂S and not to sulphur, see comment above). In the Netherlands, large refineries are active. One of the six active refineries produces

approximately 560 ton of sulphur a day, thus more than 200,000 tons a year. To represent these refineries, a second reference installation should be added.

Proposal:

Table 8. Reference installations

Reference code	Technique	Plant size range
01	Standard Claus Unit	... [t/yr]
02	Standard Claus Unit	200,000 [t/yr]

SO₂ abatement techniques

The units for the emission factor of table 4.2.3.1 should be [kg SO₂ / t Sulphur]. The abatement efficiency of category 3 abatement technique, SCOT (table 4.2.3.1 of synopsis sheet) should be 99.8% instead of 99.9%.

For a refinery producing 200,000 [t/yr] sulphur, the investment costs of a SRU amounts approximately 40 million of Euro's. Table 4.2.3.2 of synopsis sheet should include costs for reference code 02 as given in Table 8.

The costs mentioned in table 4.2.3.1 of synopsis sheet, correspond to Greenfield costs. Dutch refineries comment that the investment costs of a SRU plant should also consider investment costs for:

- Collection of sour gasses,
- Pressurisation of collected gasses,
- Washing of gases and
- Waste heat boiler application.

Considering these investments as necessary, costs mentioned could arise up to 4 times higher than given in the table. Data mentioned in the table are probably only applicable for new installations. Dutch expert's opinion is that not much new refineries will be built in Europe in the future (if any at all).

It is not clear in which way the costs mentioned in the tables will be up scaled to refineries with different sizes than the reference mentions. This methodology should be included into the document.

Additional (textual) remarks to synopsis sheet

- Delete 2nd paragraph: "Sulphur recovery crude oils". This sentence is being repeated.
- Change last sentence of 5th paragraph: "Indeed gases through Claus plants still contain substantially sulphur compounds" into ", because gases passing through Claus plants still contain substantially sulphur compounds".
- Idem, 2nd sentence of 1st paragraph under 4.2.3