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EUROMOT

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DRAFT D1 Large Combustion Plants BREF – BAT AELs for HFO-fired Engines

1. Introduction

The first draft of the revised Large Combustion Plant BREF draft (LCP BREF D1) was released by the EIPPC Bureau in Seville end of June 2013 for commenting by the Technical Working Group members.

EUROMOT welcomes the opportunity to provide comments into the process. However, the issues are complex and the draft D1 is very extensive making it difficult to meet the commenting deadline.

Finalising a new BREF LCP based on a single draft procedure is only possible if the information provided for the first draft is complete, correct and unambiguous. In the case of gas and HFO fired internal combustion engines we are confronted not only with a revision but with proposals for new BAT associated emission levels (BAT AELs) which do not exist in the LCP BREF from 2006.

EUROMOT has identified a number of fundamental issues in the draft LCP (D1) regarding the data and the derived BAT conclusions which need addressing. Furthermore, many important parameters such as engine loading, operational profiles, annual operating hours/year, existing infrastructure and availability of necessary abatement technology as well as the necessary space for retrofitting have so far not been adequately taken into account, further complicating the work.

EUROMOT urges EIPPCB to adopt a procedure based on two drafts for the LCP BREF in order to take in to account the complexity of the LCP BREF and to ensure a sufficient quality of the final LCP BREF.

2. BAT Conclusions – Chapter 10

In chapter 10 of the draft LCP BREF document, BAT associated emission levels stated to be **generally applicable to the combustion** in reciprocating internal combustion engines (RICE) are given. In the following we will comment the individual sections.

In chapter 10.3.2 of the draft D1, BAT associated emission levels (BAT AELs) **stated to be generally applicable** to the combustion of HFO in reciprocating engines (RICE) are given. However, the proposed BAT AELs for HFO engines are not generally applicable for a number of reasons:

- **The data base used to derive the BAT AELs is not representative of the HFO technique:** Almost all of the draft BAT AEL are based on data from one plant consisting of in total 8 engine units (plants No 362, 363, 364, 365 in BATIS), situated in Malta. It is our understanding that this plant was submitted as a case study for emerging technique and not as reference plant. The obtained measurement data from all other eight reference plants (with many engines) situated in Greece, UK, and Portugal has been largely disregarded;
- The Maltese HFO engine plant is a **special design base load plant** equipped with a **novel** secondary SO_2 abatement technique new to the HFO stationary engine industry sector – this design cannot be generally applied to other plants (e.g. not applicable to peak load plants, "remote plants" please see Annex 1 for a detailed discussion of the novel technique and its limitations)
- The new Maltese plant has very **limited operation hours** so far and no long term experience exists with this technology. The lack of experience with this novel technique is also noted in chapter 10.3.2 of the LCP BREF D1 document in the context with the proposed BAT AELs *" [..] The values of BAT AELs will be adjusted also taking into account 1-year data of plants [..] once they will be made available".*

The plant thus does not fulfil all criteria set for BAT in Annex III of Industrial Emissions Directive (IED; 2010/75/EU) such as

- Item 4: "comparable processes, facilities or methods of operations which have been tried with success on an industrial scale"
- Item 8: "the length of time needed to introduce the best available technique."

EUROMOT cannot accept that BAT AELs are set based solely on data from one plant which has experienced extremely limited running hours. One year of data as proposed by the EIPPC Bureau is not enough to assess a novel technique. A new plant in general shows an excellent performance and a skewed emission picture of the performance will probably be obtained after limited operation hours. Only time and wear and tear will show the real long term performance.

It is clear that the proposed BAT AELs need to be significantly modified based on generally applicable reference plants. In the following we explain in more detail why the proposed BAT associated emission ranges of the BREF D1 cannot be generally applicable to the whole HFO fired stationary RICE plant field and make justified recommendations for alternative BAT AELs.

3. Proposed BAT AEL Limits for stationary HFO fired engines and discussions

In section 10.3.2.2 of BREF D1 BAT associated emission levels for HFO fired stationary RICE engines are given.

NOx, NH3, CO, TOC (table 10.20) at 15 % O_2 reference:

The BAT-associated emission levels for NO_X, NH_3, CO and unburnt carbons (as TOC) emissions to air from the combustion of HFO in reciprocating engines that are not emergency plants are given in Table 10.20.

Table 10.20: BAT-associated emission levels for NO_X, NH3 and CO emissions to air from the combustion of HFO in reciprocating engines

Type of engine		Pollutant	Unit	Monitoring frequency	BAT-AEL		
					Yearly average	Daily average	Average of samples obtained during one year
All but emergency plants	Existing	NO_X	mg/Nm^3	Continuous measurement	90 – 250	ND	-
	New				< 140	< 150	-
All but emergency plants		NH_3 ([1])			< 5	ND	-
		CO			50 – 100	ND	-
		TOC		Periodic measurement	-	-	10 – 40

([1]) Ammonia emissions are associated with the use of SCR.

The current proposed values are based on a period shorter than 1 year. The values of the BAT-AELs will be adjusted also taking into account 1-year data of plants 362, 363, 364, 365 (very recently built plants – operations started only in 2012) once they will be made available.

NOx:

The emission limit are reachable only by use of an efficient SCR. SCR pre-requisites are:

- **Sufficiently high exhaust gas temperature:** In order to avoid ammonium bisulphite clogging of the catalyst elements – SO_3 reacts with NH3 and formed ammonium bisulphite condensates out at lower temperatures – with consequences such as NOx reduction collapsing, NH3 slip increasing tremendously, flue gas pressure drop increases ultimately leading to the plant being shut down or the SCR reactor being by-passed. The recommended minimum temperature of the (HFO fuel) flue gas is 330 - 350 degree C (based on experience) before the SCR unit dependent on S content of the HFO, see also /6/ about ammonium bisulphite clogging challenge ("[..] *The ideal temperature for the SCR should have been above 700 F* [..]") .

- Reagent and spare part infrastructure has to exist.
- A major issue for existing plants might be the space requirement of the SCR system.
- Disposal of used elements has to be done properly.
- Fuel should not contain strong catalyst poisons in order to avoid frequent catalyst exchanges.

It should be noted that the **NOx abatement cost for diesel engine plants is about 3 - 9 times higher than for a boiler case** ! (see reference /4/). The large additional cost of SCR results in higher electricity generation price.

Furthermore, according to source /2/: " *SCR ..* ***cannot be seen as BAT for engines with frequent load variation due to technical constraints [..]*** *A SCR unit should not function effectively when the operation conditions and the consequent catalyst temperature is fluctuating frequently outside the necessary effective temperature window"*.

For these reasons, EUROMOT recommends to include flexibilities for certain plants, i.e. for peak plants and plants in regions with a lack in the infrastructure, flexibilities as is the case in the recently updated Gothenburg Protocol (Source /5/ page 37, see footnotes b and c below table 9).

NH_3:

The BAT AEL proposed in table 10.20 is exceedingly low and only achievable with a well maintained fresh active catalysts. The proposed values do not constitute BAT as in order to achieve these BAT AEL the SCR elements have to be exchanged very often.

In order to avoid too frequent SCR element changes. EUROMOT strongly recommends raising the BAT AEL to 10 mg/Nm3 (15 % O_2), for comparison German the TA-LUFT limit is 30 mg/Nm^3 .

CO:

In chapter 6.2.4 (table 6.5) of BREF D1, CO emission data can only be found sparely. After studying the obtained field measurement data following can be noted: Measured CO emissions data in the Maltese plant seem to have been disregarded. Nevertheless this plant is indicated as the reference plant for the BAT AEL values in table 10.20 ! In the Maltese plant the average CO levels were around **120 – 136** (peaks up to 166 .. 196) mg/Nm^3 (15 % O_2) **which is much higher** than set BAT associated emission level span 50 – 100 (15 % O_2) ! From some other of the reference plants higher field measurement CO levels than the proposed span could also be found ! Furthermore, an oxicat for CO abatement is not recommended when operating on HFO (section 6.5.5.5 /8/. Thus the proposed emission BAT range has to be modified. The measured CO emissions (reported in the field emission data plant questionnaires) vary a lot therefore we propose to maintain the current LCP BREF approach which is similar both for TOC (NMHC) and CO, see text below.

TOC:

The stated average of samples BAT AEL, seem to be from different Portuguese plants and not from the Maltese plant (references 362 -365), which is the main source for the BAT AELs of the other pollutants(NOx, NH_3), as is indicated above in table 10.20. As we explain in more detail in Annex 2, it it is not technically sound to combine BAT emission values from different sources in the way it has been done in table 10.20. Furthermore, the TOC measurement data used as base for the set BAT AEL range seems to be erroneous as we have pointed out previously (see Euromot e-mail /7/ to EIPPCB). Overall the draft text on TOC needs big modifications, especially, as the currently proposed BAT AEL spans for TOC are **NOT achievable at least over a longer period of time even with a well maintained engine**.

In EUROMOT's opinion the best option for keeping TOC emissions low is to require good maintenance of the engine and we therefore propose a similar approach as in the current EU LCP BREF document (**<u>no set emission limit values but requirement on good maintenance procedures</u>**) /8/.

BAT-associated emission levels

The BAT-associated emission levels for SO_X from the combustion of HFO in reciprocating engines are given in Table 10.21.

Table 10.21: BAT associated emission levels for SOX emissions to air from the combustion of HFO in reciprocating engines

Type of engine		Pollutant	Unit	Monitoring frequency	BAT-AEL	
					Yearly average	Daily average
All but emergency plants	Existing	SO_X	mg/Nm³	Continuous measurement (1)	100 – 200	ND
	New				< 100	< 110

(1) Only SO_2 is continuously measured, SO_3 is periodically measured (e.g. during calibration)

The current proposed values are based on a period shorter than 1 year. The values of the BAT-AELs will be adjusted also taking into account 1-year data of plants 362, 363, 364, 365 (very recently built plants – operations started only in 2012) once they will be made available.

SOx (or SO2 ?):

The SOx (SO2 ?) BAT AEL range proposed in table 10.21 (above) is very challenging to meet. There are different secondary abatement technologies for SO2:

1. Dry FGD: In the Maltese plant used as main reference, the Sulphur content of the HFO was about 0.694 wt-% S (low sulphur HFO!) and thus the applied novel dry FGD technique has to achieve approximately a 50 - 75 % SO_2 reduction rate, in order to achieve the proposed BAT AELs for new and existing HFO plants. Combusting alternative HFO types with higher sulphur content will have following impacts:

   - A dry FGD (such as based on $NaHCO_3$) needs a high over-stoichiometry to reach the proposed BAT AEL when burning HFO containing higher levels of sulphur. For example, with a 3 wt-% S an about 89 % reduction rate is needed to achieve the 200 mg/Nm^3 (15 % O_2) SO2 limit (applicable only to existing plant) and about 94 % for the 100 mg/Nm^3 (15 % O_2) limit (applicable to new plant).
   - As Annex 3 shows, for a plant operating on a 3 wt-% S HFO, the proposed SOx (SO_2?) BAT AEL of 100-110 mg/Nm^3 (at 15 % O_2) is only achievable with a very high reagent consumption (→ at a high cost) when utilising a dry FGD.

2. Wet FGD: Due to the very high reagent consumption of the dry NaHCO3 FGD type, an alternative type of FGD such as $CaCO_3$ type is recommended, when aiming to fulfil the stricter SO_2 BAT AEL of 100 mg/Nm^3 (15 % O_2) ! A wet FGD needs clean make-up water or approximately 1.1 m^3/MWhe (plant without exhaust boiler) ! – **100 MWe plant → e.g. 110 m^3/hr of water consumed**) . Thus when a wet FGD is used also a huge amount of **clean** fresh water has to be available.

Further constraints are:

- In some locations, such as remote islands, the infrastructure needed for dry or wet FGD (reagent supply, end product disposal, fresh water supply) may not exist.
- For existing plants the space availability might also be a big obstacle.
- FGD:s need also a long start up time thus not suitable for peaking plants, etc.

As is shown in detail in Annex 1, a dry $NaHCO_3$ FGD type might be only applicable to certain HFO stationary RICE plants (novel technique!) and thus generally applicable emission limits can and **should NOT be based on this technology**. Thus at least for remote plant installations with a restricted infrastructure and for peak load plants usage of low sulphur HFO should be regarded as BAT (from an overall view) as long as the Ground Level Concentrations are within set limits – flexibility should be allowed in order to safeguard affordable electricity supply.

EUROMOT believes that the BAT AEL should only cover SO2 and not SO3 as correct measurement of SO3 is very difficult and not covered by current CEN measurement standards, see Annex 2.

Dust/Particulate:

The BAT-associated dust emission levels from the combustion of HFO in reciprocating engines are given in Table 10.22.

Table 10.22: BAT-associated emission levels for dust emissions to air from the combustion of HFO in reciprocating engines

Type of engine	Pollutant	Unit	BAT-AEL		Monitoring frequency
			Yearly average	Daily average	
New	Dust	mg/Nm^3	1 – 5	6 – 12	Continuous measurement
Existing, all but emergency mode			1 – 10	ND	

The current proposed values are based on a period shorter than 1 year. The values of the BAT-AELs will be adjusted also taking into account 1-year data of plants 362, 363, 364, 365 (very recently built plants – operations started only in 2012) once they will be made available.

Applicable also on emergency plants ? Emergency plants shall be excluded from emission limits (not stated for table 10.22)!

The BAT AELs proposed in table 10.22 (see above) are too strict for a number of reasons:

- In the Maltese plant given as reference, the measured peak values published in the field emission measurement data sheets were about three times higher than the proposed upper BAT AEL value proposed for a new plant.
- It is questionable how reliable the particulate measurements are for such low levels. It is not clear which standard was used, however, we assume that EN 13284-1 measurement method or a principally similar measurement method were used.
- To our knowledge bag filters have very rarely before – if at all – been used in HFO fired stationary RICE plants and as mentioned above also much higher particulate limits have been measured than shown in below table after bag filters in some other diesel engine installation /1/.
- As shown in more detail in Annex 1, the dry FGD technology in combination with bag filters are not suitable in many HFO fired stationary plants and thus a generally applicable BAT AEL for dust cannot be based on this technology.

Furthermore, It is highly likely that the measured emission values are achievable only by "fresh" bag filters and thus are NOT representative for the long time operation of the plant.

An alternative abatement technique, ESP (Electrostatic Precipitator), is mentioned in table 39 of chapter 10.3.2.4 of BREF D1. However, the proposed BAT AEL range for dust is NOT reachable with ESP in context with HFO fired stationary RICE engines. The current LCP BREF from 2006 /8/ chapter 6.5.5.2 highlights that " *Due to the different temperature and oxygen content of the diesel flue gas the electrical properties of the diesel particles are* *different compared to particles from boiler of flue gas.”.* As a consequence the ESP performance for flue gases from a boiler and diesel engine plant will be very different. Boosted demo ESP (two field type) field testing in a HFO plant indicated that about the same particulate level about 30 mg/Nm^3 (15 % O_2) as above achieved in the long term bag filter testing /1/ could be reached. Existing plants may face problems to install ESP due to their size. ESPs for HFO engines are very large due to the need to keep the flow speed of the flue gas at around 1 m/s and thus space requirement is big. ESP cost is also high and the removed ash is to be disposed in an environmentally acceptable way.

The proposed dust BAT AEL are not achievable with current BAT technique and if adopted will result in the closure of all HFO fired plants !

4. EUROMOT proposals for BAT AELs for HFO fired RICE plants

As discussed above, the BAT AEL ranges proposed in section 10 of BREF LCP D1 have unfortunately been based on a very special plant design NOT applicable for the whole HFO stationary RICE plant field (thus NOT generally applicable !) and to some extent on “cherry picking” as not a single reference plant can fulfil the BAT AEL for all pollutants. Some simultaneously required BAT emission values have not been achieved simultaneously at same reference plants but derived from different plants, for more details see below.

In this section we propose a differentiated BAT approach which takes into account the surrounding environment (plant location and existing infrastructure), costs, as well as the availability and feasibility of techniques. The proposal is also mindful of the big transition of the power plant market which has and still occurs as a consequence of big installed/increasing capacity of renewable such as wind and solar around the EU area. As a consequence many thermal power plants are today used more and more as peak loading plants for grid stabilization in cases with deficits of energy production from renewable.

4.1 <u>EUROMOT proposals for New Plant:</u>

<u>NOx:</u>

- Base load plant:
  - o Unit < 20 MWth: 225 mg/Nm3 (15 % O2),
  - o Unit > 20 MWth: 190 mg/Nm3 (15 % O2)
- Plants in remote area/small islands with restricted infrastructure, provided GLC in order application of primary feasible NOx abatement techniques:
  - o Dual Fuel (DF) Engine: 1850 mg/Nm3 (15 % O2)
  - o Diesel engine:
    - > 20 MWth unit 1850 mg/Nm3 (15 % O2),

        - < 20 MWth unit 1460/1300* mg/Nm3 (15 % O2)

- Peak load plants:
    - Dual Fuel (DF) Engine: 1850 mg/Nm3 (15 % O2)
    - Diesel engine
        - Unit > 20 MWth: 1850 mg/Nm3 (15 % O2),
        - Unit < 20 MWth: 1460/1300* mg/Nm3 (15 % O2)
- Emergency no BAT AEL

  *Only available on limited engine types with certain cylinder configurations and thus NOT suitable as an universal limit, prerequisite 2-stage turbocharging.

NH3:

- 10 mg/Nm3 (15 % O2)

SO2:

Note that according to current BREF /8/ section 6.5.5.3 " .. use of low sulphur fuel oil or natural gas, whenever commercially available is regardfed as the first choice of BAT .. !

- Base load plant > 100 MWth: 110 mg/Nm3 (15 % O2)
- For plants < 100 MWth in general, Plant in remote area/small islands with restricted infrastructure (where FGD is not feasible), peak load plants:
    - 300 mg/Nm3 (15 % O2) or 0.5 wt-% S HFO if not commercially available 590 mg/Nm3 (15 % O2) or 1.0 wt-% S HFO

CO, TOC:

- No emission limit shall be set.
- EUROMOT recommends adopting the approach of the current LCP BREF (2006) /8/ section 6.5.5.5, i.e. good maintenance is required; this can be followed via maintenance manual checks.

Dust/Particulate:

Note that according to current BREF /8/ section 6.5.5.2 ; for HFO < 50 mg/Nm3 (15 % O2) and for LFO 30 mg/Nm3 (15 % O2) are BAT .. !

- Dust (as dry dust) measurement method EN 13284-1 measurement method or other principally similar method. For Engine loading 85 - 100 % of MCR as in current LCP BREF /8/. :
    - > 300 MWth base load plants 30 mg/Nm3 (15 % O2)
  - Other plants 50 mg/Nm3 (15 % O2) (same as current LCP BREF 2006 BAT /8/)
  - Emergency engines no BAT AEL

4.2 EUROMOT proposals for Existing Plants

Sufficient lead time has to be provided taking into account plant surrounding before implementation of below limit values:

NOx:

- Base load plant:
  - 750 mg/Nm3 (15 % O2) if SCR can be retrofitted (e.g. is the necessary space available, infrastructure existing,) otherwise same limit as in below bullet.
- Plant in remote area/small islands with restricted infrastructure/space, peak load plant; application of primary feasible NOx abatement techniques:
  - Diesel and Dual Fuel (DF) engine 2000 mg/Nm3 (15 % O2)
- Emergency no BAT AEL

NH3:

- 10 mg/Nm3 (15 % O2)

SO2:

- Base load plant > 100 MWth::
  - 110 mg/Nm3 (15 % O2), if FGD can be retrofitted (space issue, infrastructure existing, etc.) otherwise same limit as in below bullet
- For plants < 100 MWth in general, Plant in remote area/small islands with restricted infrastructure here FGD is not feasible, peak load plants
  - 300 mg/Nm3 (15 % O2) or 0.5 wt-% S HFO
  - If 0.5 wt-% S HFO is not commercially available 590 mg/Nm3 (15 % O2) or 1.0 wt-% S HFO

CO, TOC:

- No emission limit shall be set. Current LCP BREF 2006 /8/ section 6.5.5.5 approach to be followed i.e. good maintenance is required this can be followed via maintenance manual checks.

Dust/Particulate:

(Dust (as dry dust) measurement method EN 13284-1 measurement method or other principally similar method**)**

- For Engine loading 85 - 100 % of MCR as in current LCP BREF /8/:
  - Base load plants > 300 MWth 50 mg/Nm3 (15 % O2) (if space available and needed infrastructure exist). Otherwise same limit as below bullet.
  - Other plants 75 mg/Nm3 (15 % O2)

5. CEMS

In BREF D1 section 10 CEMS is required for NOx, NH3, CO, SO2 and dust. Prerequisites for CEMS is a good existing infrastructure and special trained personnel.

General aspects:

IED 2010/75/EU allows the intermittent measurement possibility in general for oil (with known S-content) fired plants (without FGD) in regard of SO2 and in general for all emissions for plants < 100 MWth size. According to current BREF 2006 /8/ section 6.5.5.2 table 6.47 BAT monitoring of particulate is *"discontinuous once every 6 month*" NH3 measurements especially in a HFO plant are very challenging (NH3 has a tendency to deposit on particulate, etc.), on top of this we are not aware of any ISO or CEN measurement standards for ammonia.

For stationary engine plants in remote areas with a weak infrastructure and for peak load plants intermittent measurement procedures should be allowed for emission compounds due to practical/cost reasons.

For more information see document /10/.

6. Conclusion

As we have shown in this paper, the some of the proposed BAT emission associated spans in BREF D1 for liquid fired stationary RICE are not **generally applicable/feasible** on all HFO fired stationary RICE plants. It is important that the final BAT AEL are based on BAT, i.e. on available commercial technologies and have a balance between cost and benefit and EUROMOT is committed to support the Sevilla process in setting viable BAT AELs for HFO fired engines.

EUROMOT has made counterproposal for strict but feasible emission limits based on BAT, which in the case of NOx emissions are largely based on the recently concluded Gothenburg Protocol including necessary flexibilities for certain areas and peak load plants. The same flexibilities should also be applied for all other emissions.

In general it has to be stressed that by no means all plants are base load plants. Today more and more installed thermal power plants are used for peak loading (grid stabilization) in order to cover the increasingly volatile energy production which is the result of a big transition in the power plant market as a consequence of the big installed and increasing capacity of renewable energy sources such as wind and solar throughout the EU /10/. This change is not adequately addressed in the BREF D1 BAT approach.

EUROMOT strongly believes that as plant loading and annual operating hours have to be taken into account when setting BAT AELs and emission limits or in other words a new regulation has to reflect the recent market trends in order to represent a cost effective BAT. Also varying "local conditions" such as the existing infrastructure should be considered when setting BAT AELs (see texts above).

Additionally in order to have a cost-effective and meaningful regulation following options are to be inserted into the BREF D1 with regards to CEMS:

- The intermittent emission monitoring option should be inserted into the BREF D1 in general for SO_2 for plants without FGD firing oil with a known S-content. NH_3 measurement shall be biannually for plants equipped with SCR.
- Due to technical/economical constraints all emission compounds shall for "remote (such as islands)" or peak load plants be intermittently measured (e.g. biannually) and between measurements surrogate measures used. Ditto in general for all < 100 MWth plants.

EUROMOT – 2013-09-23

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ANNEX 1

Maltese RICE plant and discussions

The data on NOx emission, SOx emission and Dust emission found in chapter 6.3, figures 6.9 – 6-11 of the LCP BREF Draft D1 have been gathered in the Malta RICE (Reciprocating Internal Combustion Engine) plant (references 362, 363, 364 and 365). No other plant emission field data has been taken into consideration for the BAT associated for these emission levels in chapter 10.3. The proposed CO and TOC BAT AELs are however not from the references 362 – 365 (but are based on other reference plants) as indicated in section 10 of BREF D1 – e.g. the CO BAT AEL proposal is lower than the measured emissions in the Maltese plant !)

Maltese reference plant:

As stated above the Maltese HFO fired RICE power plant is of "special design" consisting of 8 big HFO engines with 17 MWe each) (for further information see BATIS and following link http://www.enemalta.com.mt/index.aspx?cat=20&art=129):

- Each engine has a SCR unit for NOx reduction
- Each engine has an exhaust boiler for intermediate pressure 14 bar (g) superheated steam production for a common 12 MWe steam turbine producing additional electricity
- A bag filter dry Flue Gas Desulphurization (FGD) unit per 2 diesel engines in total 4 FGD units in the power plant
- A FGD end product storage silo
- Two FGD reagent ($NaHCO_3$) silos

The dry $NaHCO_3$ FGD technology is new in the HFO fired stationary RICE power plant concept. We are not aware of any other stationary RICE power plant equipped with this FGD technology and to our understanding up to now this FGD technique has primarily been used in smaller installations as waste incinerator/boiler plants. It is important to note that according to table 5.32 (chapter 5.1.4.4.3.4) of the BREF D1 the NaHCO3 FGD process is also very rare in the boiler sector.

Dry FGD

The dry FGD technology is not generally applicable to HFO fired stationary RICE installations due to its following characteristics:

- **Long start-up time: 2h-3h are necessary for pre-coating the bag filter with the reagent before** starting up the plant equipped with dry FGD. This is not a problem in the case of the Maltese plant, as it is a base load plant. However, most liquid fired

RICE plants today in the EU are either peak plants or operated only irregularly during some season thus making them not well suited for secondary emission abatement techniques.

- **Expensive reagent $NaHCO_3$ needed for dry FGD:** About 2.65 kg is needed per removed SO_2 kg in stoichiometric reactions, if a higher stoichiometry is used figure increases. This should be compared to a $CaCO_3$ wet scrubber where about 1.56 kg $CaCO_3$ is consumed per kg removed SO_2 kg. I.e. a bigger mass amount of the $NaHCO_3$ is needed, the price of the reagent depends on the plant location/reagent buying amounts. Thus NaHCO3 cost (http://www.alibaba.com/showroom/nahco3-price.html) might according to internet (big amount purchase) typically be from equal to about 4 times higher than $CaCO_3$. (http://www.alibaba.com/showroom/calcium-carbonate-price.html)→ 1.7 .up to 7 times higher reagent cost (in stochiometric conditions) compared to the wet $CaCO_3$ FGD!

- **A reagent supply infrastructure** has to exist for the special reagent.

- **A suitable waste infrastructure** needs to exist for the end product. In the reaction used to abate SO_2, the dry FGD produces mainly Na_2SO_4 (and some unreacted reagent). Na_2SO_4 is leachable in water and thus cannot be disposed safely without special treatment. Instead it has to be sent to a factory for treatment. A special infrastructure has to exist in order to be able to apply dry FGD. This is not the case in all locations !

- **Flue gas temperature:** The FGD unit has bag filters on which the injected reagent reduces the SO_2 of the flue gas. Furthermore, the bag filters also reduce dust emissions. A bag filter has a high pressure drop and thus exhaust gas fans are needed to compensate for this resulting in parasitic electrical loads. The reported stack temperature is 170 degree C which indicates that a typical (conventional) bag filter material is applied in the FGD. Depending on the diesel engine type a typical flue gas temperature out of the engine is 250 up to 400 degrees C. The EU LCP BREF D1 chapter 3.3.3.1.2 states that bag filter requires fabric filter selection adequate to the characteristics of the flue gas and the maximum operating temperature. If the flue gas temperature is too high for the filter bag material cooling of the flue gas is needed. In chapter 3.1.2 of the BREF D1 operation the temperature span of bag filters is given as 120 – 220 degree C. In the Maltese stationary RICE plant the FGD reactors are situated after the steam boilers and thus sufficient cooling of the flue gas is achieved and filters are not damaged. If there is no need of steam/hot water production in a RICE plant there will be no full heat recovery boiler and thus the flue gas temperature will be too high making usage of conventional bag filters not viable. Exotic filters such as ceramic bag filters (used in some Integrated Gasification Combined Cycle; IGCC; plant) could withstand higher flue gas temperatures upto 450 degree C (see section 4.3.1.2 of BREF D1) but these filters are very expensive and not state of the art in a RICE plant (thorough testing should be needed in a HFO fired stationary RICE plant before any commercial release in order to gather experience (on cracking, clogging risks, pressure drop, etc.) in order to see if suitable or not. Thus these are for time being not viable.

The Maltese RICE plant emission performance data is for a new plant with limited operating hours. In chapter 3.3.3.1.2 The BREF LCP D1 lists following challenges with a fabric filter (bag filter) based technique:

- Clogging problems for some fuels especially oil is mentioned.
- Cracking of the filter material is highlighted which might significantly raise the particulate emission from the plant.
- Wear and tear of the filter bags results in a gradual but measurable reduction in performance.

In source /1/ chapter 1.3 some particulate emission experience from a bag filter CaO FGD (Flue Gas Desulphurization) unit is shown: In this plant excessive wear and tear of the bags was noted due to the small sized sharp edged diesel particulates and as a consequence holes (sharply increased wear especially in the seam regions) in the filter material occurred now and then resulting in high particulate emissions. On average a 30 mg/Nm^3 (15 % O_2) particulate emission was measured in the stack from this plant.

Above text taken from BREF D1 indicates that long performance operating data of a plant is really needed before making any BAT conclusions, in order to stipulate meaningful emission limits.

NOx / general comment

In the recently finalized UNECE Gothenburgh process /2/ chapter OO (page 254) a note is given for limitation of applicability of SCRs in RICE plants with varying loads with corresponding reasoning.

This kind of installation (SCRs, boilers, FGDs, steam turbine, silos, tanks, etc.) requires a relatively large amount of space in order to house all components which is not available in all locations and might be a big obstacle especially for existing plants

ANNEX 2

Discussion of data in the draft LCP BREF used in BAT conclusions

The NOx emissions depicted in figure 6.9 (below) are only achievable when using an efficient SCR in combination with a sufficient reagent consumption (the NOx reduction is dependent on the injected reagent amount). The reagent needed is typically a 25 wt-% NH_3 or 40 wt-% urea (urea to be of technical grade) water solution, reagent is expensive.

In source /3/, the additional cost due to SCR usage on the power price is shown in unit Euro/MWhe for engines with different operating hours and reagent prices and the cost is substantial ! In document /4/ is shown that with SCR the **NOx abatement cost for a diesel engine case is approximately 3 - 9 times higher than for a boiler case** ! NOx abatement cost seems not to have been noticed when setting strict NOx limits in the BREF D1 ! Cost should however be part of a BAT conclusion . In chapter 3.3.3.3.11 of the BREF D1 some technical considerations relevant to applicability in RICE plant context have been listed such as:

- Existing infrastructure of reagent, spare part supply a must
- Needed flue gas minimum temperature
- Poisoning risk due to impurities in fuel oil
- Maintenance need for good performance
- Etc.

In the text above figure 6.9 (of BREF D1) is stated that the average NH_3 slip yearly average range was below 1 mg/Nm^3 (15 % O_2), which seems to be based on the Maltese plant . This is a very low figure, to be remembered is : NH3 measurement are difficult and a single small cold spot may absorb all NH_3 and lead to too low NH3 results. Actual NH3 level depends on tuning of SCR at the moment of measurement, **so the results have no value if they are not paired with the actual NOx reduction at the moment**. NH_3 performance depends greatly on catalyst setup and performance achievable with one setup may not be possible with another. In a well tuned SCR equipped with a fresh oxidation catalyst and new fresh SCR elements this kind of very low NH_3 slip could be measured but in HFO fired plants oxidation catalysts are not recommended (will get poisoned) and with time (wear and tear) ammonia slip will increase from this level. SCR suppliers usually do not guarantee NH3 levels less than < 10 mg/Nm^3 (15 % O_2) ! A low stipulated ammonia slip limit will also result in more frequent costly SCR layer changes in a plant.

To TWG: Data and plot will be updated once the questionnaires from the plant 362, 363, 364, 365 are provided (expected for September 2013).

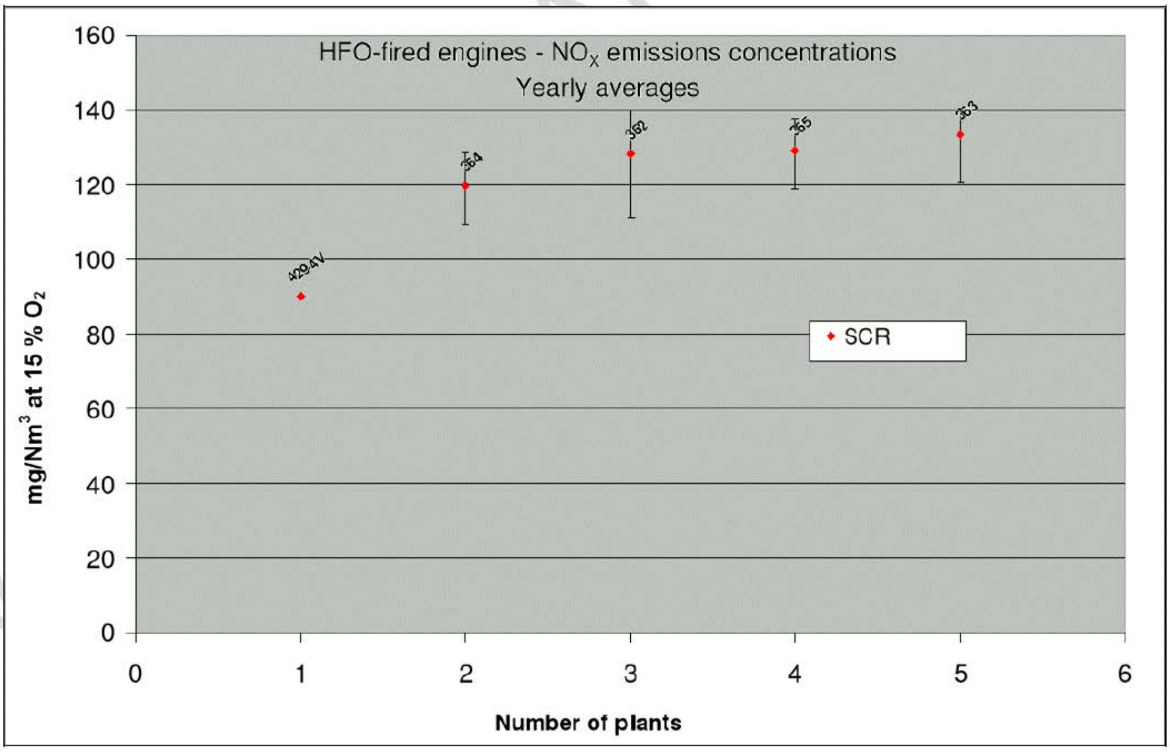


Figure 6.9 **HFO-fired engines – NO_X emission concentrations, yearly averages; 5th and 95th percentiles of short-term values are represented as span bars**

In the Greece field measurement data **following is mentioned** in the emission sheets "*BAT candidates 1) No secondary measures for Nox reduction for* *<u>engines located in small isolated systems</u>*. ***<u>Such measures are not technically feasible or economically viable</u>*** ", primary measures are used thus NOx emissions are as a consequence higher than in a plant equipped with SCR. This has however been neglected when setting the NOx BAT levels in the BREF D1 !

Note also that for an existing plants the extra needed space of a SCR unit might be a big obstacle !

Note in table 6.5 of section 6.2.4 of BREF D1 a NOx span based on obtained field data from HFO fired stationary RICE plants is give of 100 . 2500 mg/Nm3 (15 % O2). Both plants applying only primary NOx abatement methods (high range values) **or** SCR seem to be included in this span. **This shows that for plants for which SCR is not feasible (see above texts) higher BAT AELs are needed than proposed!**

<u>SOx (SO2 ?)</u>:

In the Maltese plant a HFO with a low sulphur content of 0.694 wt-% is used. Thus the unabated SO_2 emission should be about 400 mg/Nm^3 (15 % O_2) . Below figure (6.10 of section 6.3.3.3 of BREF D1) y-axis has a reference point of 3 % O_2 which should be changed to 15 % O_2 in order to be consistent with the obtained field measurement data ! In order to achieve the 100 - 110 mg/Nm^3 (15 % O_2) SO_2 level an about 75 % reduction is needed in the Maltese stationary RICE plant burning a low sulphur HFO containing 0.694 wt-% S. For a HFO containing 3 wt-% S an about 94 % SO2 reduction should be needed which should be possible for a dry FGD only with a high reagent overstochiometry (see Annex 3). To be remembered is that with this type of FGD the reagent is to be sent to a treatment plant (see above). **Thus for many locations this kind of FGD technology is not viable if the existing infrastructure is not good enough and full heat recovery exhaust boilers are installed in the plant (for needed flue gas cooling, see above).** In existing plants the extra needed space of the FGD unit might also be a big obstacle. With all FGD types the end product should be disposed or recycled in an environmentally acceptable way, as earlier stated Na_2SO_4 main by-product composition of the $NaHCO_3$ FGD needs special treatment which is not possible in all locations around the world.

To TWG: Data and plot will be updated once the questionnaires from the plant 362, 363, 364, 365 are provided (expected for September 2013).

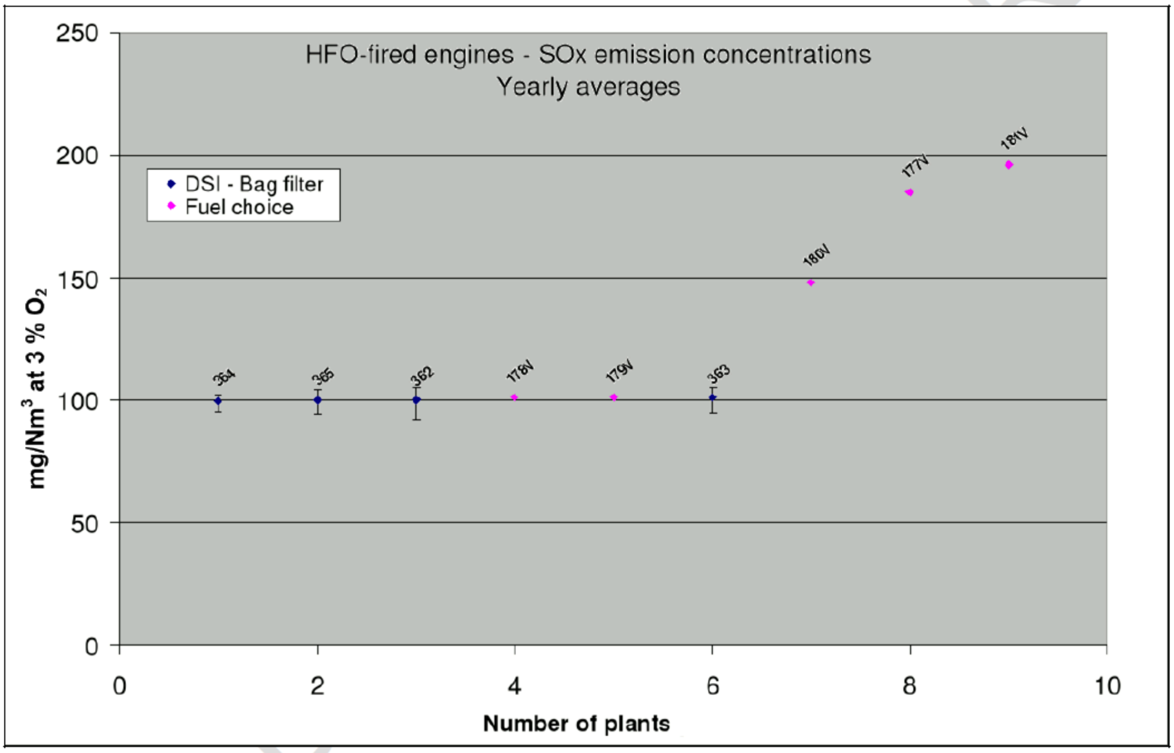


Figure 6.10 HFO-fired engines – SO_X emission concentrations, yearly averages; 5th and 95th percentiles of short-term values are represented as span bars

Note in table 6.5 of secrtion 6.2.4 of BREF D1 a SOx (SO_2 ?) span based on obtained field data from HFO fired stationary RICE plants is give of 100 . 560 mg/Nm3 (15 % O2). Both plants applying only primary SO2 (such as choice of low sulphur S HFO) abatement methods (high span values) **or** FGD seem to be included in this span. **This shows that for plants for which FGD is not feasible (see above texts) alternative higher BAT AELs are needed than proposed !**

Question: Has SOx or SO2 reported ?

In the BREF cover letter /9/ on page 4 is stated: " *The data on sulphur emissions to air, collected through the questionnaires, are expressed as SOx (**being the mixture of SO2 and SO3 expressed as SO2**), and **not as SO2.** Having been provided with such data and **not having received any comment about this pollutant, we assume that the provided data indeed represent SOx emissions. Therefore, the EIPPCB proposes BAT conclusions for SOx emissions to air based on the data collected*** "

EUROMOT Response: We have studied the obtained field emission data (from the HFO fired stationary RICE plants) gathering sheets and **we conclude that reported emissions are probable only SO2 and not SOx as SO_2. → Only SO_2 component shall be regulated, NOT SOx ! For more information see document /10/.**

Dust (particulate, dry dust),

In the Maltese plant ("plants" 362 – 365) a low ash 0.024 wt-% and sulphur 0.694 wt-% HFO is used resulting in particulate emissions in estimated range of < 50 mg/Nm^3 (15 % O_2) out of the engine. In below picture (6.11 of BREF D1) the reference point on the y-axis shall be 15 vol-% O_2 in order to be in line with obtained field measurement data. The particulate measurement method should also be stated (we assume EN 13284-1 measurement method or other principally similar method). **As has already been stated above performance of secondary abatement techniques usually degrade with time due to wear and tear of the filter and thus it is highly likely the proposed extremely low BAT AELs might be only achievable with new fresh filter bags**. **Thus proposed BAT dust limits in table 10.22 of BREF D1 based on Maltese plant emission data have to be modified.** To note also is the maximum temperature issue for the bag filter material and thus in many RICE plants this technique is not applicable. This is especially the case for peaking plants and seasonal now and then operated RICE plants. In existing plants the extra needed space of the bag filter unit might be a big obstacle. **!**.

To TWG: The total operating hours are not an appropriate parameter because the plants have been run only a few weeks since the commissioning period. Data and plot will be updated once the questionnaires from the plant 362, 363, 364, 365 are provided (expected for September 2013).

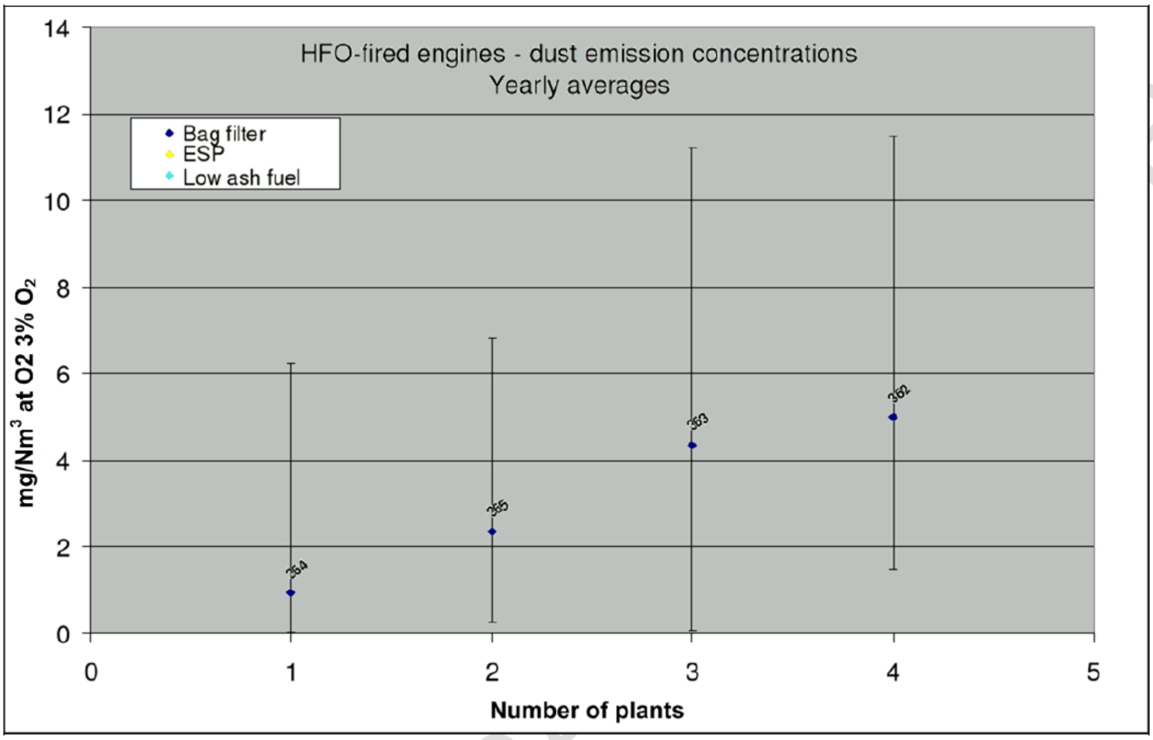


Figure 6.11 HFO-fired engines – dust emission concentrations, yearly averages; 5th and 95th percentiles of short-term values are represented as span bars

Note in table 6.5 of section 6.2.4 of BREF D1 a dust span based on obtained field data from HFO fired stationary RICE plants is given of 1 ... 200 mg/Nm3 (15 % O2). Plants applying only primary dust (such as choice of low sulphur S/ash HFO) abatement methods (high span values) **or** the bag filter FGD seem to be included in this span. **This shows that for plants for which the bag filter FGD or other secondary abatement technique such as ESP is not feasible (see above text), higher than proposed BAT AELs are needed !**

TOC:

Only in table 6.5 (section 6.2.4) TOC data for stationary HFO fired RICE plants (as 15 – 75 mg/Nm^3 (15 % O_2) are given in chapter 6 of BREF D1. Nevertheless, in table 10.20 BAT associated emission level of TOC are set lower i,e. 10 – 40 mg/Nm3 (15 % O2). To note is **that in the referred reference plant of table 10.20 (Maltese one) NO TOC emission measurements were done !** When checking the obtained field measurement data from UK, Greece and Portugal one can see that TOC was measured only in some Portuguese stationary RICE plants.

"Cherry picking" seems to have occurred. It is not technically sound to select best emission data from different plants and combine as now done. Furthermore, Euromot sent an e-mail to EIPPCB /7/ and pointed amongst all out that a check of most of the Portuguese TOC measurement results are too low and need a check. E.g. the engine manufacturer of reference 427-8 has also informed that TOC emissions from a new well maintained engine should be higher than reported value - Note that measured TOC value in reference 427-7 starts to be in the correct range for a new well maintained big engine (same engine type in same plant and difference between references 427-7 and 427-8 is 400 %. Measurements based on only a few samples → **big variation errors** .. measurements seem to be difficult to conduct in field conditions !).

BIG changes of the TOC BAT range text is needed. TOC emission is dependent on the engine condition and load and might therefore vary a lot from time to time. The challenge is that when operating on HFO an oxidation catalyst cannot be used due to poisoning effect of the impurities in the fuel. **Then best cost effective way to reduce TOC is to perform scheduled maintenance of the engine as also the current EU LCP BREF 2006 proposes in chapter 6.5.5.5. and no limit value is stipulated*.**

CO:

Only in table 6.5 (section 6.2.4) CO data for stationary HFO fired RICE plants (as 40 – 200 mg/Nm^3 (15 % O_2) are given in chapter 6 of BREF D1. But in table 10.20 BAT associated emission level of CO is set lower i,e. 50 – 100 mg/Nm3 (15 % O2). To note is **that in the referred reference plant of table 10.20 (Maltese one) CO emissions measured were higher (average 119 – 136 and peak upto about 196 mg/Nm^3 (15 % O_2)**), BAT span is based on measurements from some other plant **–** CHERRY PICKING**!** . CO emission is highly dependent on engine condition and load and might therefore vary a lot from time to time. The challenge is that when operating on HFO an oxidation catalyst cannot be used due to poisoning effect of the impurities in the fuel. **Then the best cost-effective way to reduce CO is to perform scheduled maintenance of the engine as also the current EU LCP BREF 2006 proposes in chapter 6.5.5.5. and no limit value is stipulated.**

ANNEX 3

Sodium based Dry FGD (Main Reactions)

$NaHCO_3$ (dry) as reagent

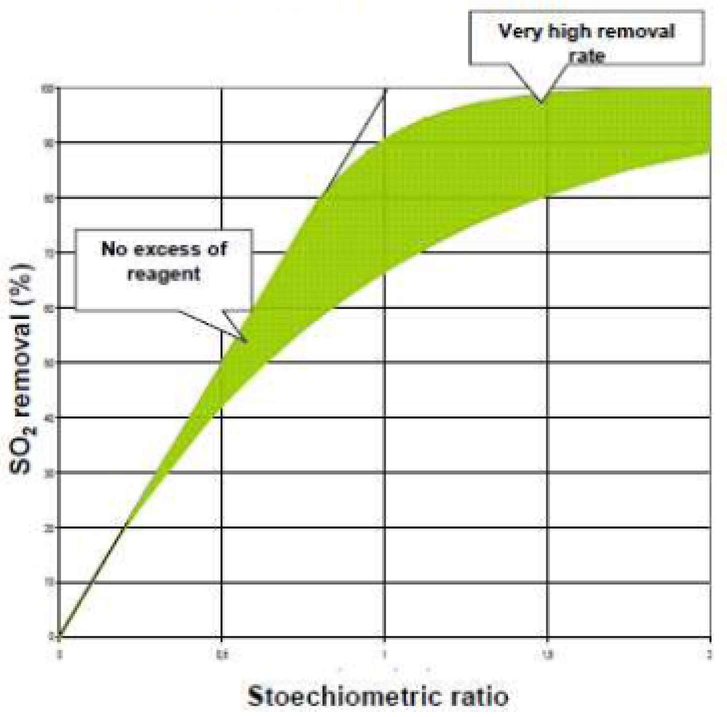
$$2\,NaHCO_3 \rightarrow Na_2CO_3 + H_2O + CO_2$$

$$Na_2CO_3 + SO_2 + \tfrac{1}{2}O_2 \rightarrow Na_2SO_4 + CO_2$$

NOTE:

SO_2 reductions of up to 50 % can be achived in conditions close to stoichiometric. Higher SO_2 reductions require overstoichiometries of 1.2 – 1.5 At overstoichiometries the end-product contains a lot of unreacted sodium carbonate and bicarbonate.

SO2 removal with NaHCO3



SOURCES

/1/ Euromot Position Paper at
http://www.euromot.org/download/a625184f-9f85-4a64-9551-0f9437b393d8/GENERAL%20engine%20emission%20legislation%20TA%20Luft%202002%2010.pdf

/2/ UNECE Gothenburgh Protocol Guidance Document on Control Techniques for emissions on ... at
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/3/ UNECE: EGTEI cost stationary engines at
http://www.unece.org/fileadmin/DAM/env/documents/2011/eb/wg5/WGSR49/Informal%20docs/17_EGTEI-Cost-stationary-engines-UNECE-06-04-2011.pdf

/4/Euromot Position Paper at
http://www.unece.org/fileadmin/DAM/env/documents/2011/eb/wg5/WGSR49/Informal%20docs/9_UNECE_Gothenburg_EUROMOT_Position_final_2011-08-16.pdf

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/7/ Euromot e-mail on 17th of May 2013 from P. Zepf to T. Lecomte

/8/ LCP BREF 2006 at http://eippcb.jrc.ec.europa.eu/reference/BREF/lcp_bref_0706.pdf

/9/ BREF cover letter “**Consultation on the first draft of the revised Best Available Techniques Reference Document for the Large Combustion Plants” dated Seville,27th June 2013**

/10/ Euromot Position paper “ General Comments regarding draft BREF D1 covering Large Combustion Plants”, September 2013, available at Euromot public internet page.

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