Euromot

Emission Legislation for Stationary Gas and Diesel Engines in the Netherlands

The Euromot Position

as of 29 October 2007

EUROMOT

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ENGINES IN SOCIETY

Associations Register at the Local Court Frankfurt /M. No. VR4278

Euromot is the **European Association of Internal Combustion Engine Manufacturers**.

We represent the leading manufacturers of internal combustion engines used in a broad range of nonroad and marine applications (construction, mining and material handling equipment, trucks and buses, agricultural and forestry equipment, lawn/garden and recreational equipment, commercial marine and seagoing vessels, workboats and pleasure boats, rail traction, power generation).

Euromot has been working for many years with international regulatory bodies, e.g. European Union, the UN Economic Commission for Europe (UNECE), the UN International Maritime Organizations (IMO) and the Central Commission for the Navigation on the Rhine (CCNR). In addition, we are seeking an open and fair dialogue with national governments to provide reliable know-how on advanced internal combustion engine technologies in general and, in particular, on the feasibility of environmental as well as cost-effective product regulations. To achieve a pro-active engagement of all stakeholders in international harmonisation of regulations affecting engines and equipment, we coordinate our activities worldwide with trade associations of the nonroad and marine industry sector.

For further information about our Association please pay us a virtual visit at **http://www.euromot.org** – your bookmark for engine power worldwide.

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Executive Summary of Euromot concerns and recommendations

- For a reciprocating internal combustion engine power plant the emission concentration reference oxygen point 15 vol-% O_2 is the logical choice.

- It is not correct to apply the LCP EU BREF limits on power plant installations below 50 MWth; the cost picture will be very different.

- NOx:
  - The proposed NOx-values for stationary Diesel engines are only reachable by usage of an very efficient adequate exhaust gas after treatment (namely SCR) that implies inappropriate high invest- and O&M costs, especially for small Diesel engines and engines with varying load or engine that have to be started up and down several times. The transport of reagents makes the CO_2- and NO_x-balance of the whole system worse. and for some applications the technical feasibility is questionable, see below.

  - The use of a reagent (ammonia or urea) is necessary. This may cause increased ammonia slip (the catalyst activity decrease with time with varying speed depending on the used fuel composition, etc.) which might clog installed heat recovery boilers, etc. The increased transport of reagents to all stationary engine plants around the country by lorries, etc. will decrease the benefit of the achieved emission reductions. Transportation generates additional emissions of CO_2, NOx, etc. In order to evaluate the real benefit of the strict ruling a LCA (Life Cycle Analysis) should be made. The cost-effectiveness of NOx-reduction for stationary engines drops rapidly (cost increases rapidly) with reduction rates above 90%. Therefore in order to avoid excessive operation and maintenance costs (O&M) of the SCR the NOx-reduction rate should not be set above 90%. I.e. for bio oil plants the NOx-limit should preferable be > 500-600 g/GJ, otherwise the O&M cost will be excessive. Current limits of 400 g/GJ with efficiency bonuses should be maintained for liquid fired stationary engines! Note: In the EU LCP BREF document no BAT-span has been given for liquid fired stationary engine due to different operating conditions!

  - Bio gases: NOx secondary abatement technique installations for gas engines fired with renewable gases are not state-of-the-art. Further field tests, research and development are necessary. A minimum three years lead-time for testing of such systems (gas cleaning with SCR, etc.) is recommended. Current NOx limits of 140 gr/GJ_{fuel}, etc. with efficiency bonuses shall be maintained. Note in the EU LCP BREF document “split views” were given on the NOx-BAT span for stationary gas engines, the value of 190 mg/Nm^3 (15% O_2) equal to about 175 gr/GJ_{fuel} was one given proposal!

  - Natural gas: Euromot recommends not to introduce the NOx limit of 30 gr/GJ for new gas engines in CHP-mode fired with natural gas and operated in other than greenhouse applications. Furthermore we recommend not to introduce 80 gr NOx/GJ for existing gas engines.

Current NOx limits of 140 gr/GJ_{fuel}, etc. with efficiency bonuses shall be maintained. Note in the EU LCP BREF document “split views” were given on the NOx-BAT span for gas engines, the value of 190 mg/Nm^3 (15 % O_2) equal to about 175 gr/GJ_{fuel} was one given proposal!

- SO_2:
  - Fuel sulphur contents allowed in the EU directive 1999/32/EC for liquid fuels for stationary engine plants should be followed for liquid fired stationary engines. Note this is in line with the EU LCP BREF recommendation for liquid fired stationary engines! For gas fired engines the SO_2 limit shall be omitted.

- Particulate:
  - The Euro 3 “on-road high-way” standard cannot be applied on the stationary engine sector as a general rule. Stationary engines are regulated separately from the “high-way” sector e.g. in France, UK, Finland, etc. The proposed limits are too low and need to be corrected. The particulate limit should be given at 15 % O_2 (NOT at 3 % O_2), i.e. for new engines 30 mg/Nm^3 (15 % O_2) for with distillates (clean fuels) and higher for heavy fuel oil. Note this is in line with the EU LCP BREF recommendation for liquid fired stationary engines! Similar measurement standards (measurements at steady state conditions at high normal loads) as rest of the power plant sector should be used, e.g. VDI 2066 or principally similar.

1 Introduction

The following position paper represents the opinion of the engine manufacturers organised in Euromot. It describes the main concerns of Euromot relating to the ongoing update of the emission regulation process in the Netherlands (see /2/). The so called BEES B regulation is intended for power plants with a fuel input between 900 kW and 50 MW (emergency gensets are excluded). BAT (Best Available Technique) (in Dutch BTT, “Beste Beschikbare Technieken”) is required from the sources. The EU LCP BREF BAT limits (see /1/) are said to have been introduced on small plants in the Dutch BEES B draft regulation.

By 2010 the European Union (EU) Emission Ceiling Directive 2001/81/EC is to be fulfilled and EU is currently updating new stricter ceiling requirements for 2030. In the Netherlands different sectors have got own quotas (in kt/year) of the emission ceilings, that have to be fulfilled. The new BEES B limits are a tool in order to fulfil these targets.

In this document we want to draw your attention to the concerns of the piston (reciprocating) engine manufacturers especially of the proposed emission limits of Diesel and Gas engines.

- Firstly, it is not a correct approach to assume that small and bigger stationary plants can apply the same emission limits, the cost increase usually when plant size decreases. In some other countries where BAT is also to be applied on small plants, the BAT values stipulated for the small plants differ considerably from those for big plants e.g. in Finland, due to technical and economical constraints.

- Secondly, we have noticed that the EU BREF /1/ document has in many aspects not been cited correctly especially in regard of the stationary engines. E.g. wrong emission concentration reference point and BAT spans have been used in many parts of the BEES document (see text below).

The proposed emission limits are very strict, a very clean liquid fuel or a secondary abatement technique (if existing) is needed in order to fulfil the SO_2 and particulate limits for liquid fired stationary engines. For all types of stationary engines Selective Catalytic Reduction (SCR) is needed in order to comply with the proposed NOx-limits.

In our position paper we consider on one hand technical constraints and on the other hand the economic feasibilities of the proposal. In the current Dutch ruling /5/ for reciprocating engines an efficiency bonus starting from 30 % with a linear **in**crease for higher efficiency is granted for the NOx-limit. In today’s´ world with the Kyoto Protocol in focus, this innovative bonus approach should be continued and extended. We have in the text therefore made a reference to a new bonus-proposal.

2 Stationary engines

2.1 General

Euromot recommends not to mention the LCP Directive 2001/80/EC as a reference in the ongoing discussions in the Netherlands. This Directive does not cover the following installations (please see page 3): “Plants powered by diesel, petrol and gas engines shall not be covered by this Directive.”

The discussion below covers proposed new emission limit values for liquid fired stationary engines in the Netherlands. Current NOx-limits for liquid fired stationary engines are (dependent on date of license) 400-1200 g/GJ_{fuel} with a linearization starting from 30 %, SO_2 and particulate emissions are not regulated currently. Below table 1 shows an overview of the proposed new emission limit values for liquid fired stationary engines:

Table 1: Proposed limits BEES B NOx-limits for liquid fired stationary engines

Emission	New plant	Existing plant
NOx (as NO_2) g/GJ	130, 80 (option), (technical feasible after 5 years 40)	400
SO_2 mg/Nm^3 (3 % O_2)	200	200
Particulate mg/Nm^3 (3 % O_2)	30	50

Thanks to the high combustion temperature in a diesel engine, the thermal efficiency is high and
emissions of unburned gaseous components such as CO, NMHC, etc. are low. The high combustion temperature in the diesel engine, on the other hand, results in the generation of some
nitrogen oxides in the exhaust gas emissions. In chapter 3 the consequences of above limits are further discussed.

Current NOx-limits for gas fired stationary engines are (dependent on date of license) 140-800 gr/GJ_{fuel} multiplied with engine efficiency percentage/30. In below table 2 the proposed gas engine emission limits are shown:

Table 2. Proposed BEES B for gas fired stationary engines

Emission	New Plant	Existing Plant
NOx (as NO_2) g/GJ	30	80

For the SO_2 a limit of 200 mg/Nm^3 (3 % O_2) is proposed.

Modern bigger gas engine types (Spark ignition, Dual Fuel (low pressure gas)) in gas mode are usually of lean-burn type. In the lean-burn approach fuel gas and air are premixed before introduction into the cylinders, which results in a lower combustion temperature and NOx formation is efficiently reduced. This primary NOx reduction method is analogous to the dry Low-NOx combustion used in gas turbines. An added performance advantage of the lean burn operation is the higher output and higher efficiency obtained. The dual fuel engine (DF) has in liquid fuel mode emissions in the range of a liquid fired diesel engine. In chapter 4 the consequences of above limits are further discussed.

The compact size makes that the engine driven plant can be located in urban or industrial areas close to heat and electricity consumers. Thus the need for transmission lines is reduced and related energy losses and lands need can be minimised.

The high thermal efficiency is typically about 40-45 % (medium … bigger sized engine) in single cycle mode and the engines are suitability for the Combined Heat and Power (CHP) applications. The total CHP-efficiency (electrical + heat) is typically about 60-70 % in steam production and up to 80-90 % or higher in hot water generation. CHP minimises the emission of the most important green house gas, CO_2, emissions occur also during fuel production and distribution, thus a lower fuel consumption leads to a lower overall environmental burden. It should be considered that gas engines play an important role in the European and especially the Dutch electricity production. In the Netherlands several thousands MW of peak production is delivered with gas engines. The heat is stored in buffers to be used in the colder periods. This means that the efficiency is high especially as engines typically do not cause the huge transport and transforming losses that big power plants do.

Stationary engines have a fast load response, good loading following characteristics and a good part load efficiency. In the case of peak power this is even more important as peak power other wise is delivered by older power plants that show bad efficiency and high emissions per kWh delivered. This will become even more important with the growing amount of wind and solar power. These clean energy sources by nature show big and unpredictable swings in their production. Engines will be required to balance this. All this means that the effect of engines on the environment and on the total emissions in the Netherlands is much more positive than the bare emission number per kWh_{el}.

In the current Dutch /5/ ruling a high efficiency is rewarded in an innovative way in for reciprocating engines. This bonus system should be maintained and extended to all regulated emission components for efficient single cycle prime movers and processes. In document /6/ on page 8 we have proposed bonus coefficients for following applications: efficient prime movers (linearization starting point 35 or 40 % dependent on size of prime mover), combined cycle processes, combined heat and power systems, sustainable fuels (bio fuels) and for mechanical drive applications.

2.2 Emission concentration reference point (O_2 reference)

For the emission concentration reference point of the stationary engine a reference point of 3 vol-% O_2 has been used in the BEES B document. This is a reference point used for liquid/gas fired boilers in many legislations. It is however important to set emission limits close to “actual conditions”, by this approach equal requirements are set on the secondary flue gas cleaning equipment for the different prime movers “Actual conditions" is a fair approach. by this the real performance of the secondary cleaning device is best described. The approach to have the emission reference point close to the "actual conditions" is widely accepted for *boilers (liquid/gas fuels 3 vol-% O_2)* and gas *turbines (liquid/gas fuels, 15 vol-% O_2)*. Emission concentration of 3 vol-% O_2 is however for a bigger stationary engine far away from the "actual approach". Below is shortly explained why 3 vol-% O_2 is not feasible for liquid/gas stationary engines (comparison to the EU norm for boilers):

- <u>Liquid fired bigger stationary engine</u>:

  Typical "real condition data" of the flue gas (dependent on engine type): temperature 350-400°C, 13-15 vol-% O_2. In UK /7/ the particulate emission limit (oil firing) is set to 50 mg/Nm^3 (dry, 15 vol-% O_2). The secondary flue gas cleaning device such as an Electrostatic Precipitator (ESP) is to be situated after the engine before the SCR (if used) and boiler in the flue gas train, in order to protect these from fouling. For a diesel engine having 13 vol-% O_2 and a temperature of 350 degree C of the flue gas this means that the ESP is to clean the flue gas down to about 29 mg/"actual m^3" of particulate.

- <u>Oil Boiler:</u>

  Typical "real condition data" of the flue gas conditions are: temperature about 170 degree C and 3 vol-% O2. European Union stipulated in the LCP 2001/80/EC following strict dust emissions for boilers:

  - 50-100 MWth: 50 mg/Nm^3 (3 % O_2) and for bigger ones 30 mg/Nm^3 (3 % O_2). This means that an ESP situated after the boiler has to "clean" the flue gas of particulate down to about 31 mg/"actual m^3" or 18 mg/"actual m^3" depending on the plant size.

If the stipulated emission limit of 30 mg/Nm^3 is given e.g. at an artificial oxygen content of 3 vol-% for the stationary engine this means that the ESP is to work down to about 7 mg/"actual m^3", which is a **much stricter than requirement set for big oil fired boiler plants**. Using an artificial reference point such as 3 vol-% O_2, etc. for the emission limits of stationary engine driven plants is not a logical approach, as this will set very different requirements towards other competing different prime movers, hence this is not describing the required performance requirement of the secondary cleaning equipment.

In some existing legislation (Finland, UK, USA, etc.) the emission concentration reference point for stationary engines are set to 15 vol-% O_2. This is also the case in the EU LCP BREF document /1/:

- On page 404 is stated "*A diesel flue-gas typically contains 13 to 15 vol-% O_2 and therefore, the emission levels associated with the use of BAT are based on O_2 level of 15 vol-% O2, as the reference point*."
- On page 481 of /1/ is stated "... *Flue-gases from gas turbines and gas engines typically contain about 11 – 16 vol-% O_2 and therefore, the emissions associated with the use of BAT for turbines and engines have been based on an O_2 level of 15 vol-% O_2 and standard reference conditions as the reference point* .."

Conclusion:

For a reciprocating internal combustion stationary engine power plant the emission reference oxygen point 15 vol-% O_2 is the logical choice.

3 Concerns on proposed emission limit values for liquid fired stationary engines

3.1 NOx:

General aspects:

The proposed NOx-limit (for new engines) of 130 gr/GJ_{fuel} is equal to about 140 mg/Nm^3 (15% O_2) = 400 mg/Nm^3 (5% O_2). For existing plants the NOx-limit 400 gr/GJ_{fuel} is proposed. These values are only reachable by usage of an efficient exhaust gas after treatment (namely SCR) that implies high invest- and O&M costs. As an option for new plants a lower NOx-limit of 80 gr/GJ_{fuel} (about 90 mg/Nm3 (15 % O_2)) and even a said “technical feasible” limit of 40 gr/GJ_{fuel} (about 45 mg/Nm^3 (15% O_2)) after a five years transition time are proposed. These proposals and especially the two latter ones are too strict (not BAT and not even LAER (Lowest Achievable Emission Rate)) due the associated technical risks and costs. This will be further discussed below.

On page 6 in document /2/ in table “Voorgestelde greenswaarden voor NOx” is **no** BAT-span “bandbreedte emissieniveau BREF” in g/GJ given. **But** however strict limits are proposed (“Voorstel in g/GJ”) 130 down to 40 gr/GJ for new diesel engines. These values are more than 2 - 4 times stricter than the new German TA-LUFT 2002, which is usually considered to be one of the strictest norms in Europe. There is no EU Directive existing for stationary diesel engines and these are regulated nationally and vary from country to country. In Finland a cost-effective environmental approach is followed with stricter limits in cities and leaner in rural areas. The federal Italian NOx-limit is similar to the Finnish “city emission limit” 750 mg/Nm^3 (15% O_2) = about 2000 mg/Nm^3 (5% O_2) = about 700 g/GJ_{fuel}. From this can be seen that the proposed limit for existing plants is also very strict.

SCR:

SCR (Selective Catalytic Reduction) is an efficient but sensitive abatement method, which shall be used with care. In the BREF document Integrated Pollution Prevention and Control (IPPC) Reference Document on Best Available Techniques (BAT) for Large Combustion Plants /1/ following is stated on page 406 for SCR-installations in liquid fired stationary engines:

“A limitation for the applicability of SCR is given for small diesel and two-stroke engines which needs to be operated with often varying loads. These units are operated frequently on isolated systems to be operated on a number of hours only. According to the electricity demand, these engines need to be started up and down several times a day. SCR is an applied technique for diesel engines, but can not be seen as BAT for engines with frequent load variation, including frequent start up and shut down periods

due to technical constraints. A SCR unit would not function effectively when the operating conditions and the consequent catalyst temperature are fluctuating frequently outside the necessary effective temperature window. As a result SCR is part of BAT, but ***no specific emission levels are associated with BAT in general case****."*

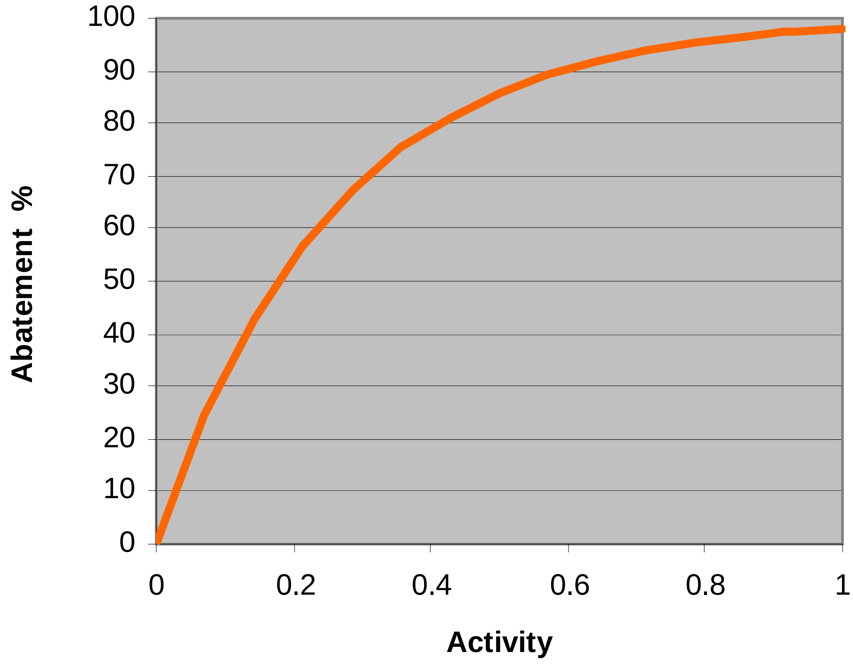
On page 360 /1/ is further stated:

- *"firstly, focus should be put on the exhaust gas temperature in order to avoid salt formation on the catalyst elements. A certain minimum flue-gas temperature, which depends on the sulphur content of the fuel, has to be maintained.* ***Some trace metals which might be present in the fuel can act as 'catalyst poisons'*** *and, therefore, the ash content of the fuel to be used should preferably be analysed before the method is installed if low grade heavy fuel oil is utilised. Most diesel plants today equipped with SCR run on low sulphur oils or natural gas. Experience has shown that when operating on heavy fuel oil or other residual fuels, a soot blowing system is to be installed in the SCR reactor in order to keep the elements clean and avoid pressure drop increases over the SCR. …*
- *thirdly, the SCR has a high capital and operating cost. …. Operating costs depend on the amount of reagent needed and on the frequency at which the catalytic elements need to be replaced or newly added to maintain the design efficiency of the SCR (after a few years of operation) …"*
- *finally, the SCR system is recommended to be subject to regular planned maintenance or inspection, e.g. annually, in order to prevent ammonia slip. For instance with high ammonia slips harmful salt deposits can occur on the internal surfaces of the components sited after the reactor, for example on the boiler."* '

With low NOx limits (high NOx reduction needs) the control system of the SCR will be critical due to the narrow operation window. At high reduction rates the size of the SCR reactor increases (in the proposal is mentioned double catalyst + oxicat) and a more complicated premixing and reagent injection system are needed, which raises the investment cost. A high NH_3/NOx ratio is needed at high NOx reduction rates, i.e. more reagent is needed, which results in higher operating costs. A high NH_3/NOx ratio may also lead to increased emission of ammonia (slip). Ammonia slip from a fresh SCR is low, but will increase with time, when catalyst activity is decreased. NH_3 is also contributing to the acidification and regulated in the EU Emission Ceiling Directive 2001/81/EC. NH_3 should therefore be kept as low as possible.

The limit of 400 g/GJ with efficiency bonuses means that an about 75-80 % NOx reduction need is needed when burning a bio fuel (such as palm oil) in a new liquid fired stationary engine and about 94-98 % reduction (130 .. 40 g/GJ_{fuel} limits without efficiency bonuses impact) with proposed values. From below graph 1 can be seen that the activity needs to be increased a lot in order to achieve efficiencies above 90 %, in other words the *cost-effectiveness drops rapidly (cost increases rapidly) with reduction rates above 90 %* !

Activity of the SCR is decreasing due to chemical (due to certain trace metals, etc.), physical (deposition, erosion, (soot blowing needed for liquid fuels and an appropriate temperature to avoid condensation of ammonium-sulphate) and thermal (sintering due to temperature shocks) deteriorations.



Graph 1: Typical activity versus abatement % relationship for SCR.

SCR is as above stated sensitive to some trace metals ("catalyst poisons") such as Na, K, Ca, Mg, As, Se, P, etc. which can be found in different concentrations in the fuels. Liquid bio fuels contain impurities and amongst all one of the most critical ones namely P, a strong well-known catalyst deactivator. It has been seen in field conditions that bio fuels tend to deactivate the catalyst more rapidly than fossil fuels, in a reference plant operating on a good quality refined bio fuel oil the deactivation during the first year was corresponding to a deterioration experienced during a five year operation with fuel oils. It should be noted that the quality and composition of available bio fuels might vary greatly. The cost of the catalyst elements of the SCR might represent up to an about 40-50 % of the total SCR investment cost. If during the first year 2 of 3 layers have to be changed due the rapid deactivation it is almost equal to a cost of about 30% of the SCR investment cost.

Therefore in order to avoid excessive O&M costs (BAT) of the SCR the NOx-reduction rate should not be set above 90 %. I.e. for bio oils limit should preferable be > 500 -600 g/GJ. Current limits of 400 g/GJ (new source), etc. with efficiency bonuses should be maintained!

Conclusion:

The current NOx-limit of 400 g/GJ with efficiency bonuses for new stationary liquid fired engines should not be reduced. The existing plant limit should also be maintained. Stricter NOx-limits will increase the O&M costs tremendously and are not representing BAT.

3.2 SO_2

Liquid fuels:

The limit is set to 200 mg/Nm^3 (3 % O_2), this equal use of a light fuel oil with a maximum sulphur content of 0.1 wt.%. In document /2/ on page 5 in table "voorstel grenswaarden voor SO_2" is also a reference made to the EU BREF/1/ document regarding the BAT span. It is to be noted that the given BAT-span cited seems similar to those in table 6.43 at page 399 of the BREF document /1/ for boiler plants 50-100 MWth. It should be noted that liquid fired diesels have an own BAT recommendation on page 406 /1/: *"… the use of low sulphur fuel oil or natural gas , whenever commercially available is regarded as the first choice of BAT…".* **I.e. no SO_2-BAT level-span is set for the liquid fired stationary engine in the EU LCP BREF document**!

Conclusion:

Fuel sulphur contents allowed in the EU Directive 1999/32/EC for liquid fuels for stationary engine plants should be followed for the liquid fired stationary engines. For gas fired plants the SO_2 limit should be omitted.

3.3 Particulate

Liquid fuels:

The limit is set to 30 mg/Nm^3 (3 % O_2), in document /2/ (page 6 in table "voorstel grenswaarden voor fijn stof") **no** reference is made to the EU BREF/1/ BAT ("geen", not existing?). But in the BREF document /1/ a BAT span is given for liquid fired stationary engines (see below). On page 12 in document /2/ is referred to the Euro 3 standard and drawn a conclusion that the proposed limit is achievable. It should be noted that Euro 3 is a high-way engine regulation. Stationary engines can also operate on various fuel qualities such as bio oils, heavy fuel oils, etc. and this engine category has therefore its´ own norms/ruling in many countries such as in France, UK, Finland, etc. High-way engines are usually using good quality distillates. **Therefore Euro 3 can not be applied on the stationary engine sector!**

On page 405 EU BREF /1/ is given following BAT-levels (table 6.47) for the stationary engine plant:

- Diesel engine operating on HFO (Heavy Fuel Oil): 50 mg/Nm^3 (15 % O_2)
- Diesel engine operating on LFO (Light fuel Oil): 30 mg/Nm^3 (15 % O_2)

In the text above the table is stated: "*A large capacity plant can also exist of a number of several aggregates with comparatively small capacities. In this case, each individual aggregate can be equipped with filters for particles, especially soot. Dust emissions from engines of up to 1.3 MW fuel input can be reduced below emission values of 20 mg/Nm^3*". For bigger engines (note limits given above) is said in the text: *"... for larger diesel engines, the use of engine measures in combination with the use of ash and low sulphur fuel, whenever commercially available, can be considered as BAT for reducing particulate emissions*".

The proposed limit 30 mg/Nm^3 (3 % O_2) = about 10 mg/Nm^3 (15 % O_2) is technically not feasible for bigger engines, see pages 5-7 of Euromot document /3/. No proven secondary technique exists for time being.

Used measurement standard should be VDI 2066 or principally similar other methods as used in the stationary power plant sector. For further information, please see CIMAC document annex 2 /4/.

Conclusion:

Proposed particulate limit is too low and needs to be corrected. The particulate limit should be given at the reference point 15% O_2 (NOT at 3 % O_2), i.e. 30 mg/Nm^3 (15 % O_2) for distillates (clean fuels) and higher for heavy fuel oil. Similar measurement standards (measurements at steady state conditions at high normal loads) as rest of the power plant sector should be used, e.g. VDI 2066 or principally similar.

4 Gas engines

4.1 General concerns - gas engines

BREF (LCP) and BAT: The BREF's are for installations >50 MW thermal input. SCR installations for small gas engines are not BAT. For small gas engines costs for SCR installation (investment and maintenance costs) will be prohibitive and disproportional high unless the new NO_x limits are accompanied by a good support scheme. Note that not only the equipment costs but also installation costs, maintenance costs and the costs for the extra space have to be considered. Many existing sites do not have the space available required for the equipment needed to reach the proposed NOx-limits in case a new engine has to replace an existing one. This will increase the costs considerably.

The proposed NOx-limit of 30 gr/GJ_{fuel} for new plants is equal to about 30 mg/Nm^3 (15 % O_2) = 80 mg/Nm^3 (5% O_2). This value is only reachable by usage of an adequate exhaust gas after treatment (namely SCR) that implies high invest- and O&M costs. As an option a NOx-limit of 80 gr/GJ_{fuel} (about 80 mg/Nm3 (15 % O_2) = 210 mg/Nm^3 (5% O_2)) is proposed for existing plants.

On page 6 in document /2/ in table "Voorgestelde greenswaarden voor NOx" is a BAT-span "bandbreedte emissieniveau BREF" in g/GJ given. Limits proposed ("Voorstel in g/GJ") are 17 up to 64 g/GJ_{fuel}. On page 481 in the EU BREF /1/ a NOx-BAT span of 20 .. 75 mg/Nm^3 (15 % O_2) (about 18 .. 70 g/GJ_{fuel}) for new and 20 .. 100 mg/Nm^3 (15 % O_2) (about 18 .. 93 g/GJ_{fuel}) for existing engines are proposed.

But it is not noted that in the same table in /1/ is **given "split views**" (in sub-header) that BAT value is 190 mg/Nm^3 (15 % O_2) (about 175 g/GJ_{fuel})! On page 7 in /2/ is referred to the UNECE Protocol NOx value equal to about 80 g/GJ_{fuel}, industry has in several position papers explained that the **UNECE Protocol is not representing** BAT /8, 9/. UNECE NOx-limits will for lean-burn engines lead to a decreased total efficiency and increased emissions of unburned gaseous species (not according to the ”Kyoto spirit”).

For further general aspects, please see chapter 2 above.

4.2 Gas engines fired with renewable fuels

Gas engines fired with renewable gases (biogas, sewage gas, etc.) are predestinated for CO_2 reduction and thus reduction of global warming and climate change. They offer a huge potential to reduce CO_2 and to deliver heat and power if they are used in the CHP-mode (combined heat and power) without using fossil fuel. Experience shows that a gas engine can work in CHP-mode even with an efficiency of 90%.

In respect of the Kyoto Protocol gas engines operated in CHP-mode should be promoted in order to decrease specific CO_2 emissions. The contribution of the high efficiency of engine power plants to reduce CO_2 (“the most important green house gas”) is however not honoured by stipulating a NO_x-limit of 30 gr/GJ for new engines. For biogas fired engines common standard NOx-value is 190 mg/Nm3 (15 % O_2) about 175 g/GJ_{fuel}. Lower NOx-levels are in general possible, but these gas types shows typically contaminations (e.g. volatile organic silica compounds: siloxanes, silanes, etc.) which have a indirect impact on the combustion parameters by deposits in the combustion chamber and so on the related emissions. Furthermore Euromot would like to point out that SCR installations for gas engines fuelled with renewable gases are not available. The components in the exhaust gases (trace elements) of gas engines fired with renewable gases are destroying (“poisoning”) the catalyst elements.
The engine industry is working on technical solutions but at the moment there are currently no viable, durable and cost-effective solutions available.

Thinkable is to implement gas cleaning installations before the renewable gas is burned. But this technology is not proven. More research and development activities of the engine industry are necessary. These activities will take time, it is not yet clear if the NOx reduction by using gas cleaning installations is constant over the total engine lifecycle. These systems are not state-of-the-art at the moment. It is clear that the maintenance costs for these installations will be very high. Further long term field test are necessary. Euromot estimates that a minimum 3 year-lead-time for the development of suitable NOx reduction systems for gas engines fired with renewable gases is needed. The costs for NOx reduction are very high and this will mean a further burden for the engine industry. This will have a negative impact on the development of gas engine applications that are operated with renewable gases. After-treatment Installations will have an enormous economic impact and will be a huge financial burden for the engine operators. The NOx-proposal is **not** according to BAT principle. According to BAT the techniques are to be existing on a scale which allows implementation in the relevant industrial sector, under economically and technically viable conditions, taking into consideration the costs and advantages.

4.3 Gas engines fired with natural gas

The greenhouse industry uses a lot of gas engines fired with natural gas and has an enormous demand for CO_2. This industry needs CO_2 as fertiliser. Therefore this industry implements SCR technology due to the fact that the CO_2 has then an adequate quality for the use in the greenhouse.

This is not the case for other CHP markets. As these markets also are barely cost effective at the moment they will be stopped completely when SCR is forced upon them without any financial compensation by introducing the new NO_x limit of 30 gr/GJ. The consequence will be that this efficient technology will not be used in applications outside the greenhouse industry. This will increase the output of the emissions of big power plants and boilers that will then deliver heat and power instead of high-efficient gas engines. Especially the total emission of CO_2 will be much higher compared to the cogeneration with gas engines.

For gas fired lean-burn engines the common standard optimum NOx-value is 190 mg/Nm3 (15 % O_2) about 175 g/GJ_{fuel} with minimum unburned emissions and minimum fuel consumption. We would like to highlight that it is technically possible for new bigger engines to meet the reduced NO_x limits according to the UNECE Gothenburg Protocol. However, in order to meet these reduced NO_x values gas engines will have an increased fuel consumption, higher maintenance costs and higher emissions of unburned gaseous species (CO, CH_4, etc.). An increased fuel consumption means more CO_2 emissions. Please note that reduced NO_x “UNECE”-values are technically not reachable for all existing engines.

Conclusion:

Euromot therefore recommends not to introduce the NO_x limit of 30 gr/GJ for new gas engines in CHP-mode fired with natural gas and operated in other than greenhouse applications. Furthermore we recommend not to introduce 80 gr NO_x/GJ for existing gas engines. Current limit values e.g. 140 g/GJ_{fuel} with efficiency bonuses for new engines shall not be lowered. E.g. 140 g/GJ_{fuel} is equal to the overall “optimum” NOx-level of 190 mg/Nm_3 (15 % O_2) = 175 g/GJ_{fuel} for high efficient lean-burn gas engines. ! Limits for existing engines should also be maintained (in many plants no space is available required for the equipment needed, etc.).

5 Conclusion

In above text the proposed limits in the Netherlands for liquid and gas fired stationary engines have been discussed. Amongst all following has been discussed:

- In the BEES B document references are made to the EU LCP BREF document, but it has been shown that some of the used reference values are not intended for stationary engines but for boiler plants. The O_2-reference point seems also to have been taken from the boiler section of the BREF document. In the document it is shown that for a bigger stationary engine the logical emission concentration O_2-reference point is 15 vol-% O_2. Stationary engines have their own emission limits (different from boiler limits) as shown in the EU BREF document. In our opinion it is not correct to apply the LCP EU BREF limits on power plant installations below 50 MWth, the cost picture will be very different.

- Certain fuel compositions put technical constraints of the SCR performance, this is the case with bio oils and gases, certain fuel impurities present in the flue gas will fast deactivate the catalyst. Installation of SCRs on all stationary engines (small and big ones) in the Netherlands will as a consequence imply more transportation of reagents to the different sites by lorries, etc. In order to see the real benefit of regulating also smaller plants than 50 MWth strictly a LCA (Life Cycle Analysis) should be made on the additional transportation and manufacturing impact of urea/ammonia on the total NOx/CO_2-emissions.

- Set SO_2 and particulate limits for liquid fired stationary engines are too strict. In the EU LCP BREF document stationary engines have their own BAT-span and this have not been considered in the BEES B proposal, In the proposal the stationary engine has been compared to the high-way diesel (Euro 3 discussion), which is not correct. In many countries stationary engines have their own ruling very different from the high-way sector.

- We have in the above text also made counter proposals in order to maintain the cost-effectiveness and technical feasibility of the stationary engine plant. Emission bonuses as existing in present emission ruling shall be maintained ("in the Kyoto spirit") and enlarged to the new regulated emission components is also proposed.

Vaasa / Frankfurt/M., 2007-10-29

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