WGSR 49 – Dual Fuel Engines

WWW.EUROMOT.EU

EUROMOT

Gothenburg Protocol: Dual Fuel Engine

Regarding Dual Fuel Engines (DF Engines), the experts of EGTEI concluded:

"ELV 3

The emission limit value of 380 mg NOx/Nm3 for dual fuel (DF) gas engines in gas mode, can be complied with the lean-burn principle (primary measures) of the engine with optimum fuel consumption and lowest unburned gaseous emissions of CO, etc., which is according to the IPPC principle and have been considered to ***represent also BAT for DF engines in gas mode****. The* ***limit value of 380 mg NOx/Nm³*** *(15 % O_2) for DF engines in gas mode has* ***following additional advantages (besides those listed above) compared to the limit value of 190 mg NOx/Nm3: … higher flue gas temperature, easier to tune at site (DF engine is sensitive to differences in gas compositions).***"

Source: ECE/EB.AIR/WG.5/2009/18 see page 30
http://www.unece.org/env/documents/2010/eb/wg5/Informal%20documents/Info%203.%20Annex%20V_BAT-ELV-explanation-final.pdf ,

EUROMOT

GP: DF Engine - Additional explanation

- A DF engine is designed to run both in gas and liquid fuel modes. NOx emissions are optimised for 190 / 380 mg/Nm^3 (15 % O_2) **in gas mode**.
- With pipe line quality gases (Methane Number (MN > 80)) it can be tuned in gas mode to 190 mg/Nm^3 (15 % O_2) NOx with **sufficient optimum properties** (see however previous slide).
- A higher NOx limit of 380 mg/Nm^3 would enable development of optimized mitigation measures (best control system, etc.) to the **detrimental effects** (and minimize cost impacts) of the future planned EU EASEE Gas Directive – some expected impacts on DF engine are described on slides 6 and 7

  → Note: The general Euromot Position Paper regarding the effects of Gas Quality on Engines is available at http://www.euromot.org/download/ec4913cb-48f7-45ad-8aae-b5f5fe69cc10/GAS%20QUALITY%20euromot%20position%202011_05.pdf
- **Note:** DF engines are ignited by a pilot liquid fuel in gas mode. The pilot fuel creates **higher** NOx due to diffusion combustion.

EUROMOT

GP: DF Engine - Additional explanation II

- In order to have the engine cylinders operating in the optimum point for highest thermal efficiency and combustion stability the operating point has to be between **(close to) knocking** and misfiring

→ **The optimum point for a natural gas fired DF engine is at NOx 380 mg/Nm^3 (15 % O_2) for a broad gas span.**

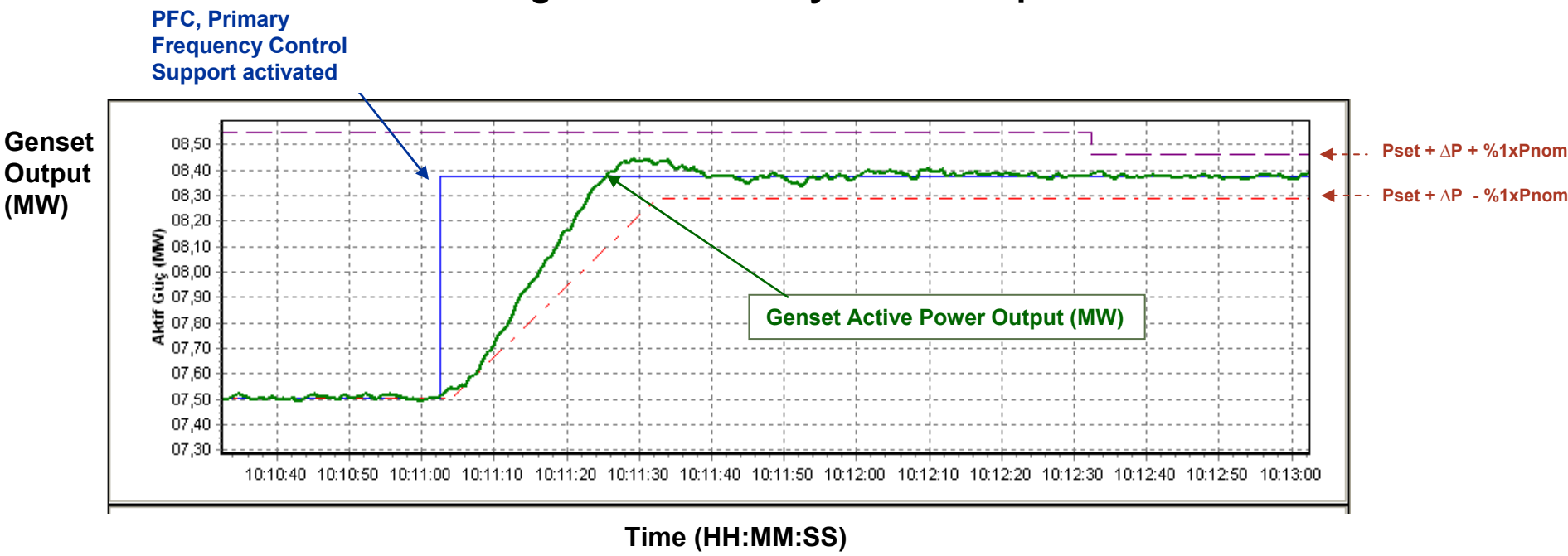
- On (gas mode) NOx level 190 mg/Nm^3 (15 % O_2) the DF engine will run closer to the misfiring limit thus consuming more gas leading to higher CO_2, other unburned gaseous emissions and less load stability.

EUROMOT

GP: DF Engine - Additional explanation III

- On lower NOx level (190 mg/Nm^3 (15 % O_2)) the DF engine will run closer to the misfiring limit thus having a **less load stability** especially with low MN gases
- According to ISO8528-5 G2 the allowed steady state load fluctuations are < 1,5 %
- At NOx level 380 mg/Nm^3 (15 % O_2) this can **easier be fulfilled** with DF engines **on a broad gas quality range**.

Graph 1: Typical pure gas engine field snapshot (high MN gas case). Allowed engine load stability variation span and actual load variations



Additional Explanation IV

At lower methane numbers (MN, typically below 80), DF engines in gas mode have to be derated **and** tuned “leaner” in order to avoid knocking. As a consequence the **efficiency and output power of the engine decrease**. At lower MN fuel gases **NOx emission** from the engine **tends to increase** due to earlier ignition of the gas (“earlier ignition --> **hotter combustion**”).

One option to avoid ”extreme lean combustion” is to add **more ignition energy**, i.e. to use more liquid pilot fuel **but this should lead to higher NOx emissions.**

I.e. needed engine adjustments to cope with low methane number (MN) gases is a matter of operation safety and higher NOx values are then unavoidable.

EUROMOT

Additional Explanation IV continues

Stipulating a NOx limit of 380 mg/Nm^3 (15 % O_2) for lower MN gases would give possibilities to minimize the decrease in engine efficiency (and derating (= lower engine output)) and thus minimize **huge cost-impacts associated to the expected future EU EEASE GAS Directive** by allowing industry to develope an optimized engine control system enabling the engine to operate closer to the knocking limit.

Conclusion:

The NOx limit of 380 mg/Nm^3 (15 % O_2) limit is needed for low MN gases !

EUROMOT

Footnote addition to Annex V

EUROMOT proposes to take account of the EGTEI experts opinion regarding DF engines by adding a new footnote to Table 4 ("Limit values for NOx emissions released from new stationary engines"):

d) Where the gas quality available has a lower MN (< 80) following emission limit value may be applied for dual fuel engines during:

- dual fuel engines: max. 380 mg/Nm^3 in gas mode (The reference oxygen content is 15% O_2).

EUROMOT

EUROMOT