EUROMOT

The European Association of Internal Combustion Engine and Alternative Powertrain Manufacturers

POSITION PAPER

Power Plant Emission with Hydrogen as Energy Carrier

19 November 2025

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Executive summary

The current normalisation method for correcting emission concentrations, in particular nitrogen oxides (NO_x), to reference conditions adds a burden (an increase) of about 37% on hydrogen (H_2) compared to natural gas when converted to pollutant mass flow per used fuel energy quantity (mg/MJfuel) .This emission concentration increase is mainly attributable to the higher H_2O content and the absence of CO_2 in the exhaust gas when utilizing pure hydrogen. In view of this, EUROMOT members have agreed to support a correction factor of 1.372 for NO_x (concentration) emissions when pure (100 vol-%) hydrogen is used. For blends of hydrogen and natural gas used as fuel, there should be a range according to the vol-% share of hydrogen defining an increase of concentration (natural gas) ELVs between 1 and 1.372. *This in order to adequately reflect the specific combustion characteristics and associated complexities.*

1. Introduction

Introduction of Hydrogen is part of the ambitious targets of the European Union to reduce emission with 55% by 2030 (compared to 1990 levels) and become climate neutral by 2050. There are several actions initiated and one of them is to reduce the usage of natural gas (Methane) as fuel.

Methane will be substituted with hydrogen, as a consequence the usage of Hydrogen would increase from 2% in 2022 to 10% by 2050 of the total energy market in Europe*. The Hydrogen fuel is considered as a green fuel as no CO_2, CO emissions are emitted despite NO_x emissions are still generated.

As a consequence, there are clients looking for Hydrogen ready technologies already today and engine manufacturers need to give if not guaranties at least indications of the emission levels for H_2.

Compared to Methane (CH_4) Hydrogen (H_2) does not have a carbon molecule, therefore there will be no CO_2, CO emissions from combustion. Anyway, when burning Hydrogen, nitrogen from the combustion air reacts with oxygen and forms NO_x emissions. There are secondary abatement techniques (such as SCR technology) available, if primary methods depending on the case are not sufficient enough.

Fuel Factor (flue gas volume (m^3) per unit of useful (net) thermal energy (MJ), supplied by the fuel is for hydrogen about 30% lower compared to Methane.

Due to reduced dry gas, more H_2O, and no CO_2 in the exhaust from hydrogen combustion, the measured NOx concentration normalized to 15% O_2 reference conditions result to 1.372 times higher emission value than with methane combustion —if hypothetically assuming the same pollutant mass flow produced per unit of fuel energy ($\mathrm{mg_{NOx}/MJ_{fuel}}$).

2. Correction of NO_x emission for Hydrogen fuel

The current large combustion plant (> 50 MWth) standard for emission reporting in the European Union is stipulated in consolidated **Directive 2010/75/EU (as amended by Directive 2024/1785)** (Industrial Emissions Directive – "IED"). Emissions are reported dry in **mg/Nm³ at standard conditions** (0 °C, 101.3 kPa, dry gas, 15% O_2 reference) for engines.

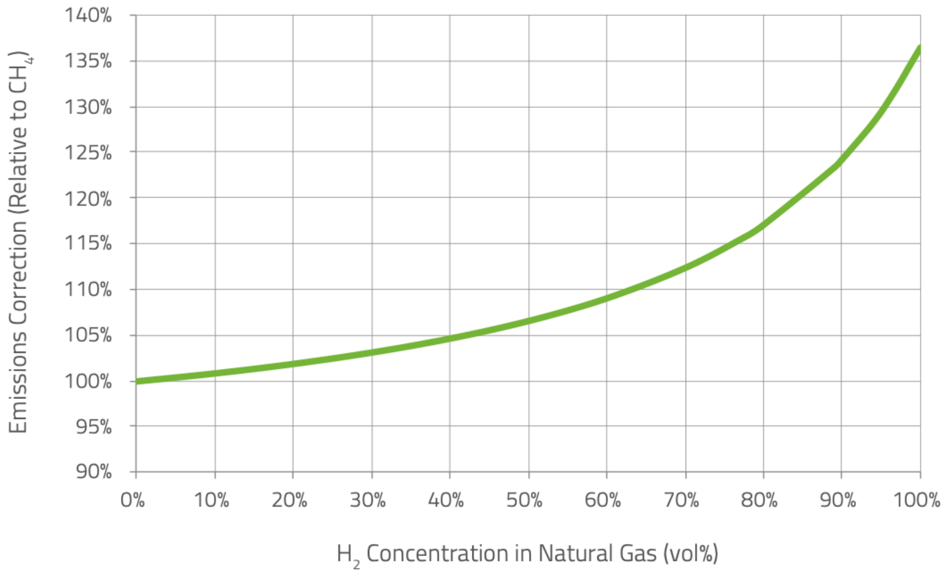
Hydrogen is generally regarded as a clean fuel, since no CO_2 is emitted during combustion. However, NO_x emissions are still generated:

- **Methane combustion**
  - Produces both CO_2 and H_2O.
  - Typical dry flue gas main composition: ~3–5% CO_2, ~10-12% O_2 (depending on lean burn engine type), balance N_2.
- **Hydrogen combustion**
  - Produces only H_2O (no CO_2).
  - Typical dry flue gas main composition: negligible CO_2 (~0%), higher O_2, Balance N_2. Wet gas has significantly increased H_2O fraction.

In accordance with EU Directives, NO_x emissions are expressed as **ppm or mg/Nm³ @ 15% O_2 dry**. This requires a correction formula in which all H_2O is mathematically removed from the flue gas, leaving only the "dry" components (N_2, O_2, CO_2, NO_x, etc.) to calculate emission concentrations.

Because hydrogen combustion produces no CO_2 and a much higher water vapor content, the corrected NO_x emission concentration appears **~37% higher** - in the hypothetic case with same pollutant mass flow per used fuel energy quantity (mg/MJ_{fuel}) from the stack. This increase arises from the correlation method which was originally made for carbon containing fuels and not considering the specific characteristics of the carbon free fuels.

To address this, **EUROMOT proposes the introduction of a NO_x concentration correction factor** linked to the hydrogen vol-% share of the mixed fuel gas (natural gas/H_2) mix. For operation on 100% hydrogen, the proposed correction factor is **1.372**, see graph 1.



Graph 1, Correction factor for calculation of NO_x emission concentration with Hydrogen fuel compared to natural gas case (ETN Position Paper)

In order not to unnecessarily punish green hydrogen applications emission limits should be equal to the natural gas applications when comparing emissions neutrally in mg/MJ_{fuel}. However, adopting a mg/MJ_{fuel} or mg/kWhe-based emission reporting method would introduce unnecessary complexity (additional parameter measurements need at site) to the existing, well-established standardized process based on emission concentrations for emission measurement and reporting.

EUROMOT members have therefore agreed unanimously to support the application of a **correction factor of 1.372** for NO_x emission concentrations (referenced to dry gas at 15 vol-% O_2) when 100 vol-% hydrogen is used as fuel. This approach avoids the need for e.g. kWhe-based calculations and addresses the potential complications that may arise during on-site emission measurements.

3. H_2 - NO_x interpretation

Transitioning to an energy-based measurement methodology for emissions would require the determination of engine power output (rated, nominal, or actual) or energy input. This would represent an additional complication that is not supported by EUROMOT, as it deviates from the established and standardized emission concentration reporting procedures.

Instead, EUROMOT supports the application of a **NO_x concentration correction factor of 1.372** (to compensate for the absence of CO_2 and the higher H_2O content in the exhaust gases) at 100% hydrogen operation as explained above.

For internal combustion engines operating on hydrogen, the resulting NO_x levels should be interpreted in line with this correction approach.

The **Large Combustion Plants Directive** (consolidated Industrial Emissions **Directive (IED) 2010/75/EU)** specifies the following NO_x emission limits for new natural gas fired lean burn engines:

LCP – Large Combustion Plants >50MWth

Natural Gas	NOx mg/Nm³@15% O2	CO mg/Nm³@15% O2
New plants	75	100

Table 1, NO_x, CO emissions limits for a new lean burn engine operating on natural gas

The **Large Combustion Plants Directive** establishes an emission limit value (ELV) for NO_x of **75 mg/Nm³ @ 15% O_2 (dry)**. When applying the hydrogen emission correction factor of **1.372**, the corresponding limiting value for NO_x emissions under 100% hydrogen operation is then **102.9 mg/Nm³ @ 15% O_2 (dry)** – allowing theoretically the same pollutant mass flow from the stack per used fuel energy quantity (mg/MJ_{fuel}).

4. Sources

* EU-Hydrogen Strategy,
at web: https://energy.ec.europa.eu/topics/eus-energy-system/hydrogen_en

Graph 1. ETN Position Paper, March 2023, «Proposed NOx Emissions reporting for hydrogen-containing fuels«, at web: https://etn.global/wp-content/uploads/2023/03/ETN-Proposed-NOx-emissions-reporting-for-hydrogen-containing-fuels-Position-paper-March2023.pdf

THIS IS EUROMOT

Founded in 1991, EUROMOT is the European association of internal combustion engine and alternative powertrain manufacturers. Representing the key global manufacturers for over 30 years, we provide an invaluable centre of expertise for businesses, authorities, regulators and public stakeholders worldwide. We are the industry's united voice to drive smart and gold standard global regulations for sustainable mobile machinery and stationary applications, helping the manufacturers shape innovations and markets for the future.

With an ecosystem of working groups spanning current and future power and mobility systems, we facilitate cross-fertilisation of innovation across industries. EUROMOT provides an essential gateway to the EU Single Market and forms a bridge for the transition from traditional to alternative energy and advanced powertrains.

Since our foundation, we have been facilitating ever increasing environmentally friendly and sustainable products as well as the decarbonization of our sector and its transition to low/zero-carbon emissions and renewable energy. With a membership encompassing all major ICE and alternative powertrain manufacturers and well-established connections to regulators, EUROMOT is uniquely positioned to decarbonise entire industries from agriculture to construction and from land-based to marine alongside stationary power for heat and electricity.

Headquartered in Brussels, EUROMOT is a European interest group, and our profile is registered in the EU Transparency Register under the identification number 6284937371-73. We have been granted consultative status at the United Nations IMO (International Maritime Organization, London) and United Nations ECE (Economic Commission for Europe - Geneva) and other relevant stakeholders.

OUR MEMBERS

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A Non-Governmental Organisation in consultative status with the UN Economic Commission for Europe (UNECE) and the UN International Maritime Organisation (IMO)

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