Hydrogen Use in Hard to Abate Industries

THE FAST TRACK TO THE HYDROGEN ECONOMY

EUROPEAN HYDROGEN ENERGY CONFERENCE

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NIPPON GASES EURO-HOSLDING

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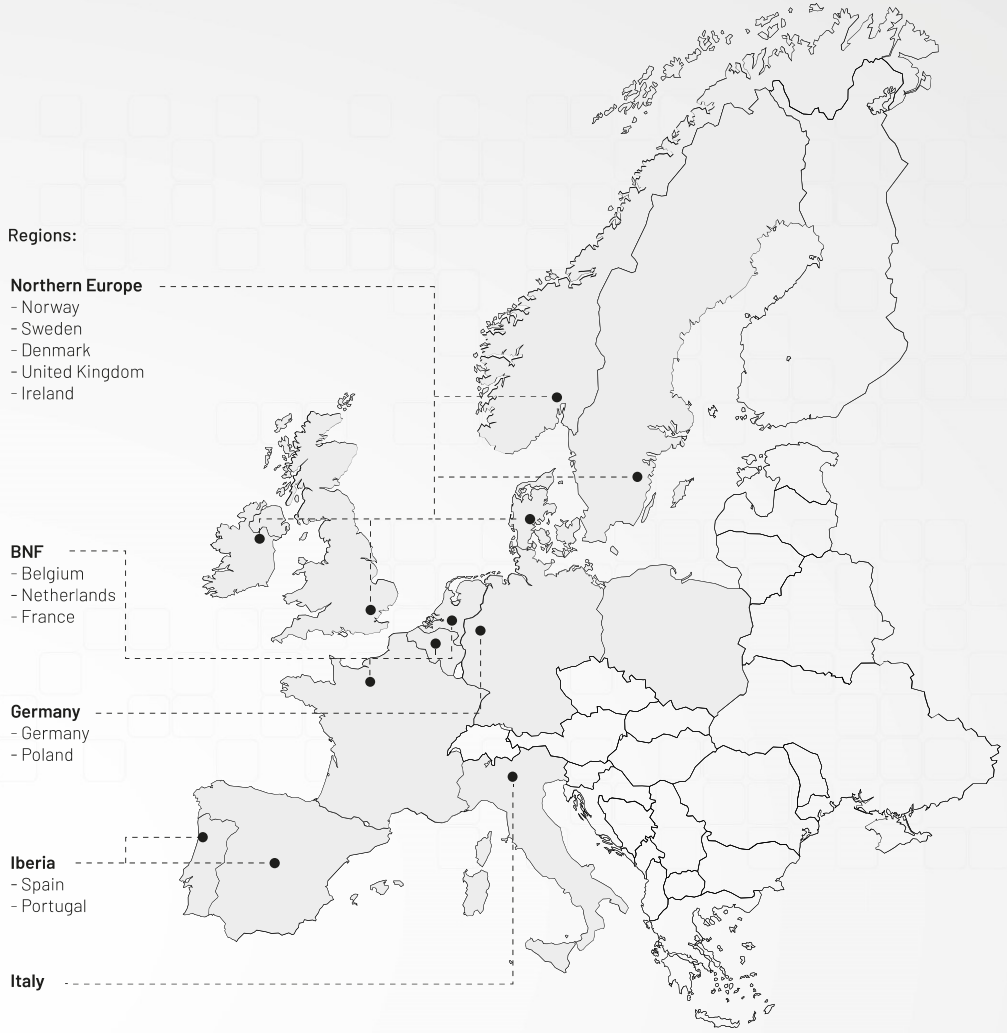
EHEC 2024 EUROPEAN HYDROGEN ENERGY CONFERENCE | AeH2 SPANISH HYDROGEN ASSOCIATION

Summary

- NIPPON GASES presence in Europe
- Combustion fundamentals
- DiluJet® JL O_2-H_2/NG
- Experiences in Industrial tests

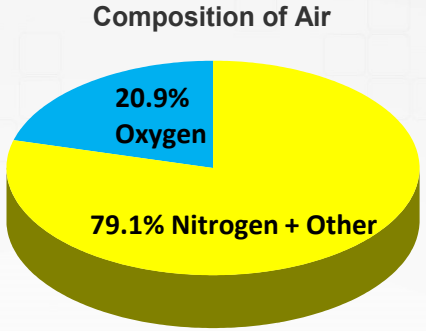
NIPPON GASES, Our Presence in Europe

- **14** Pipelines
- **5** Specialty Gases Laboratories
- **30** Air Separation Units
- **6** Hydrogen Plants
- **44** On-Site
- **12** CO_2 Plants
- 1K trucks
- Over **2.8 M** cylinders
- **40** PAG Plants
- **7** Operative Terminals



Combustion Fundamentals

The Adverse Impact of N_2 on Heat Input



Air-Fuel Combustion

$$CH_4 + 2O_2 + 7.6N_2 \rightarrow 2H_2O + CO_2 + 7.6N_2$$

1 Nm^3 of air per $Mcal_{HHV}$ of heat input
241 Nm^3 of air per GJ_{HHV} of heat input
868 Nm^3 of air per MWh_{HHV} of heat input

1 Volume of Methane produces ~ 11 volumes of waste gas

Oxy-Fuel Combustion

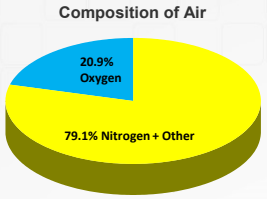
$$CH_4 + 2O_2 \rightarrow 2H_2O + CO_2$$

0.21 Nm3 of O2 per $Mcal_{HHV}$ of heat input
50 Nm3 of O2 per GJ_{HHV} of heat input
181 Nm3 of O2 per MWh_{HHV} of heat input

1 mol of Methane produce 3 mol of waste gas

Flue Gas Composition According to Fuel Used

Combustion with Air



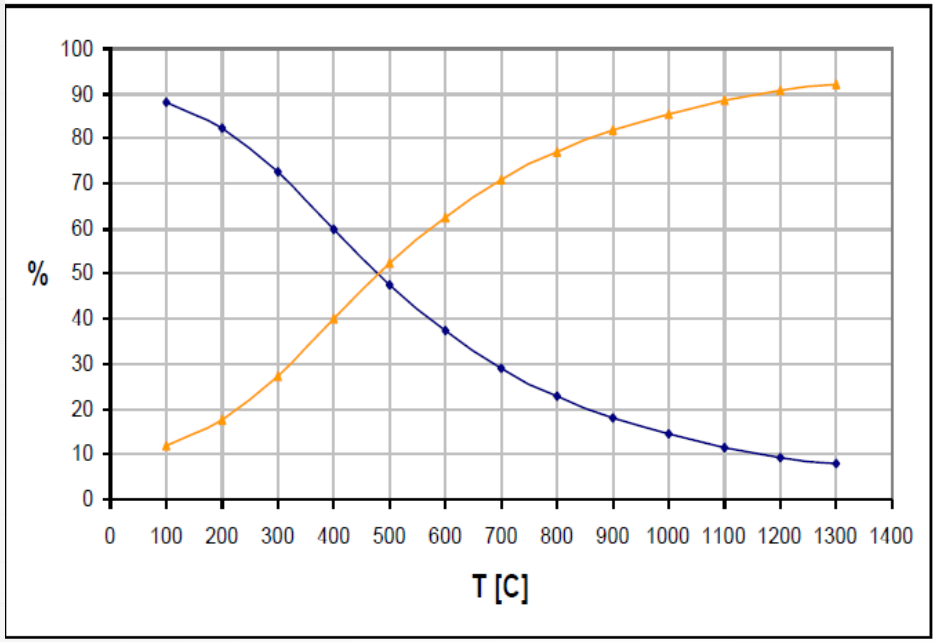
100% H_2 + Air
0% CO_2
3,1% O_2
67,3% N_2
29,6% H_2O

Assuming an excess air of 1/11,5

Combustion with Oxygen

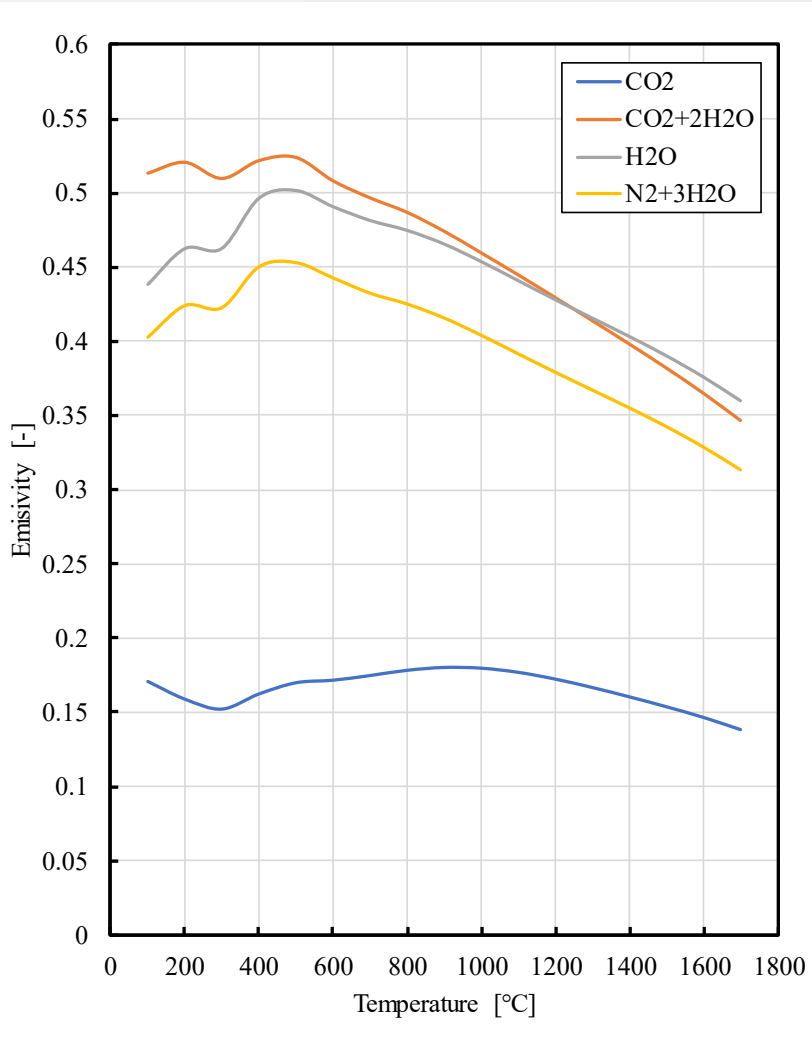
100% H_2 + O_2
0% CO_2
0% O_2
0% N_2
100% H_2O

Heat Transfer

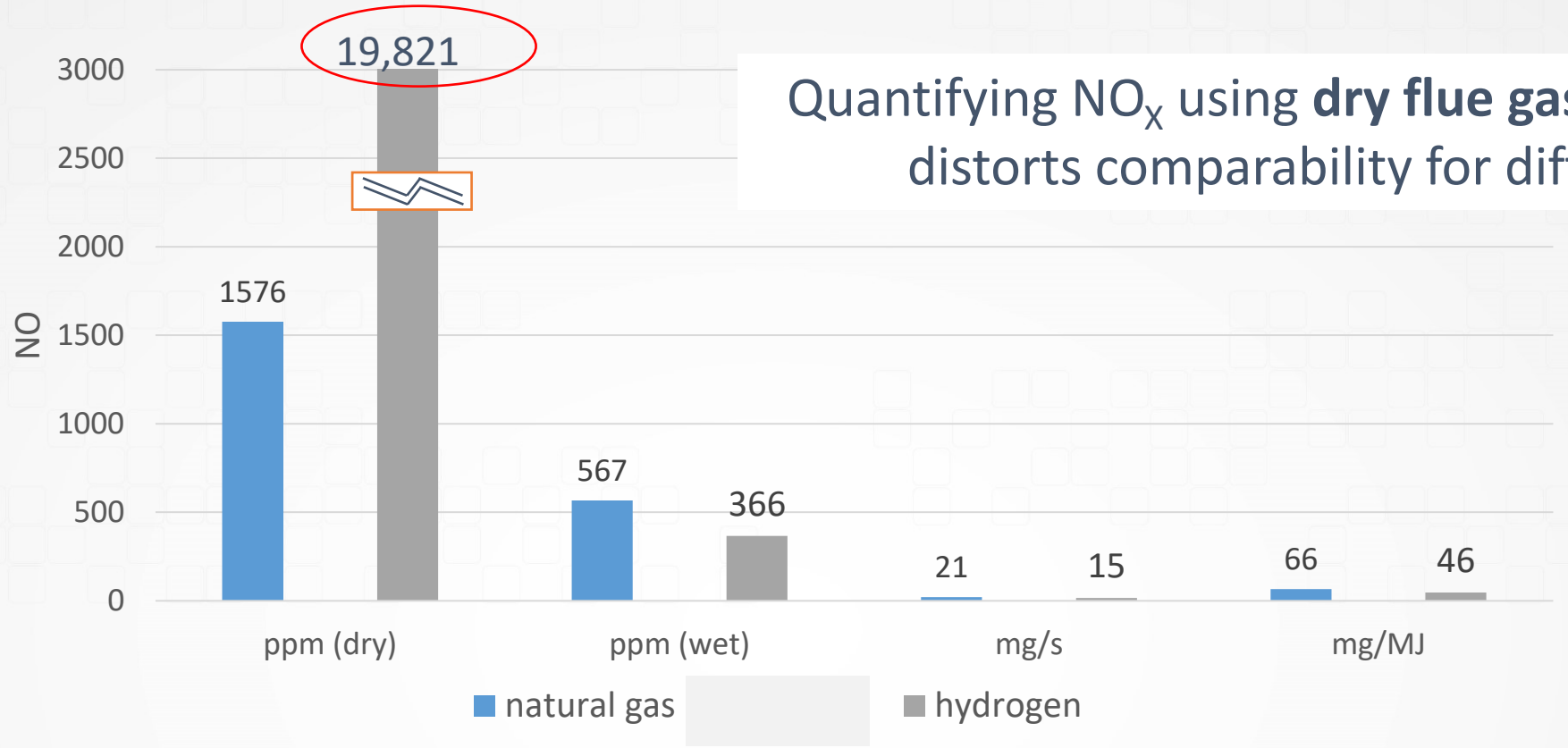


Convection

Radiation



The Metric Matters When Comparing NO_x in Oxy-fuel!

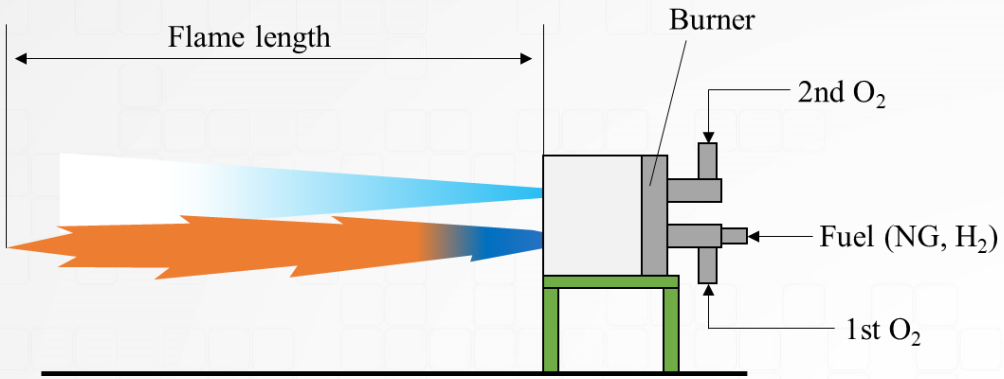


Quantifying NO_X using **dry flue gas concentrations** distorts comparability for different fuels

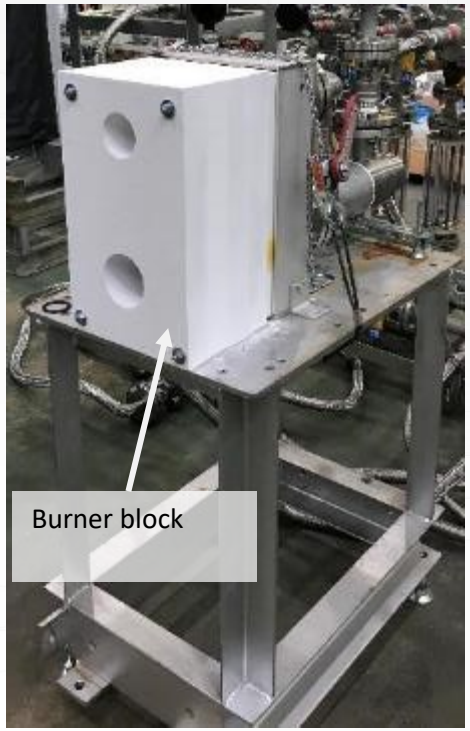
DiluJet® JL O_2-H_2/NG

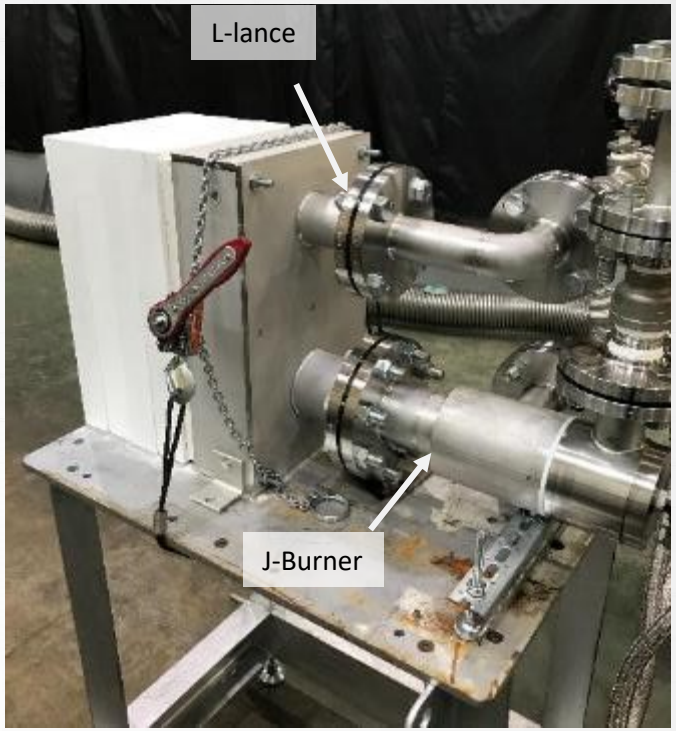
Burner Test

DiluJet® JL. O_2-H_2/NG test in open-air



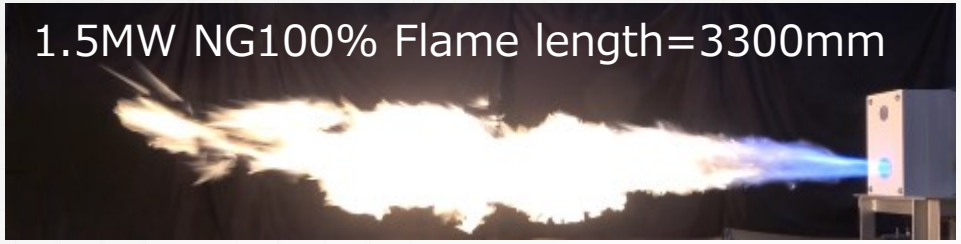
Schematic drawing of experimental setup

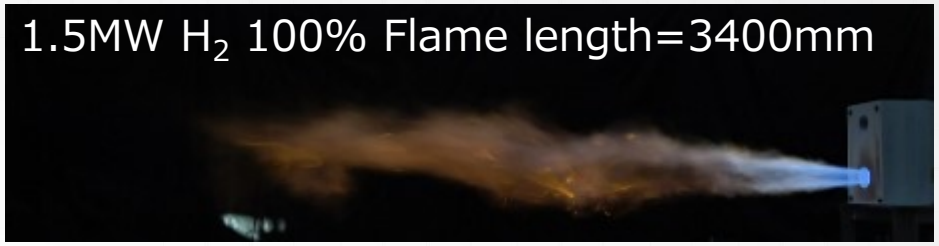


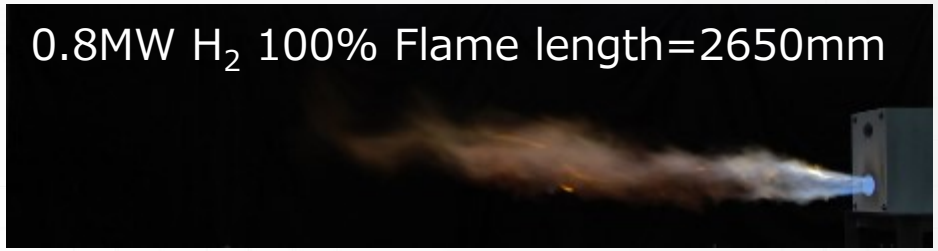


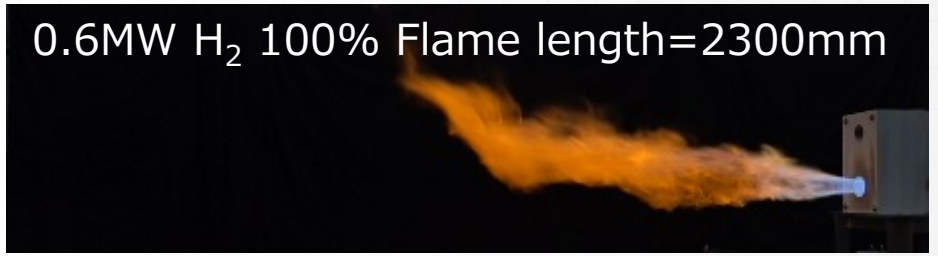
Power: max 1.5MW

DiluJet® JL. O_2-H_2/NG test in open-air

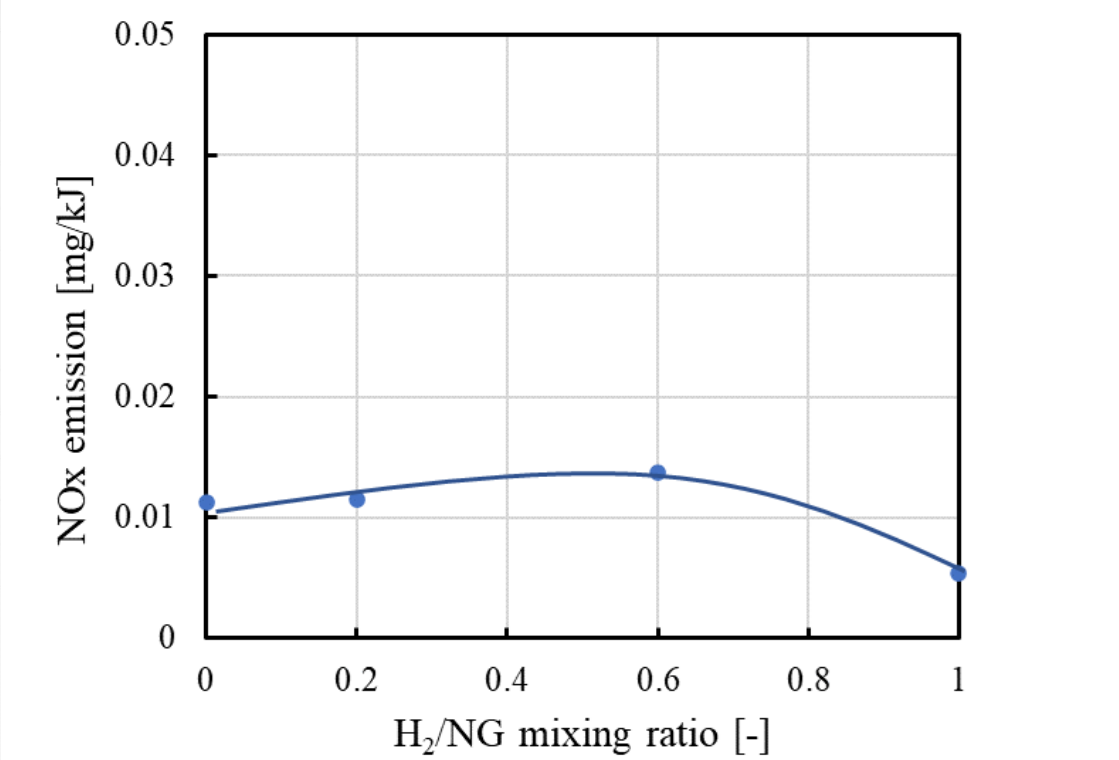








DiluJet® JL. O_2-H_2/NG NOx Emissions



- The higher the hydrogen mixing ratio, the higher the **NOx concentration.**
- The effect of the hydrogen mixing ratio is small when evaluated in terms of **NOx production.**

DiluJet® JL O_2-H_2/NG

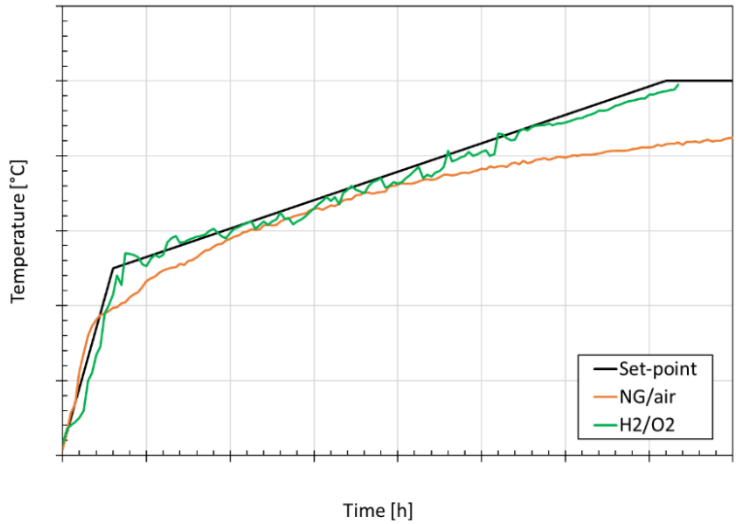
Industrial Experience

DiluJet® JL. O_2-H_2 In Steel Ladle Preheating

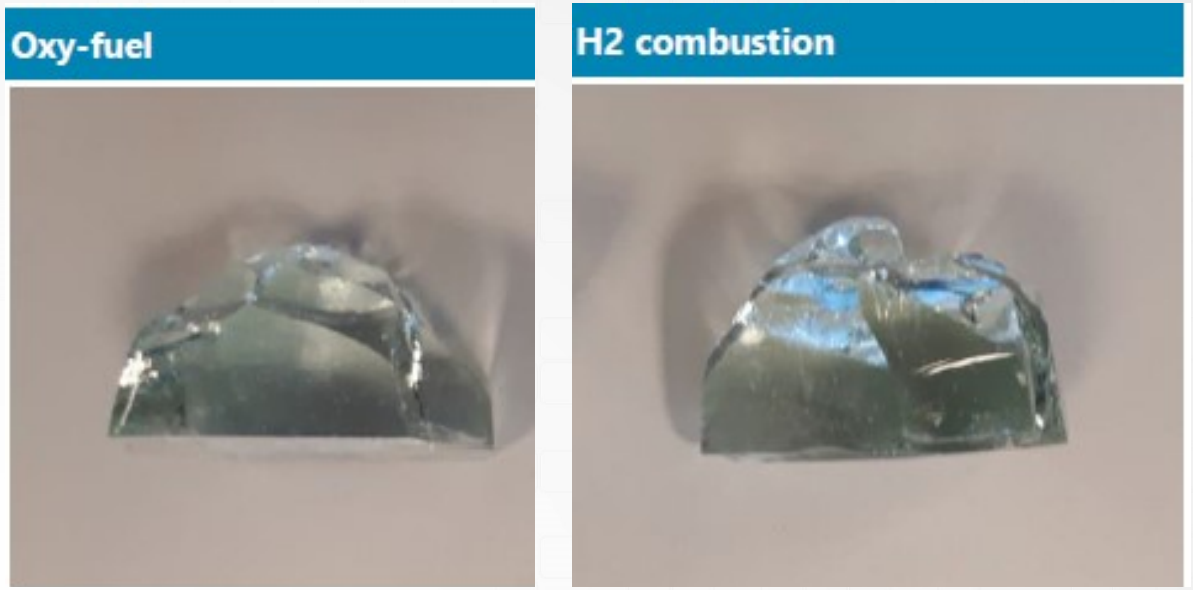
Heating and Drying Curve Trail Campaign:

- Monitoring of temperatures
- Study of refractory materials
- Measurement of flue gases

Industrial heating/drying trials with 100% H_2



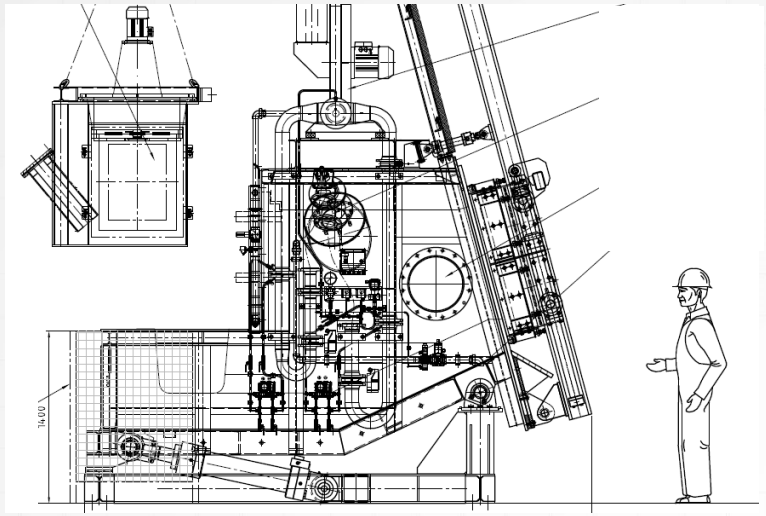
DiluJet® JL. O_2-H_2 In Glass Furnaces



Photographs of glass samples are no marked differences visible

- Study of refractory materials
- Measurement of flue gases

DiluJet® JL. O_2-H_2 In Non-Ferrous



- Testing of H_2 combustion.
- 2 tons test furnace.
- Successful test.
- Slight pick up of H_2 into the melt.
- SNIF in-line system remove it.
- Not consider this as a problem.

What did we learn?

- The technology to use H_2 as fuel is ready to use.
- The emissions associated to the H_2 use are in line with today BAT.
- Creating experience on using H_2 on hard to abate industries.

- H_2 on necessary volumes and price to be used in the industry