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DevH2forEAF

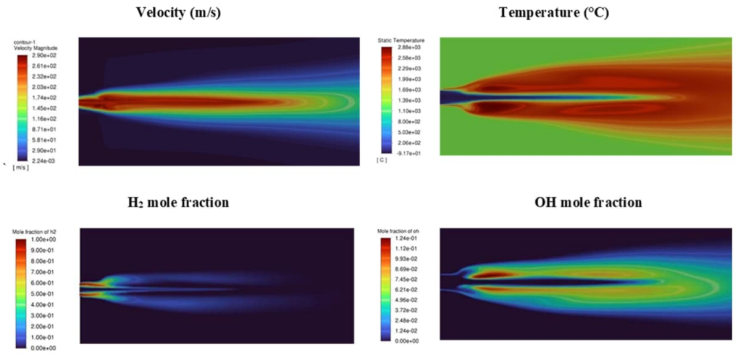
Developing and Enabling H2 Burner Utilization to Produce Liquid Steel in EAF

https://www.devh2eaf.eu/

In the modern EAF, the contribution of chemical energy for the scrap melting and refining is the range of 25-45% of the total energy required. The Natural Gas (NG) burners provide in the range of 40-80 kWh/t of energy. It means that the production of 100 tons of steel requires the combustion of 370-750 Nm3 of NG with CO_2 emission of 0.75-1.5 tons. The substitution of NG with hydrogen in the EAF steel production will bring a remarkable reduction of CO_2 emission.

In this frame the RFCS project "*Developing and enabling H_2 burner utilization to produce liquid steel in EAF*" DevH2forEAF is in line with the European roadmap toward achieving zero greenhouse gas emissions. The project focuses on the design and realization of burners for EAF, able to work with NG/H_2 mixture, up to 100% hydrogen. The fuel mixing was performed by a dedicated mixing regulation system developed by Nippon Gases. These experimental trials represent a preliminary step to verify the functionality of the H_2 burner and to identify the optimal operating conditions for industrial-scale tests at Ferriere Nord and Celsa.

Characteristics of the 3 MW flame fed with 100% hydrogen



Design and construction of the H2 injector-burner

H_2 injector-burner, able to burn a mixture of NG with H_2 up to 100% with oxygen in order to preheat and cut the scrap, as well as to inject oxygen to decarburize the steel bath.

CFD simulations have been carried out to analyze in detail the combustion phenomena of NG and H_2 with the following methods:

1) Reynolds Averaged Navier Stokes (RANS) approach to numerically solve turbulent flows
2) Discrete Ordinates (DO) model to describe the radiative heat transfer
3) Eddy Dissipation Concept Model (EDC) to describe the evolution of the chemical species during the combustion.

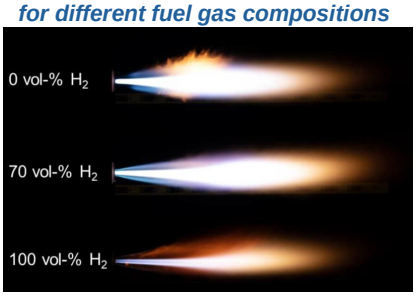
CFD results have shown that the increase of the H_2/NG ratio increases the maximum flame temperature and moves the maximum temperature closer to the burner tip.

Experimental trials in pilot scale EAF

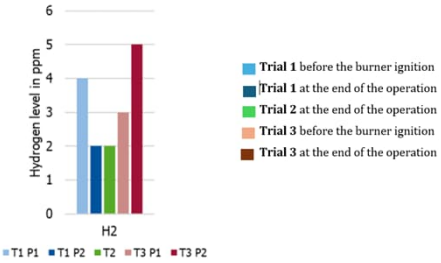
The burner with a power of 50 kW has been tested in a pilot scale EAF with an active power of 600 kW and 2000 A of maximum arc current. The burner is able to combust different fuel gases and their mixtures ranging from 100% natural gas (NG) to 100% hydrogen (H_2).

The flame with 100% hydrogen in the fuel gas is visible, due to particles present in the ambient atmosphere which accumulate in the long exposure picture. The results of the analysis show that the H_2 content in the steel remined within the range of 2-5 ppm.

Free-flame trials of 50 kW burner for different fuel gas compositions

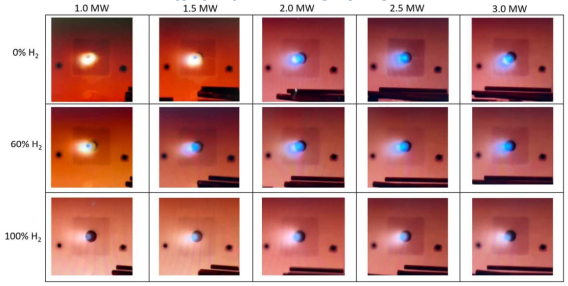


Hydrogen content in the steel



Combustion chamber at RINA-CSM in Dalmine

Flame appearance at various power and %H2 in front view



Preliminary experimental campaign with Oxyfuel burner

The experimental campaign with an Oxyfuel burner has been conducted, at the RINA-CSM combustion chamber in Dalmine, to evaluate performance and feasibility of the H_2-burner with different fuels supplies: from 100% NG to 100% Hydrogen, including mixed configuration of NG-H_2. The fuel mixing was performed by a dedicated mixing regulation system developed by Nippon Gases.

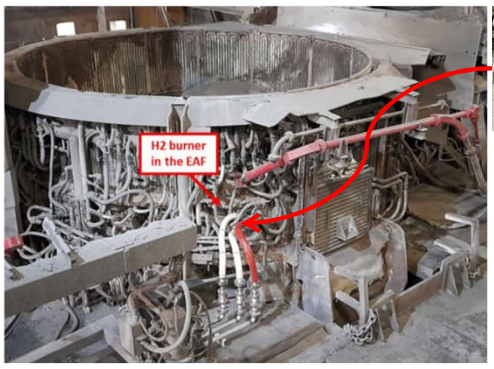
Industrial experimental trials with Oxyfuel burner

The experimental campaign at the Ferriere Nord Electric Arc Furnace (EAF) aimed to evaluate the feasibility of using a hydrogen (H_2) burner to replace one of the existing natural gas (NG) burner.

The Ferriere Nord EAF has a capacity of 155 tons. It is equipped with 8 natural gas burners of 4 MW, 4 jet burners of 3 MW, and 3 bottom tuyeres fed with oxygen. Additionally, the furnace is equipped with injectors for slag reducing agents and slag conditioners.

Experimental tests have demonstrated that hydrogen burners can be safely used in electric arc furnaces without requiring significant changes to operating conditions. The results also confirm that hydrogen use does not compromise steel quality.

Location of the H2 burner in the Ferriere Nord EAF



H2 burner