EXPERIMENTAL VALIDATION OF AN HHO GAS CUTTING FLAME CFD MODEL

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1. Introduction

A special patent [1] has been developed to produce hydrogen gas by means of water electrolysis. Due to the physical patented process, hydrogen is generated together with oxygen in a quasi - stoichiometric proportion realising the HHO gas. An important particularity of this process consists of the mobile characteristic of the whole installation. The main features of this productive installation are the following: gas flow rate 750 Nm^3/h , gas pressure 0.2 MPa, gas temperature 20-45 ^oC.

One important field of using this gas phase mixture (HHO) can be found in cutting/welding metals and other hard materials (such as ceramic, stones, etc.), but an adequate tool has to be technically adopted in the first place.

This paper tries to establish a correlation between the unexpected visible aspect of a premixed hydrogen flame [2] generated by a normal gaseous cutting tool and the physical – kinetic mechanism involved in this process, with some conclusions concerning the best geometrical details of the cutter tool.

Briefly, a very short and condensed flame has been expected at the cutter tool outlet, but a very long and luminous flame has occurred instead - fig.1; very high temperature has been expected and low values have been registered.

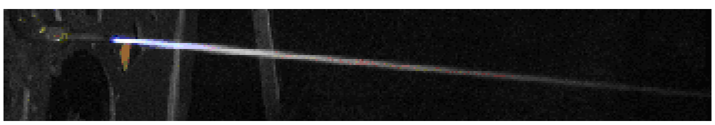

Fig.1. General aspect of the HHO flame.

Due to this fact a numerical model has been created and then an experimental session of validation has been performed in order to analyse these facts.

2. Numerical model of the HHO flame

To develop this numerical model of the HHO gas, Fluent code has been adopted [3]. First some important assumptions have been established:

- The HHO gas is perfectly mixed (hydrogen and oxygen) at the cutter tool outlet, due to the relative long path (l/d) from the gas generator to the cutter, lap over the multitude of bents, even within the cutter;
- The HHO composition is a stoichiometric one, based upon the electrolysing process;

Kinetic mechanism of the HHO burning process has been adopted after Warnatz [4]. Flame post-processed aspect is presented in Fig.2 and the temperature distribution (calculated).

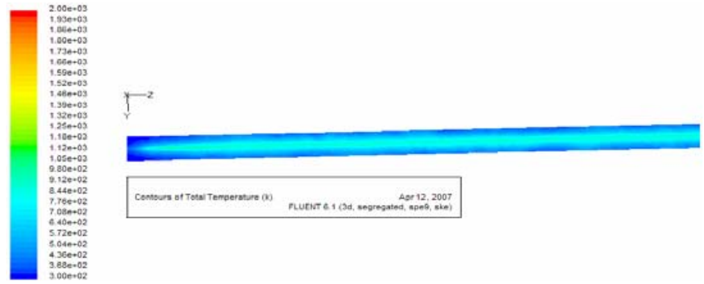

Fig. 2. Global contour of the HHO flame post-processed of a Fluent numerical simulation. It is to be seen that autorange temperature scale found invisible high temperatures. Flame domain has been shorted to emphasise details.

3. Experimental validation and conclusions

Experimental results are presented in Fig.3. It consists of a set of temperature values recorded by a double wavelength (0,9 – 1,8 μm and 7 – 14 μm) infrared pyrometer OMEGA S3750 with the temperature range between 350 – 3000 ºC .

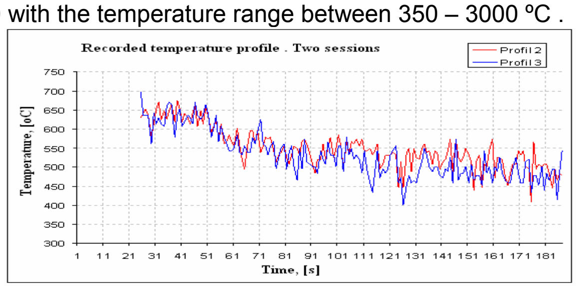

Fig.3. Recorded temperature values in two different sessions. Decreasing values due to the HHO outlet decreasing pressure.

The most important conclusion ist that the HHO real flame is very small (1-1.5 mm) and the recorded and computed images are post-combustion reactions generated by the high temperatures in the main flame.Further experiments have been performed to visualize the small main flame.

REFERENCES (selective)

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[4] J. Warnatz, Survey of the C/H/O reactions, Combustion Chemistry II, Springer Verlag, New York, 1991.