

PARTICULARITIES OF HYDROGEN COMBUSTION IN A NON- PREMIXED DIFFUSIVE REGIME WITH ACCOMPANYING AIR JETS, EITHER COAXIAL OR PARALLEL

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ABSTRACT

Hydrogen-based energy production involves the use of fuel cells or the direct combustion of hydrogen (a particular case being hydrogen combustion in internal combustion engines). Direct hydrogen combustion is still in the testing phase, with challenges arising from its energetic properties, which continue to be a difficult factor. For instance, hydrogen has a low calorific value (about three times lower than methane) in its gaseous phase, which is the phase where combustion occurs, a very high combustion speed (about eight times faster than methane), and wide concentration limits in air for ignition (explosion). From a thermodynamic perspective, the adiabatic combustion temperature is very close to that of methane, while the ignition energy is very low. When hydrogen is mixed with methane in proportions of up to 15%, it has been noted that all combustion systems designed for methane, particularly those using kinetic combustion technology (with air-gas premixing), can still operate effectively. However, transitioning to higher hydrogen proportions, up to 100%, and increasing the thermal power of burners present significant challenges that must be addressed through the use of diffusive combustion with separate fuel-air jets. This becomes essential to prevent flashback and ensure high flame stability. The paper presents an approach to diffusive combustion of pure hydrogen or hydrogen mixed with gaseous hydrocarbons, along with a detailed analysis of optimization using jet gas dynamics. The paper also presents a prototype burner with separate jets and preliminary results regarding its performance.

Keywords: hydrogen; diffusive combustion; prototype burner; methane; hydrocarbon

INTRODUCTION

Regarding the combustion of a gaseous fuel, it is specified that two completely different technologies can be used, namely, [1]:

- the combustion of an air-gaseous fuel mixture, known in physics as kinetic combustion;
- combustion with separate jets of air and gaseous fuel, known as diffusive combustion, because the processes are governed by the diffusion of one gas into the other.
- diffusive combustion can be achieved in most cases through the presence of concentric coaxial gas-air jets or through the presence of accompanying lateral jets.