ALTERNATIVE FUELS

(620) - (*) - INFLUENCE OF HYDROGEN ADMIXING TO METHANE ON THE COMBUSTION PERFORMANCE OF A COMMERCIAL PREMIXED BURNER

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Combustion of natural gas is a widespread process to provide heat and electricity to the residential, commercial and industrial sectors. One of the major products of this process is carbon dioxide, which is considered as the primary driver of climate change. Renewable energies are a prominent solution to cope with the increasing need to reduce greenhouse gases and with the anticipated depletion of fossil resources. Within this framework, the power-to-gas (P2G) technology may be considered as a powerful tool, as the storage of energy in chemical form is technically more feasible than storing electricity, either in terms of storage time and scale. The most promising P2G path for excess renewable energy is arguably the production of hydrogen via electrolysis. Due to its high energy density and its Wobbe Index being similar to that of methane, hydrogen may represent a competitive renewable fuel to partially or even fully replace natural gas. Since the amount of hydrogen in the gas distribution network is limited within the 6-20vol% concentration range for reasons related to embrittlement of metallic materials and leakage issues, in-situ admixing of hydrogen may be a potential solution to locally displace pipeline natural gas. In this work, a commercial premixed burner representative of gas-fired condensing boilers is evaluated at 5 kW to assess the influence of hydrogen addition to methane on combustion features such as burner temperature, flashback limits, flame characteristic as well as the concentration of pollutants (CO, NO, NO_2 and UHC). For the purpose of comparison, two different hydrogen sources are examined: pure H_2 from a tank and a stoichiometric H_2/O_2 mixture from an on-site electrolyser. As commercial pre-heated burners are employed in combustion chambers, the shape and flame stability are investigated for various hydrogen contents in a both unconfined and confined configuration (enclosure in quartz cylinder). Since the flame velocity of H_2 containing fuels increases with the hydrogen content, the burner temperature is found to increase with the H_2 addition. This means that at an equivalence ratio φ=0.75, which represents the standard setting for condensing boilers, the addition of hydrogen leads to burner temperatures exceeding those expected for an operation with 100% CH_4. As a consequence, the stable burner operation cannot be ensured in the presence of hydrogen at such operating point, due to burner overheating and following flashback phenomena. Nevertheless, the contribution of hydrogen to enhancing the flame velocity enables to reduce φ down to values at which flames of pure methane would be unstable and near to blow-off conditions. At φ=0.65 the thermal load on the burner surface is far below that foreseen for the standard operational adjustment for pure CH_4, with no flashback phenomena taking place in the entire range of hydrogen content examined (0-48vol%), either for CH_4/H_2 and $CH_4/H_2/O_2$ mixtures. This work also highlights that the reduction of φ, allowed by H_2 addition, enables to halve the NO_x concentration, to keep the CO level unchanged and to also potentially improve the turn-down ratio of premixed burners.

Palavras-chave : Methane, Hydrogen, Electrolysis, NOx