Oxycombustion de l'hydrogène et de mélanges hydrogène-méthane : étude des caractéristiques de flamme

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Abstract

The decarbonation of high-temperature industrial combustion processes (to produce iron, glass, cement . . .) is considered using alternative fuels. Among them, hydrogen is considered. Compared to methane, hydrogen has a lower density and lower energy density for an equivalent volume. Its combustion is characterized by an increase of laminar flame speed, water vapor content in flue gases and flame tempera- ture, this latter one more significant in air combustion than in oxycombustion. A progressive replacement of methane by hydrogen induces significant changes in flame structure and combustion features that need to be explored. The objective of this work is to study these effects by an experimental approach on a coaxial diffusion oxyflame, characterizing the consequences of increase of the hydrogen proportion in the ($CH_4 - H_2$) fuel blend up to pure hydrogen. This is done in a lab-scale facility reproducing industrial furnace operating conditions and allowing in-flame measurements thanks to modular optical accesses. The study characterize spontaneaous emissions from hydrogen oxyflame and particularly its orange can- doluminescents properties. Reaction zones structure and flame length are studied with OH^* and CH^* chemiluminesences. Interactions between flame and flow are studied with synchronized planar laser indu- ced fluorescence and particles images velocimetry. Finally, consequences of hydrogen proportion increase on thermal transfer and nitrogen oxydes are mesured. These experimental results are sustained by mo- nodimensionnal numerical thermokinetical and radiative transfer calculations. The applied methodology used in this work having experimental results, together with numerical calculations allowed to unders- tand the significant modifications of flame characteristics when transitioning gaseous fuel from methane to hydrogen with pure oxygen oxidizers.