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NUMERICAL ASSESSMENT OF ENTRAINMENT COEFFICIENT OF TURBULENT JET IN CASE OF HYDROGEN RELEASE IN A TWO-VENTED CAVITY

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ABSTRACT

Hydrogen is considered as one of the green and alternative energy sources due to its reduced emission of CO₂. As its high risk of detonation, which is often associated with a mixture of hydrogen and air, appropriate security measures are required for its usage. In accidental situations, hydrogen escapes and rises in form of a plume-jet that entrains ambient air and potentially forms a dangerous flammable mixture. Predictive models have therefore to be developed to assess its potential use in specific configurations like highly confined environments (garage, containment building ...). Macroscopic models as those proposed by Linden et al. (1990) based on Morton's turbulent jet model (Morton et al., 1956) for building applications have been used to predict hydrogen concentrations in vented cavities. The determination of entrainment coefficient α , which is supposed to be constant in the Morton et al.'s model, plays an important role in the estimation of hydrogen concentration.

We present numerical results from direct numerical simulations (DNS) of an air-hydrogen buoyant jet in a two-vented cavity, configuration dedicated to analysis of hydrogen distribution in accidental situations for highly confined environments. We compare the result of 3D numerical simulation with the simplified models proposed by Linden et al. (1990) based on Morton's turbulent jet model (Morton et al. 1956) used to predict hydrogen concentrations in vented cavities in industrial context. By integration of time-averaged fields obtained by DNS simulation, we associate the profiles of characteristic quantities of the jet with its predicted values, to study the choice of entrainment coefficient α in Morton's model. The coefficient is determined by three methods with different values which gives indication about its value depended on different flow regime. By comparing the results, we find that α -constant models present restriction in application of simplified models used in industrial context.

Keywords: Hydrogen safety, DNS, turbulent jet, ventilation model, entrainment coefficient