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Authors: Gianmaria Pio, Ernesto Salzano

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THE EFFECT OF ULTRA-LOW TEMPERATURE ON THE FLAMMABILITY LIMITS OF A METHANE/AIR/DILUENT MIXTURES

*Gianmaria **PIO**, Ernesto **SALZANO***

Dipartimento di Ingegneria Civile, Chimica, Ambientale e dei Materiali, Università di Bologna, via Terracini 28, 40131 Bologna (IT)

Highlights

- Evaluation of safety parameters at ultra-low temperature by detailed kinetic mechanism
- Validation by means of comparison with experimental data and correlations from literature
- Adoption of limiting burning velocity theory for the evaluation of flammability limits
- Estimation of limiting oxygen concentration by the same kinetic mechanism
- Assessment of the effect of the addition of inert gases to LNG at low temperature

Abstract

Natural gas represents an attractive fuel for industrialized and developing countries seeking an alternative to petroleum. Due to economic and safety considerations, liquefied natural gas (LNG) at cryogenic conditions is preferred for storage and transportation. The main drawback is the poor understanding of the physical and chemical phenomena that occur at the storage conditions of liquid methane, i.e. at ultra-low temperatures around 110 K and, if released, at temperatures below ambient. In this work, a procedure to evaluate the laminar burning velocity, the flammability limit (FL) and the limiting oxygen concentration (LOC) of methane-air-diluent mixtures based on detailed kinetic mechanism at ultra-low temperatures is proposed. The estimation of the FL was obtained with the limiting burning velocity theory. The effects of inert content (extinguishing) and agent (N_2, H_2O and CO_2) on FL were evaluated and compared with data retrieved from the literature. The agreement between experimental observation and model results from 200 K – 300 K incentivizes the adoption of the new procedure for further studies of fuel reactivity and safety parameters. Moreover, the proposed procedure may be suitable for the estimation of the safety parameters of complex fuel mixtures whose composition is closer to the actual values of LNG.

Keywords: Low temperature; laminar burning velocity; flammability limits; limiting oxygen concentration; Liquified Natural Gas, LNG