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PRESSURE EFFECTS ON RADIATIVE HEAT TRANSFER IN SOOTING TURBULENT DIFFUSION FLAMES

Fatiha Nmira[1], Yuying Liu[2], Jean-Louis Consalvi[3*], Frederic Andre[4], Fengshan Liu[5]

[1]Direction R&D EDF, 6 quai Watier, 78400 Chatou, France.
[2]School of Energy and Power Engineering, Beihang University (BUAA), Beijing, 100191, China
[3]Aix-Marseille Université, IUSTI/ UMR CNRS 7343, 5 rue E. Fermi, 13453 Marseille, France.
[4]Univ Lyon, CNRS, INSA-Lyon, Université Claude Bernard Lyon 1, CETHIL UMR5008, F-69621 Villeurbanne, France.
[5]Metrology Research Centre, National Research Council of Canada, 1200 Montreal Road, Ottawa, Ontario K1A 0R6, Canada

ABSTRACT. This article investigates the effects of increasing pressure on radiative heat transfer in sooting methane and ethylene momentum-driven turbulent jet flames by using state-of-the-art chemical mechanism, combustion, soot production and radiation models. A transported PDF method is used to close properly the emission TRI term and a Narrow-Band CK (NBCK) model is considered. The absorption TRI is modelled by considering the Optically-Thin Fluctuation Approximation (OTFA). In accordance with a previous study dealing with non-sooting hydrogen flames (Nmira et al., JQSRT 220 (2018) 172-179), the 4-atm flames are designed from the atmospheric ones by using a Froude modeling that allows to preserve the flame geometry and the global residence time as the pressure is scaled-up. The radiant fraction evolves with increasing the pressure as a result of two competitive mechanisms: i) an increase in soot production that reduces significantly the emission characteristic time scale leading to an increase in radiant fraction and ii) a reduction in flame transparency that tends to reduce the radiant fraction. This differs from non-sooting flames where only the second mechanism is present. These two mechanisms are balanced in the methane flames whereas the first mechanism prevails in the ethylene flames. It is also found that the increase in net radiative loss owing to TRI is reduced as the pressure is scaled up. This is due to an enhancement of the contribution of soot emission which is less sensitive to TRI than gas emission. This behavior differs also from non-sooting flames where TRI effects were found to be enhanced by pressure rise.