MODELLING OF FURNACES AND COMBUSTION SYSTEMS

(697) - (*) - THERMAL RADIATION AT HIGH-TEMPERATURE AND HIGH-PRESSURE CONDITIONS: COMPARISON OF MODELS FOR DESIGN AND SCALE-UP OF ENTRAINED FLOW GASIFICATION PROCESSES

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Thermal radiation is an important sub-process in high-pressure entrained flow gasification. However, it was seldom investigated in previous CFD studies and was usually accounted for by common radiation and simplified gas radiation property models. Therefore, comparative radiation simulations were performed within this work and with respect to the bioliq Entrained Flow Gasifier (bioliq EFG) [Eberhard, 2020] of Karlsruhe Institute of Technology. The bioliq EFG operates at 40 bar and has got, contrary to other entrained flow gasifiers, a segmental cooling screen enabling local heat flux analysis [Eberhard, 2020]. This feature allows a unique comparison of experimental with numerical results; the latter have been obtained by performing one-dimensional radiation and two-dimensional CFD simulations. The CFD simulations were carried out to investigate the performance of simplified gas radiation property models incorporated within the CFD model of the bioliq EFG [Dammann, 2021], while the one-dimensional radiation simulations have enabled further comparison with the most recent developments for gas radiation property models. This paper reports on the simulation results and provides recommendations for the selection of gas radiation property models for CFD simulations with the discrete ordinates model and with emphasis on radiative heat transfer at high-pressure conditions. In case of largely isothermal and homogeneous conditions with exemption of the flame zone, weighted-sum-of-grey-gas models can be recommended to be used with the discrete ordinates model if user-defined weighted-sum-of-grey-gas models (i) are obtained from accurate line-by-line calculations, (ii) are based on conditions prevailing in the entrained flow gasifier and (iii) are applied using the non-grey or band approach. In absence of such weighted-sum-of-grey-gas models, spectral-line-weighted-sum-of-grey-gas models based on the latest tabulation [Pearson, 2013; Pearson, 2014] can be used instead. In addition to that, soot radiation becomes important at soot volume fractions above 1E-06 and should be accounted for if such conditions are expected in entrained flow gasifiers.

Palavras-chave : Entrained flow, Gasification, High pressure, Radiation, CFD