VALIDATION OF THE SNB FULL-SPECTRUM CORRELATED-K METHOD FOR LES OF MILD COMBUSTION

M. Cordier[1*], P. Bénard[2], P. Lybaert[1], V. Feldheim[1], L. Bricteux[1]

[1]University of Mons, Faculty of Engineering, Mons, BE 7000, Belgium
[2]Normandie Univ, INSA Rouen, UNIROUEN, CNRS, CORIA, 76000 Rouen, France

Moderate or Intense Low-oxygen Dilution (MILD) combustion constitutes a promising combustion technique as it combines low pollutant emissions, e.g. nitrogen oxides NOx, and high combustion system efficiency. The reduction of NOx emissions is achieved by mixing the reactants with the inert combustion products before the combustion takes place. Due to this dilution of the reactants, their concentrations are locally lower, leading to a reduction of the reaction rates. The global objective of our research is to demonstrate the possibility of obtaining accurate numerical predictions of industrial MILD combustion processes using Large Eddy Simulations (LES) and, therefore, to promote their use in industry. Numerical simulation of such combustion systems is very challenging as many multi-scale physical phenomena are involved. First, it includes turbulence, chemistry and radiation. Second, it involves complex interactions such as the turbulence-chemistry interaction (TCI) and the turbulence-radiation interaction (TRI). As a consequence, the validation of our modeling methodology has to be decomposed in different tasks and this study focuses on the assessment of the radiation modeling.

The test case under consideration is the Jet-in-Hot-Coflow, also known as the Adelaide flame [1]. It consists in an open free flame, hence the effect of the radiative transfer is not as high as in a furnace. However, this simple test case is typical of MILD conditions and is adequate to perform such validation at a small computational cost. Furthermore, a detailed data set of measurement, including temperature and species mass fractions, is provided for this flame.

The methodology for the combustion modeling, combining LES with Finite Rate Chemistry, has already been validated on the flame under consideration, neglecting the radiative effects. In this work, a radiation model is added to study the influence of the radiative heat transfer. The radiative transfer equation is solved with the local radiation modeling approach of the YALES2 code [2]: the discrete ordinate method (DOM) combined with a global model for the evaluation of the radiative properties, the SNB full-spectrum correlated-k (FSCK) method. In the FSCK model, the spectral absorption coefficient is reordered in a monotonically increasing distribution function. This reordering enables a significant reduction of the computational cost generated by the radiation modeling.

The simulations results, with and without radiation, will be analyzed in terms of average and fluctuating temperatures profiles as well as fields of radiative heat source. One expects to observe a global decrease of the temperature levels in the radiating flame.

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* Corresponding Author: marie.cordier@umons.ac.be.