

Detailed soot modelling in laminar methane flames

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Abstract

Soot particles are formed during the combustion of hydrocarbon/air mixtures in most combustion devices related to transportation. These particles have significant effects on public health and radiative forcing which depend on their size. In this context, experimental and numerical tools to predict Soot Volume Fraction (SVF) and Soot Number Density Function (SNDF) are required. The present work aims at modelling soot formation and evolution using a sectional description of the SNDF [1]. The proposed model accounts for particle inception, condensation, surface growth, coagulation and oxidation processes and directly predicts the SVF and SNDF at each time and location. Moreover, it also includes modelling of Polycyclic Aromatic Hydrocarbons (PAH) addition processes (particle inception and condensation) reversibility inspired of recent study [2].

In the present work, the model is coupled to the detailed kinetic solver Cantera [3] in order to solve both the gas and dispersed solid phases in steady laminar flame conditions. The gas phase chemistry is modelled using a kinetic scheme including large gaseous PAH and previously validated on methane laminar flames [4].

Measurements of sooting laminar methane flames at various equivalence ratios [5] have been used to validate the model. The simulations predictions concerning soot volume fraction show a good agreement with the experimental measurements. The evolutions of the modelled particle average diameter through the flames are also consistent with the available data. Parametric variations highlight the importance of PAH addition processes reversibility in these flames.

Key Words: Modelling, Flames, Soot, Sectional Model, PAH

References

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