Droplet Heating and Evaporation: Simple Models of Complex Processes

S.S. Sazhin
Advanced Engineering Centre
School of Computing, Engineering and Mathematics
University of Brighton
Brighton BN2 4GJ, UK

The most recent developments in the modelling of heating and evaporation of mono- and multi-component droplets are reviewed. In contrast to the models used in most engineering applications, the effects of temperature and species mass fraction gradients within spherical droplets are taken into account based on the analytical solution to the one-dimensional heat transfer and species diffusion equations, assuming that the heating process is also spherically symmetrical. It is shown that this approach is particularly useful for practical applications in CFD codes. The models were implemented into the ANSYS Fluent CFD code using User-Defined Functions (UDF). The predictions of this code, inclusive of the new models, were verified against the results predicted by the in-house research code. In the case of hydrocarbon fuels with large numbers of components a new multi-dimensional quasi-discrete model has been developed. In this model, the contributions of individual components are replaced with the contributions of a group of components with close transport and thermodynamic properties, called quasi-components. A new, relatively simple, approach to the modelling of heating and evaporation of suspended droplets that can be applied to water sprays for fire suppression, and the modelling of heating and evaporation of multi-component liquid films are discussed. A simplified approach to the modelling of micro-explosions for automotive applications is presented.