Modelling of sprays: simple solutions to complex problems

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The lecture will provide an overview of the new approaches to the modelling of sprays and liquid film heating and evaporation, recently developed by the author and his colleagues. The results of these developments are presented in the papers published in the International Journal of Heat and Mass Transfer in 2018/2019 [1-3]. These approaches are based on establishing a hierarchy of the importance of the sub-processes involved in the investigated processes. This hierarchy allows us to simplify the analysis considerably while capturing correctly the practically important features of these processes. The new approach to modelling the drying of spherical droplets is based on the analytical solutions to the species diffusion and heat transfer equations inside droplets subject to conventional boundary and initial conditions [1]. Small solid particles (or non-evaporating substances) in a volatile liquid, are treated as non-evaporating components. The new approach to modelling multicomponent liquid film heating and evaporation, based on the analytical solutions to the species diffusion and heat transfer equations inside the film, will be described [2]. The following boundary conditions are used for these solutions: the Robin boundary condition at the film surface, and the Dirichlet boundary at the wall. The new approach to modelling the puffing/micro-explosion of water-fuel emulsion droplets will be described [3]. This is based on the assumption that a small spherical water sub-droplet is located in the centre of a fuel (n-dodecane) droplet. The heat conduction equation is solved inside this droplet using the Dirichlet boundary condition at its surface. It is assumed that the puffing/micro-explosion process starts when the temperature at the interface between water and fuel reaches the boiling temperature of water. The model predictions will be shown to be consistent with available experimental data for the time to puffing/micro-explosion.

References

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2. Sazhin, S.S., Rybdylova, O., Crua, C. (2018) A mathematical model for heating and evaporation of a multi-component liquid film, International Journal of Heat and Mass Transfer 117 252-260.
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