Proceedings of CHT-17
ICHMT International Symposium on Advances in Computational Heat Transfer

May 28-June 1, 2017, Napoli, Italy

CHT-17-271

MODELLING OF HEATING AND EVAPORATION OF SPHEROIDAL DROPLETS

Vladimir Zubkov[*,§], Gianpietro E. Cossali[**], Simona Tonini[**], Cyril Crua[*] and Sergei S. Sazhin[*]
[*]School of Computing, Engineering and Mathematics, University of Brighton, Brighton, UK
[**]Department of Engineering and Applied Sciences, University of Bergamo, Dalmine, Italy
[§]Correspondence author. Email: v.zubkov@brighton.ac.uk

INTRODUCTION

Most of the currently used models for droplet heating and evaporation are based on the assumption that droplets are perfect spheres [Sazhin 2014]. At the same time the shapes of many observed droplets in engineering applications are far from spherical [Michaelides 2006, Crua et al. 2015]. In our previous paper [Zubkov et al. 2017] we studied the influence of droplet non-sphericity on their heating and evaporation, approximating droplet shapes as prolate and oblate spheroids. The analysis of this paper is based on the previously developed exact solutions to the heat and mass transfer equations for the gas phase surrounding a spheroidal droplet [Tonini & Cossali 2013]. The results have been applied to the analysis of heating and evaporation of an n-dodecane fuel droplet in Diesel engine-like conditions. In this paper, some key results and assumptions of the model described in [Zubkov et al. 2017] are summarised and discussed.

MODELLING METHOD

The analytical solution for the gas phase around a spheroidal droplet, presented in [Tonini & Cossali 2013], was used as a boundary condition at the droplet surface. The heat and mass transfer equations inside the droplet were solved numerically for a droplet of n-dodecane $C_{12}H_{26}$ surrounded by air. Assuming axial symmetry of the droplet, the 3D problem was reduced to a 2D problem.

RESULTS

A new mathematical model for heating and evaporation processes of a liquid spheroidal droplet was described. Droplet heating is shown to be more intense in the regions with greatest curvature. Higher evaporation at the droplet surface in these regions led to a decrease in droplet eccentricity for prolate and an increase for oblate droplets. In both cases this eccentricity is shown to tend towards 1 at the end of the evaporation process. The effect of droplet non-sphericity on the evaporation time of droplets was shown to be relatively small for the range of parameter values under consideration.

REFERENCES

Crua C., Heikal M.R., Gold M.R. [2015], *Fuel*,Vol. 157, pp 140-150.
Michaelides E.E. [2006], *Heat and Mass Transfer*, World Scientific, New Jersey.
Sazhin S.S. [2014], *Droplets and Spray*s, Springer, London.
Tonini S., Cossali G. [2013], *International Journal of Heat and Mass Tran*sfer, Vol. 60, pp 236–240.
Zubkov V.S., Cossali G.E., Tonini S., Rybdylova O., Crua C., Heikal M. and Sazhin S.S [2017], *International Journal of Heat and Mass Transfer*, Vol. 108, pp 2181-2190.