Mathematical modelling of surface tension effects in liquid wall films

Jakov Baleta*, Milan Vujanović and Neven Duić

Faculty of Mechanical Engineering and Naval Architecture,
Department of Energy, Power Engineering and Environment,
University of Zagreb,
Ivana Lučića 5, Zagreb 10 002, Croatia
Email: jakov.baleta@fsb.hr
Email: milan.vujanovic@fsb.hr
Email: neven.duic@fsb.hr
*Corresponding author

Abstract: Behaviour of liquid wall films finds its application in many industrial areas – internal combustion engines, air blast atomisers, heat exchanger ducts, etc. Given assumptions regarding thin liquid films, Navier-Stokes equations are converted to wall film governing equations. The main limitations of a continuous finite volume approach of the film model are at boundary edges of the liquid phase. To overcome those issues, mathematical model for description of surface tension effects was developed and implemented into the computational fluid dynamics (CFD) code. Further area where surface tension force effects are important is the behaviour of liquid film encountering a sharp edge. The analytical force balance approach from Friedrich was incorporated into the existing numerical framework. The improved model of liquid wall film behaviour developed within this paper is the important step in improvement of the accuracy of physical models used in CFD, necessary to comply with stringent requirements of the industry.

Keywords: wall film; computational fluid dynamic; surface tension; droplet spreading; capillary force; Eulerian approach; analytical force balance; film rupturing.

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Biographical notes: Jakov Baleta is a Researcher at the Department of Energy, Power Engineering and Environment, Faculty of Mechanical Engineering and Naval Architecture. He has completed his graduate studies in Thermal Engineering with highest honour (summa cum laude) in 2013, and for outstanding achievement during the study, he was awarded with the medal of the Faculty. His areas of research interest are rational use of energy in buildings and industry, with a focus on heat pumps, energy analysis of HVAC systems and the development of mathematical models of computational fluid dynamics problems in the treatment of exhaust gases of internal combustion engines.

Milan Vujanović is a Researcher and Team Leader of CFD Combustion Research Group at Department of Energy, Power Engineering and Environment, Faculty of Mechanical Engineering and Naval Architecture,