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IMPLEMENTATION AND VALIDATION OF THE MATHEMATICAL MODEL OF SURFACE TENSION INTO CFD WALL FILM MODULE

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Horizontal liquid film flow sheared by an external air flow field is encountered in many engineering applications, especially in IC engines. The upcoming Euro 6 standard that will come into force on 1 September 2014 demands a reduction in NOx emissions from cars and vehicles intended to be used for transport by more than 50 % compared to the currently valid Euro 5 standard [1]. The urea-water-solution (UWS) based selective catalytic reduction (SCR) is currently the most promising method for fulfilling these requirements. Once the UWS spray is injected into a hot exhaust gas stream before SCR catalyst, the water content evaporates from UWS. Afterwards, the ammonia is generated through the thermal decomposition of urea and hydrolysis of isocyanic acid. Generated ammonia participates within various deNOx reactions as a reductant. The resulting spatial distribution of the reducing agent before the catalyst is a crucial factor for the effective conversion of NOx. The uniform distribution and the degree of processing of the reducing agent upstream of the SCR catalyst can be, besides the evaporation and decomposition, also influenced by the spray/wall interaction and wall film formation [2].

Numerical simulations are becoming a valuable tool for detailed understanding of complex flow characteristic and transport phenomena especially in situations where experimental measurements are infeasible or too expensive [3]. The focus of this paper is the implementation and validation of a mathematical model of surface tension effects within the existing numerical framework in order to achieve a more accurate description of the liquid wall film phenomena. After literature review, optimum mathematical model has been chosen and implemented in commercial computational fluid dynamics (CFD) code. Validation was carried out using a well established case of isothermal droplet spreading for which there are analytical expressions. Comparison of simulation results with non-dimensional droplet profile shows excellent agreement with analytical results and gives confidence for commercial application of implemented model.

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