Integrating Filtration Mechanism with a 3D Diesel Particulate Filter (DPF) Model using STAR-CCM+

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A 3D CFD model is developed for analysis of transient soot filtration processes in a conventional wall-flow type Diesel Particulate Filter (DPF). The primary objective of this study is to quantitatively predict the local values of soot filtration parameters, such as porosity, permeability, collection efficiency and deposited soot mass, within isotropically discretized computational domains in the multi-layered filter wall region.

Standard CFD codes do not have ability to generate structured meshes with ordered cell index nor allow mathematical recursive operation using user field functions. For these reasons, it is difficult for users to utilize the code in situations where complex algorithms are required. Therefore, self-developed user subroutines written with C++ programming language are integrated to obtain local soot mass in each filter wall layer. A built-in table function, coupled with the unit collector mechanism, is used to extract corresponding local collection efficiency at each time step and feed it back to the user subroutines in order to calculate the local soot mass at the next time step.

Results, including the evolution of porous wall filtration parameters over time, are visualized in 3D along the filter wall, revealing correlations between wall flow pattern and soot deposition profile and showing their rearrangements.

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