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ANALYSIS OF DIESEL EXHAUST SYSTEMS WITH PARTICULATE FILTER AND OXIDATION CATALYST

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Diesel exhaust gas contains unburnt fuel and soot particles. Release of such particulate matter is usually reduced with a diesel oxidation catalyst (DOC), which oxidizes the unburnt fuel, and a diesel particulate filter (DPF), which collects the particles. Particles collected are burnt regularly so that more particles can be collected without having high pressure losses, and this is called regeneration. A DOC usually consists of small channels so that the surface area is high. A DPF also consists of small channels, but each channel has a dead end either on the inflow or outflow side of the filter, in a checkerboard arrangement. The walls between the channels are porous. The gas flows into the channels with the open end on the inflow side of the filter, flows through the porous walls into the channels with the open end on the outflow side, and exits the filter from those open ends. The DOC channel is large enough, so the particles are not blocked, but they adhere to the channel surfaces, creating a problem because the DOC is not designed for regeneration. To help avoid such problems, we study the adherence mechanism. We resolve the flow in the DOC and DPF channels, and model the porous walls with the Darcy's law. To reduce the number of unknowns required for resolving the flow and make the computations practical, we use higher-order functions and enforce the Dirichlet boundary conditions weakly. We use the Space–Time Variational Multiscale (ST-VMS) method [1] with the ST isogeometric discretization (ST-IGA) [2]. The weak Dirichlet condition and the Darcy's law are based on ST Slip Interface (ST-SI) method [3]. We compare the computed flow with experimental data, and predict the particle concentration with the advection–diffusion equation. The Reynolds number is very high, and the Peclet number is even higher (10^4 times higher), and therefore enforcing the Dirichlet boundary condition weakly is essential.

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