Reactor Stability and Sensitivity Analysis in a Diesel Particulate Filter

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In this work we apply traditional reactor stability analysis to the diesel particulate trap. The diesel particulate trap is a modified monolith, intended to catch particulate matter emitted from compresssion-ignition engines. As the particulates are caught by the trap, the pressure drop increases, which can reduce fuel economy. Therefore, the diesel particulate trap must be periodically regenerated. The regeneration process is the focus of our research.

We have reproduced a classical model of Bissett (Chemical Engineering Science, vol. 39, pp. 1233-1244, 1984) which is a multiple phase, one dimensional, time dependent model of the particulate regeneration within the monolith. We recently used averaging theory (Zheng and Keith, AIChE Journal, vol. 53, pp. 1316-1324, 2007) to reduce this model to an effective convection-diffusion equation with an effective Taylor-Aris thermal dispersivity.

In this research we perform an analysis to determine if the reduced model can appropriately reflect the additional physics of the full model. The agreement is found to be excellent even for large variations in the model parameters. We also perform a stability analysis by changing the gas flowrate, initial particulate loading, or gas temperature to determine the most sensitive parameters towards the diesel particulate trap regeneration process.