Control of Engine Exhaust Emissions

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ABSTRACT

The deteriorating environmental conditions due to vehicular pollutant emissions represent a major global problem, which contributes to huge economic burden owing to health problem and loss of productivity. The environmental concerns have led to the enactment of progressively strict emission regulations worldwide. To comply with these regulations, it is necessary to develop effective emission control technologies for combustion engines. An integral component of modern emission reduction technologies are aftertreatment devices. The efficient and most promising aftertreatment technologies include: three-way catalytic converters for gasoline engines; NO_x traps and selective catalytic reduction (SCR) catalysts for controlling NO_x emissions from diesel engines; and diesel particulate filter (DPF) for controlling particulate matter emissions from diesel engines.

This talk describes our current research program on the development of mathematical and numerical models for simulating and analyzing the performance of catalyst-based exhaust aftertreatment systems for gasoline and diesel engines. The models are developed by considering the coupling effect of heat and mass transfer with the heterogeneous reactions as exhaust gases flow through the aftertreatment systems. The models also include important transient phenomena such as the accumulation effects in the conservation of mass, species and energy, and some time-dependent kinetic effects. Using the results of the developed models, the talk discusses the dynamic behavior of an automotive catalytic converter subjected to transient exhaust conditions, which occur during typical driving conditions as a result of engine air/fuel ratio control system's response lag, and acceleration and deceleration. The talk elucidates the importance of modeling of the dynamic behavior and indicates the significant differences between the catalyst behavior under transient and steady state conditions.