Model-Based Estimation and Control System Development in a Urea-SCR After treatment System

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Abstract

In this paper, a model-based linear estimator and a nonlinear control law for an Fe-zeolite urea-selective catalytic reduction (SCR) catalyst for heavy duty diesel engine applications is presented. The novel aspect of this work is that the relevant species, NO, NO\textsubscript{2} and NH\textsubscript{3} are estimated and controlled independently. The ability to target NH\textsubscript{3} slip is important not only to minimize urea consumption, but also to reduce this unregulated emission. Being able to discriminate between NO and NO\textsubscript{2} is important for two reasons. First, recent Fe-zeolite catalyst studies suggest that NO\textsubscript{x} reduction is highly favored by the NO\textsubscript{2} based reactions. Second, NO\textsubscript{2} is more toxic than NO to both the environment and human health. The estimator and control law are based on a 4-state model of the urea-SCR plant. A linearized version of the model is used for state estimation while the full nonlinear model is used for control design. An experimentally validated, higher order simulation is used to evaluate the performance of the closed loop system. For the cases considered, the control strategy uses less urea, produces less NH\textsubscript{3} slip, and less tailpipe NO\textsubscript{x} than a similar strategy where NO and NO\textsubscript{2} are assumed as all NO during estimation and control law implementation.