Gas Exchange and Exhaust Condition Modeling of a Diesel Engine using the Engine Dynamics Library

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In this paper the newly developed Engine Dynamics Library is presented. Ever increasing consumer and regulatory demand for improved fuel economy and lower emissions forces the engines and Engine After-Treatment Systems (EATS) to be improved continuously. Since the complete system is very complex, models are useful in cost effectively developing new control strategies and select hardware. The library is based on a mean-value combustion model and the focus lies on modeling the gas exchange with real-time like simulation times, useful for engine optimization and for evaluation of control strategies. The library contains models of the standard engine components such as manifolds, pipe, turbines, compressors, valves, mechanics, etc.

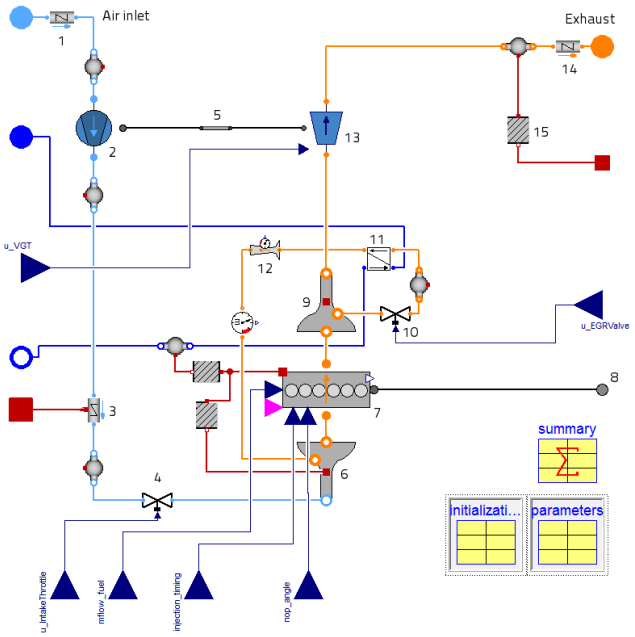

Figure 1: Diagram layer of the presented engine model

Simulation results from Dymola for a 13 L Volvo truck engine demonstrate that the model captures the transient flow and temperatures and emission trends, and has sufficient accuracy to be useful in engine optimization. The physical modeling approach allows for virtual prototyping by replacing individual components, which is an important advantage over black-box modeling. It is shown that the model captures essential system properties in the gas exchange, such as non-minimum phase behavior and sign reversal for VGT and EGR valve actuation. The model has been calibrated using surface fitting of maps and least-squares estimation of parameters in Matlab, as well as parameter optimization using JModelica and FMI.