Analyzing Local Combustion Environment with a Flamelet Model and Detailed Chemistry

Measurements have been done in order to obtain information concerning the effect of EGR for the smoke and NO_X emissions of a heavy-duty diesel engine. Measured smoke number and NO_X emissions are explained using detailed chemical kinetic calculations and CFD simulations. The local conditions in the research engine are analyzed by creating equivalence ratio - temperature (Phi-T) maps and analyzing the CFD results within these maps. The study uses different amount of EGR and the standard EN590 diesel fuel. The detailed chemical kinetic calculations take into account the different EGR rates. The CFD calculations are made with a flamelet based combustion model together with detailed chemistry. The results are compared to a previous study where a hybrid local flame area evolution model combined with an eddy breakup - type model was used in the CFD simulations. It was observed that NO_X emission trends can be well captured with the Phi-T maps but the situation is more difficult with the engine soot. Hence, the conclusion is the same as in the previous study with the hybrid combustion model. However, the local reaction zone is qualitatively very different with the flamelet model as compared to the hybrid model. Phi-T maps were also constructed for the total fixed nitrogen, using a detailed description of the nitrogen chemistry. EGR is typically used as an NO_X abatement technique, having the purpose to lower the temperature and thus the formation of thermal-NO. However, these maps revealed a new functionality of EGR as a NO_X abatement method.

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