EXHAUST AFTER-TREATMENT SYSTEM OPTIMIZATION FOR INDIAN REAL DRIVING EMISSION (RDE) CYCLE USING SIMULATION APPROACH FOR A SMALL COMMERCIAL VEHICLE APPLICATION

Emran Ashraf, Ehrly Markus, Sandhu Rouble, Chavan Sagar, Rathod Devising, Sharma Vijay, Körfer Thomas

FEV India Pvt. Ltd., India, FEV GmbH, Germany, FEV Group Holding GmbH, Germany

KEYWORDS – RDE, BS 6, small commercial vehicle, simulation, exhaust after treatment system, diesel engine

Research and/or Engineering Questions/Objective
Emission regulations across the globe are becoming stringent day by day. Seeing the alarming pollution levels across many cities in India, the Government of India has decided to enforce BS 6 emission legislation with Modified Indian Driving Cycle (MIDC) by the year 2020 & real driving emissions (RDE) cycle in the coming few years. This has put forward a major challenge for the Indian automotive industry. A RDE cycle will be quite dynamic and aggressive in terms of accelerations compared to the MIDC cycle, where the operation load points are spread across the larger part of the engine map. Therefore, the exhaust after-treatment system (EATS) solutions especially for NOx reduction to meet 2020 BSVI norms would be inadequate for future considering real driving emission norms.

Methodology
The study presented is done for a small commercial vehicle (SCV) selected from the India market in N1 Class 1 emission category. Inputs for simulations are taken from vast FEV internal database for similar engine and catalyst technologies. The merits of different EATS configurations are analyzed along with possible fuel consumption optimization strategies via a holistic simulation approach based on EATS simulations using FEV’s in-house developed MATLAB® - Simulink® based tool – FEV SimEx® & 1-D gas exchange simulations using GT-POWER tool. An Indian Real Driving Emission (RDE) cycle has been defined for this study based on actual recordings of real driving in and around Pune city, boundary conditions for which have been taken from AIS 137 draft legislation of the Automotive Research Association of India (ARAI). References for the defined RDE cycle have also been taken from corresponding European Regulation and FEV internal tool chain for RDE normalization and boundary condition verification as per actual Indian conditions.

Results
Different EATS layouts focusing more into two major available DeNOx technologies: Selective Catalyst Reduction (SCR) and Lean NOx Trap (LNT) has been selected as the part of study. The study also covers the engine level upgradations necessary to optimize the engine out emissions with respect to exhaust gas recirculation (EGR) strategy, EGR cooler & intercooler sizing etc. Cost analysis is also a part of this study, which compares different EATS layout based on required catalyst size, technology, consumed fluid cost etc. and required engine level modifications to provide an insight into the overall system cost.

Limitations
The scope for this study is limited to simulations, although the endeavor is to simulate real driving conditions, still the results may deviate to a certain extent owing to variations in actual driving conditions. It needs to be mentioned that the results presented here are validated with previous experiences with similar technologies utilizing the vast FEV experience and database.

What does the paper offer that is new in the field including in comparison to other work by the authors?
The study focuses on developing an optimized strategy for EATS considering the upcoming RDE emission norms in India post the BS 6 legislation implementation by 2020. This will be first such study for an Indian application especially in cost sensitive SCV segment where in a real RDE cycle has been defined.

Conclusion
This study provides a good insight to the Indian automotive sector regarding the optimized strategy development to arrive at the best EATS solution, which is also future RDE legislation ready for a small commercial vehicle. The paper also proposes the required modifications on the base engine to reduce the engine raw emissions keeping in mind the scope for fuel consumption improvement & overall system cost.