REWARD

REal World Advanced Technologies foR Diesel Engines

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Written By	Andrew Auld (RIC) Tiago Carvalho (RIC) Anthony White (RIC)	2016-10-12
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Project partners:
1 - AVL - AVL List GmbH - AT
2 - REN - Renault SAS - FR
3 - VCC - Volvo Car Corporation - SE
4 - CRF - CRF SCpA - IT
5 - CNRIM - Instituto Motori – Consiglio Nazionale delle Ricerche (CNR) - IT
6 - JM - Johnson Matthey Plc - UK
7 - RIC - Ricardo Plc - UK
8 - SCF - Schaeffler AG - DE
9 - LMM - Le Moteur Moderne - FR
10 - DELPHI - Delphi Automotive Systems Luxembourg S.A. -
LU 11 - UNR - Uniresearch BV - NL
12 - IFPEN - IFP Energies Nouvelles - FR
13 - VIF - Virtual Vehicle Research Center - AT
14 - CTH - Chalmers Tekniska Högskola - SE
15 - CTU - Czech Technical University - CZ
16 - UPVLC - Universitat Politecnica de Valencia – Motores Termicos - ES

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Publishable Executive summary

Recognising that real-world NO_X emissions have not decreased at the same rate as the legislated light-duty diesel (LDD) passenger car tailpipe emissions (from Euro 1 to Euro 6), the European Union is introducing the Real Driving Emissions (RDE) legislation with the aim to ensure real world and urban NO_X emissions reduction. This document details the activities within task 2.2 of Work Package 2 for the REWARD project. The main activity of this task was to evaluate exhaust thermal management (ETM) technologies and strategies, and the effect on the aftertreatment system.

To evaluate ETM technologies and strategies, simulations of the WP2 engine and aftertreatment system with the various technologies and strategies were performed using a combination of empirical input data from the appropriate engine and vehicle dyno tests, in conjunction with models of the engine and exhaust aftertreatment. From this, an assessment has been made as to the relevant applicability of each technology and strategy for aiding aftertreatment performance over the relevant vehicle drive cycles.

The aftertreatment systems recommended for the WP2 application were DOC and LNT systems twinned with a close-coupled actively dosed SCRF. It was seen that for both systems the addition of an exhaust system based electrically heated catalyst (EHC) can aid cycle conformity over the cycles evaluated. The benefit of the EHC through the local application of heat to the NO_X reduction catalyst, is mitigated by the increase in engine out NO_X from the direct loading of the engine and the losses within the electrical system. Engine based approaches for exhaust thermal management were shown, for both systems, to result in lower BSFC penalties compared to an EHC. The drive cycle simulations showed that, for low exhaust system temperature increases, intake throttling and combustion retard (through retarding the fuel injection) carried the lowest BSFC penalty – this approach is representative of typical production engines. Whereas, for higher exhaust system temperature increases, additional systems such as exhaust valve modulation through EVVT (exhaust variable valve timing) or EEVO (early exhaust valve opening) combined with combustion retard were required.

The two WP2 aftertreatment systems were evaluated, in-conjunction with the exhaust thermal management technologies, with regards to emissions control, system complexity and cost and additional fluid consumption. It was seen that the main benefit of the DOC+aSCRF system compared to the LNT+aSCRF system is the reduced cost and complexity, although this benefit is reduced by the likely additional oncost required from either an EHC or exhaust valve modulation system. The DOC+aSCRF system also carries a larger fuel consumption penalty for the increased level of exhaust thermal management required to achieve comparable urban NO_X control to the LNT system. The DOC fuel consumption penalty was found to be higher the LNT deNO_X and ETM fuel consumption penalty. From this assessment the original recommendation of an LNT+aSCRF with an engine based thermal management approach for the WP2 application still remains.