dieper

Diesel efficiency improvement with Particulates and emission Reduction

EUROPEAN COMMISSION
Horizon 2020

GA No. 723976

Deliverable No.	dieper D5.1
Deliverable Title	**Engine technology walk prediction that achieves at least 5% CO_2 improvement and EU6 RDE emissions** **Part 1 Engine Hardware** **Part 2 Aftertreatment**
Deliverable Type	2-PART REPORT
Dissemination level	Confidential – member only (CO)

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Deliverable No.	dieper D5.1 Part 1	
Deliverable Title	Engine technology walk prediction that achieves at least 5% CO_2 improvement and EU6 RDE emissions – **Part 1 Engine Hardware**	
Deliverable Type	REPORT	
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Project partners:

1 – AVL – AVL List GmbH – AT
2 – REN – Renault SAS – FR
3 – IFP – Energies nouvelles – IFPEN – FR
4 – CMT – Universitat Politécnica de Valencia – ES
5 – JM – Johnson Matthey Plc – UK
6 – CONTI – Continental Automotive France SAS – FR
7 – BOSCH – Robert Bosch GmbH – DE
8 – CNR – Consiglio Nazionale delle Ricerche – IT
9 – FMF – FPT Motorenforschung AG – CH
10 – IVECO – IVECO S.p.A. – IT
11 – RCD – Ricardo Plc – UK
12 – ECN – ECOLE CENTRALE DE NANTES – FR
13 – SIE – SIEMENS INDUSTEY SOFTWARE SAS – FR
14 – VIF – Kompetenzzentrum – Das Virtuelle Fahrzeug, Forschungsgesellschaft mbH – AT
15 – UNR – Uniresearch BV – NL
16 – CRF – Centro Ricerche SCPA – IT

Disclaimer:

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Executive Summary

As part of the Task 5.1 specified in the dieper description of work (DoW) this document was generated as the Deliverable 5.1-Part1 with the purpose of reporting the main activities that have taken place and offered significant contribution to this task (5.1). It describes the intended improvements for the F1C engine and its subsystems for the Iveco Daily donor-vehicle. The improvements will be introduced in the donor vehicle to convert it into the demonstrator vehicle for final testing at the independent Institute Virtuelles Fahrzeug (ViF).

The targets for the improved Demonstrator vehicle are to achieve half of Euro VI emissions with an 80% PN reduction including nano-particulates between 10 and 23 nm size. These requirements must be fulfilled under real driving conditions (RDE) together with a 5% fuel consumption improvement in the WLTP test procedure.

To meet the targets, the engine itself and its major subsystems are being heavily re-developed following a calculation and simulation based approach, before rolling out to hardware testing. As a first step, several engine performance simulation activities were performed to characterise the improvements that could be achieved through optimisation of the turbocharger layout together with an alternative air handling set-up (LP / HP EGR). Also, changes to cylinderhead design and cam profiles were evaluated. CFD was used to explore the potential of a quiescent combustion concept in conjunction with reduced dead volumes in the cylinder. In addition to this, the lubrication and cooling systems were modelled to allow further improvements when utilising systems such as electronic thermostat and variable displacement oil pump.

As an output of the calculation / simulation activity, the basic engine layout was defined leading to the next step of on-engine testing. It was decided that the engine will include:

- LP and HP EGR both cooled and with the ability to bypass the HP cooler
- New combustion recipe with respect to the base parameters of FIS, combustion chamber, swirl and CR
- Electronically controlled VGT with new optimised aerodynamic characteristics
- Friction reduction package
- VDOP and Electronic coolant thermostat
- Indirect water-cooled CAC system

For the on-engine testing a DOE approach has been heavily used to identify optimal hardware combinations in conjunction with traditional testing methods where necessary. It is expected that this layout, whilst utilising newly developed engine control software, will provide a suitable engine solution that when installed on the dieper demonstrator vehicle will enable it to reach the fuel economy targets (Table 1).

Table 1: Predicted FC Gains

dieper Predicted Fuel Consumption Gains	FC gain [%]
Combustion	1.2
Air Handling	2.1
EGR	0.5
Friction	1.9
Oil System	0.8
Cooling System	0.5
ATS (incr. back-pressure & heat-up needs)	-2.0
Other Powertrain Improvements	0.2
Total	**5.2**

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Deliverable No.	dieper D5.1 – Part 2	
Deliverable Title	Engine technology walk prediction that achieves at least 5% CO_2 improvement and EU6 RDE emissions – **Part 2 Aftertreatment**	
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Executive Summary

This document describes the analysis performed to specify exhaust aftertreatment for the dieper Work-Package 5 IVECO Daily demonstrator vehicle. The targets for the vehicle can broadly be described as "half of Euro 6", with compliance to be demonstrated over WLTC and RDE (Real Driving Emissions) tests, in conjunction with a 5% improvement in fuel economy (over WLTC). A complete forward-facing vehicle model (consisting of drivetrain, engine, aftertreatment, and supervisory controllers) was created using the Ricardo IMBD (Integrated Model-Based Development) toolchain. The aftertreatment section was modified to allow a wide range of aftertreatment concepts to be considered, including Selective Catalytic Reduction (SCR), Passive NOx Adsorber (PNA), Leant NOx Trap (LNT), Diesel Oxidation Catalyst (DOC), Diesel Particulate Filter (DPF) and Selective Catalytic Reduction on Filter (SCRF) catalysts, combined in any order along the exhaust path. The use of an electric heater in the exhaust line versus engine-based strategies to control exhaust temperature was also explored. The IVECO Daily vehicle was simulated over a range of drive cycles and the most promising two aftertreatment concepts to be tested on the engine test-bed were identified as:

- PNA + SCRF + SCR
- eDOC + SCRF + SCR (eDOC = electrically heated DOC)

The WP5 consortium members agreed to also test DOC + SCRF + SCR. This will enable the consortium members to gain a good understanding of the differences in performance between state of the art PNA and DOC technology. Catalysts for the selected aftertreatment concepts will be procured for screening on engine test-bed at Ricardo, then final selection of the aftertreatment for the demonstrator vehicle will be made.