



REWARD

REal World Advanced Technologies foR Diesel Engines

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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 Technologies GmbH & Co. KG - 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
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Executive summary

Within the REWARD project, many dissemination activities have been undertaken and will be undertaken towards the end of the project. Among them are many (scientific) publications. This deliverable is a summary book of all publications.

Information regarding publications has been stored in a living document. This document requires entries regarding each publication, on items such as title, author, DOI, journal etc. In addition, all have been summaries in the form of an abstract. This abstract is now part of this deliverable, for public use.

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1 Purpose of the Document

This document summarises the scientific and technical publications made in the frame of the REWARD Project.

1.1 Document Structure

The main parts of the document are dedicated to:

- Chapter 3 Dissemination Approach
- Chapter 4 Dissemination achievements (scientific and technical publications)

A current overview of the scientific and technical publications identified for the deliverable can be found in this document; any other dissemination activities and achievements (i.e. participation to workshops etc.) can be found in Appendix 1. This table also gives an insight on how publications are monitored and managed within the REWARD project.

1.2 Deviations from original Description in the Grant Agreement Annex 1 Part A

1.2.1 Description of work related to deliverable in GA Annex 1 – Part A

A Dissemination Approach has been developed (and discussed and approved by the General Assembly). The plan identifies: scientific and technical Publications, other dissemination activities, IP rights, and exploitable foreground.

1.2.2 Time deviations from original planning in GA Annex 1 – Part A

There are no deviations with respect to timing of this deliverable.

1.2.3 Content deviations from original plan in GA Annex 1 – Part A

There are no deviations from the Annex 1 – Part A with respect to the content.

2 Introduction

The REWARD project is a medium-sized research project, running over a three year period and involving 16 different partners in 8 work packages with tasks and subtasks. One workpackage in particular is dedicated to dissemination. In order to assure that the project objectives results become known, an appropriate action plan has been discussed. Also in order to keep track of all activities, a dissemination approach is in place. This document summarises the actual achievements in terms of technical and scientific publications. It is Deliverable D8.3 of the REWARD project.

The aim of the present document is to provide a public insight into results and achievements of the REWARD project.

3 Dissemination Approach

The REWARD Dissemination Plan (D8.2) was prepared in M4 to give a holistic account of the communication and actions of the project, as well as to identify the project dissemination objectives, targets, strategies and tools, also for publications. The plan has given orientation for the activities throughout the entire duration of the project, including the publications. Communication and dissemination activities are crucial for the execution and the success of the project. The Dissemination plan has therefore regularly been evaluated and updated according to the rising dissemination needs throughout the project. Feedback from the REWARD Executive Board has been assured at all times.

This summary of publications therefore describes briefly again the dissemination approach and the role of the partners within it.

3.1 Dissemination strategy

- To communicate/disseminate the knowledge – after protection of intellectual property – to the international transport community and beyond. Most partners are directly or indirectly members of the European Road Transport Research Advisory Council (ERTRAC). Renault, Volvo and CRF are members of EUCAR, the European Council for Automotive R&D in which all major European vehicle manufacturers are involved. Schaeffler and Delphi are members of CLEPA, the European Association of Automotive Suppliers. AVL List GmbH and Ricardo Plc are members of EARPA. Many consortium partners have relationships with chief scientific advisors, ministers and key influential people and are active in lobbying (inter)national governments for advancements in sustainable transport and logistics;
- To interact with international partnerships and counterparts; the latter amongst others through EUCAR, CLEPA, EARPA and ERTRAC
- To create adoption and positive public awareness through the website and optionally through campaigns directed at social media. The latter becomes more relevant in the market introduction phase.

The strategy is depicted in the figure below.

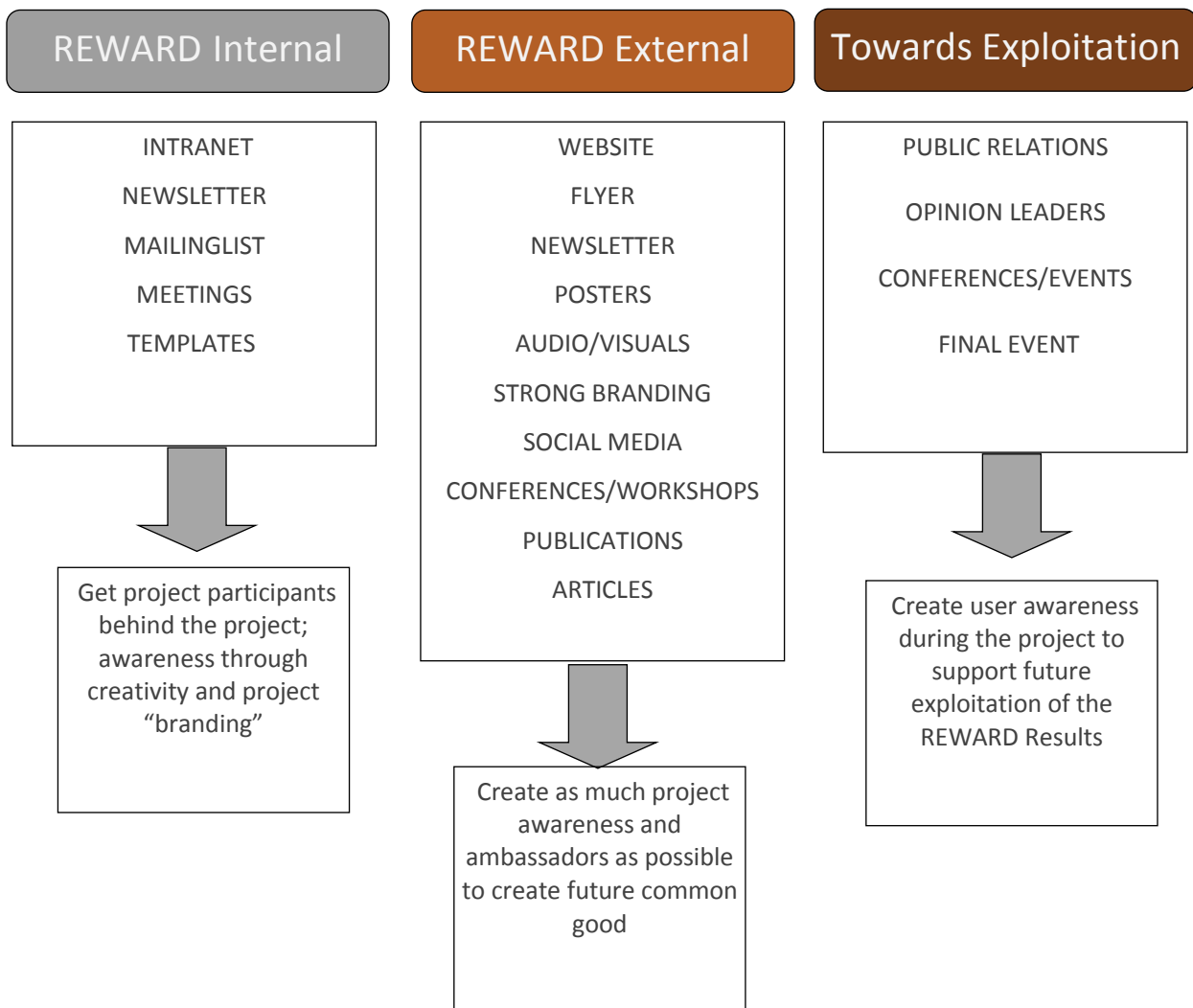


Figure 3-1 REWARD Dissemination Strategy

3.2 Target groups and stakeholders

Communication is aimed at the following target audiences and stakeholder groups:

1. The Diesel community comprising transport companies ranging from small companies to international operating medium and large sized companies;
2. The European Road Transport Research Advisory Council (ERTRAC) and underlying initiatives, e.g. Green Vehicles and advisory bodies;
3. Agencies, legislative authorities, standardization committees (e.g. ISO, SAE international), organisations and special interest groups linked to the project’s goals and topic as well as to representatives of the European - and national parliaments;
4. Any other interested parties: the general public, (inter)national newspapers, the wider press (TV, radio, schools/colleges/universities, etc.)

A list of relevant companies and persons was being compiled with input from all partners. The database is accessible via the REWARD project partner internal website. The database is maintained by the project management team (Uniresearch).

3.3 Communication, Dissemination and Exploitation Objectives

The communication and dissemination actions in REWARD are envisaged to communicate and disseminate the activities carried out during the entire duration of the project, the project's main scientific achievements and the initiatives organized by the partners of the project within the framework of REWARD as well as their participation in major European and worldwide events and scientific conferences.

This project aims to achieve, within its project duration, the following communication objectives:

- To manage the communication network of REWARD
- To communicate the activities and results of the project
- To participate in symposia, workshops, meetings as well as organise the Final Event at the end of the project
- To create a dedicated website for the REWARD project, with public and Members' Only sections
- To create all needed communication tools to give a visual identity to the project (e.g. project branding)
- To ensure the proper communication and dissemination of the information generated by the project to relevant stakeholders
- To facilitate the communication systems within the project, as well as with other relevant related projects and organizations in order to promote the sharing of data and knowledge

3.4 Dissemination Channels and Tools

The main channels and tools used for dissemination include:

- REWARD Website: a project website where the project is presented to the automotive (research) community in the first place, as well as the general public
- REWARD Reports: public versions of project reports, available at the public website. In case of restricted (confidential) deliverables: a public executive summary will be published. This will be part of each deliverable and is indicated in the project deliverable template
- REWARD Flyer: A flyer providing basic information about the project main goals, the technical approach, the expected achievements and a list of project participants and its consortium. This will serve as the project's business card and will be distributed as widely as possible at any appropriate occasion. The flyer will also be digitally available on the public website.
- REWARD Newsletters: at least three newsletters will be created in the REWARD project, comprising the description of new developments and results. Additionally, at any time where it is regarded relevant, a newsletter will be issued, especially when news results become available
- Scientific Publications: Throughout the project lifetime, the partners will produce articles defining the project and its available results, and will submit them for publication in internationally renowned business and scientific journals
- REWARD Workshops – it is foreseen that the REWARD consortium will organise 2 open workshop (or mini conferences) at the beginning and end of the project, at e.g. the TRA2016 as part of a regular International Automotive Technology conference, the IAA in Hannover (DE) in 2016.
- REWARD Final Event
- REWARD Project Logo

Apart from the mentioned tools, presentations on the project, images and graphics have been produced to support the dissemination actions.

3.5 Quantification and timing of the Dissemination activities

The following table provides a quantification of the project’s dissemination activities, and sets a basis for verifying whether the project dissemination objectives have been met. Monitoring has been done throughout the project and was included in the official reporting at M18.

Table 3-1 Quantification of general REWARD Dissemination Activities

Dissemination measure	Purpose	Key Performance Indicator	Monitoring M30
Project updates on REWARD website	General information	≥ 10 updates/year ≥ 1000 views/year	10 updates/year
Organization of GA and EB meetings	Knowledge exchange	≥ 6 meetings/year	Organization of 3 GA meetings and 24 EB meetings
Organization of workshops	Knowledge exchange	≥ 1 workshops/year	Parallel workshops with dieper project at TRA2018
Participation in Conferences, meetings	Knowledge exchange	6 conferences in total Participation in ≥ 1 meeting/year	Participation with active presentation in 22 conferences
Open Access publications	Research	≥ 5-10 publications in total	One OpenAir publications, Four scientific publications with DOI
Online publishing (online magazines, newspapers, newsletters, blogs)	General Information	≥ 6 newsletters (half-yearly)	1 newsletters, 1 press release

3.5.1 Dissemination timing

The proper timing of the dissemination actions is crucial for an effective dissemination of the project results. The picture below depicts the overall project planning of all activities in the WP8 Dissemination and exploitation.



Figure 3-2 REWARD Dissemination Timing

In the first phase of the project all the tools were set up. In the remainder of the project the planned activities have been executed and monitored.

Future dissemination activities

2018 – 2020	Demonstration activities at end-user level to gain acceptance of the new technologies
2018 – 2020	Present results of research activities as follow-up at international conferences, e.g. TRA 2018 and through the project's website
2018 – 2020	Availability of the project website, to keep results and findings directly accessible to the public
2018 – 2020	Presentation of overview reports to stakeholder groups like CLEPA, EARPA, and EUCAR

In the REWARD project, we distinguish between three types of quality: the scientific/technical quality of the work, the quality of the deliverables and the quality of the administrative processes. This document addresses the processes in place in the REWARD project to assure the scientific and technical quality of publications in general.

3.6 Scientific and Technical Quality

The quality of the overall outcome of the project is primarily dependent upon the quality of the execution of the innovation and demonstration activities. Formally, the quality of the work is monitored throughout the project by the General Assembly, the Executive Board and the project management team. Informally, each and every project team member, including the WP leaders and the coordinator, has the responsibility to critically consider the quality of the work and strive for the best possible results. Potential deviations from the project plan must be anticipated and identified in a timely manner to allow mitigating actions to be developed and planned. In this way, quality can subsequently be maintained by taking suitable corrective actions to recover the deficiency in output or time delay. In this process, particular attention will be paid to monitoring, and supporting good communication and cooperation between work packages in order to avoid a fragmentation of the activities, which could lead to a mismatch between interrelated work packages.

3.7 Quality of Results, including publications

The publications of REWARD are the output of the research and innovation activities and, as such, should be high-quality representations of the activities undertaken. The quality of the publications is managed through a straightforward review process, which was agreed during the REWARD Kick off.

During the Kick Off Meeting it was agreed that the Executive Board is the body for quality assurance. The procedure for review and approval of publications rests on the premise that the author of the publication is the technical expert on the topic of the publication and as such is responsible for the technical content. The work package leader should check the publication, as well as any other contributing partner.

The Executive Board (representing all partners in the project through its members: the work package leaders), preforms the final review of any publication, focusing on general fit with the project objectives.

3.8 Storage

All finalised publications will be stored at the internal ProjectPlace website for partners.

3.9 Procedure in Case of Disagreement in the Review Process

For every publication the author will take the review comments into account. A motivated explanation is required if it is not possible to process the comments as requested by the reviewer, or if the author(s) disagree with the comments received.

In case of remaining disagreement, the project coordinator will guide the process and will ensure a convergence of the process towards a final result.

3.10 Papers and Presentations

The review and acceptance protocols for the Deliverables regarding Dissemination (such as: publications of articles and public presentations) have been defined in the signed Consortium Agreement, article 15: Dissemination, Publicity and Press Releases as quoted below:

Article 15: Dissemination, Publicity and Press Releases

- 15.1 The BENEFICIARIES shall not issue any press release or similar publicity about the PROJECT without the prior approval of the EXECUTIVE BOARD, which shall not be unreasonably withheld or delayed longer than four weeks after receipt by the EXECUTIVE BOARD.
- 15.2 Without prejudice to any other obligations in this CONSORTIUM AGREEMENT, each relevant BENEFICIARY shall be entitled to disseminate and/or publish without prior notice to the other BENEFICIARIES its own RESULTS. In case such RESULTS are jointly generated by two or more BENEFICIARIES or contains BACKGROUND or CONFIDENTIAL INFORMATION of a CO-OWNING BENEFICIARY, the CO-OWNING BENEFICIARY being interested in dissemination and/or publication, shall ask the other CO-OWNING BENEFICIARIES for their written consent.

A BENEFICIARY shall not disseminate or publish BACKGROUND, RESULTS or Confidential information of another BENEFICIARY without the prior written approval of the BENEFICIARY.

The other CO-OWNING BENEFICIARIES are entitled to object the publication or other dissemination activities if

- (a) the objecting BENEFICIARIES' LEGITIMATE INTERESTS are compromised by the publication or other dissemination activity, or
- (b) the protection of the objecting BENEFICIARIES' RESULTS is adversely affected.

The objection has to be in writing and to include a precise request for necessary modifications.

4 Scientific and technical publications

To increase the impact of the project results and to promote debate to accelerate the implementation of these results, presentations were given at international conferences and exhibitions. Envisaged actions were:

- yearly presentations of the project/project results at one or more conferences
- (invited) presentations at events by EC, national governments and other stakeholders
- publications in scientific journals (once the IPR is protected)

Role of the partners: all partners to contribute and initiate these activities, when appropriate. UNR has issued and maintained a list of publications and presentations as part of the Dissemination plan and periodic reporting.

4.1 International conferences and exhibitions

The REWARD project partners presented project results at international conferences and exhibitions. The tables below provide an overview of conferences attended and business and technical journal publications.

Table 5-1 List of publications at Conferences and exhibitions

Title	First author	Partner	Conference and exhibitions	Year/date
Impact of soot on selective catalytic reduction of NH ₃ , NH ₃ oxidation and NH ₃ -TPD over Cu/SSZ-13 zeolite	Trandafilovic, L.	Chalmers	Yearly report KCK (<i>Competence Center Catalysis, Chalmers University</i>) 2016	2016
Impact of soot on selective catalytic reduction of NH ₃ , NH ₃ oxidation and NH ₃ -TPD over Cu/SSZ-13 zeolite	Trandafilovic, L.	Chalmers	Presented at 18th International Conference on Chemical Engineering and Heterogeneous Catalysis (ICCEHC), Paris, France, November 2016	2016
The effects of catalyst aging on sulfur degradation over fully formulated Lean NO _x Trap catalysts	Wentworth, T.	Chalmers	Yearly report KCK (<i>Competence Center Catalysis, Chalmers University</i>) 2016	2016
The effects of catalyst aging on sulfur degradation over fully formulated Lean NO _x Trap catalysts	Wentworth, T.	Chalmers	Presented at the 2 nd International Symposium on Catalytic science and Technology in Sustainable Energy and Environment (EECAT) TianJin, China	2016
The effects of catalyst aging on sulfur degradation over fully formulated Lean NO _x Trap catalysts	Wentworth, T.	Chalmers	Presented at the 2016 American Institute of Chemical Engineering (AIChE) Annual Meeting, San Francisco, California	2016
Experiment and kinetic modelling of SCR coated filters	Trandafilovic, L.	Chalmers	AVL International Simulation Conference,	2017

D8.3 – Summary book of all publications

			Graz, Austria, June 2017	
Kinetic model of DPF and SCR coated filter – Impact of ammonia	Trandafilovic, L.	Chalmers	Paper in preparation (2017)	2017
The effects of combining hydro thermal and sulfur aging over Lean NOx Trap catalysts	Trandafilovic, L.	Chalmers	Paper in manuscript (2017)	2017
Model based combustion-chamber layout for passenger car Diesel engines	Machold, A.	AVL, VCC	4th International Engine Congress, Baden-Baden, 21-22 Feb 2017	2017
Friction Reduction Tested for a Downsized Diesel Engine with Low-Viscosity Lubricants Including a Novel Polyalkylene Glycol	Sander, D.	Vif, REN	Lubricants 2017, 5(2), 9	2017
Assessment of Light Duty Diesel After-treatment Technology Targeting Beyond Euro 6d Emissions Levels	Auld, A.	RCD	SAE Paper 2017-01-0978 SAE World Congress 2017	2017
Design of a fuel-efficient two-stroke Diesel engine for medium passenger cars: comparison between standard and reverse uniflow scavenging architectures	Galpin, J.	IFPEN, REN	2017 SAE World Congress Detroit SAE Paper 2017-01-0645	2017
Experimental and Numerical Characterization of Diesel Injection in SCRE with Rate Shaping Strategy	Mancaruso, E.	CNR	ICE2017 – International Conference on Engines and Vehicles, Capri, Napoli, 10-14 September 2017	2017
Diesel Engine Technologies Evolution for Future Challenges	Tonetti, M.	CRF	ICE2017 – International Conference on Engines and Vehicles, Capri, Napoli, 10-14 September 2017	2017
Vehicle demonstration of performance and economy of a comprehensive B/C class Diesel engine and aftertreatment system approach for emissions beyond Euro 6	Buergler, L.	AVL, REN, JM, IFPEN	Transport Research Arena 2018; Vienna, 16-19 April 2018	2018
A 4-Cylinder High Performance Diesel Engine Concept for D/E-class vehicles featuring low fuel consumption and EU7 emission levels	Bohatsch, S.	VCC, AVL	Transport Research Arena 2018; Vienna, 16-19 April 2018	2018
Design of a fuel-efficient two-stroke Diesel engine for medium passenger cars: assessment of the best suited scavenging architecture, stroke-to-bore ratio and air-loop lay-out	Galpin, J.	IFPEN, CTU, CMT, REN	Transport Research Arena 2018; Vienna, 16-19 April 2018	2018
A tribological study of DLC systems for valve train application	R.H.Brugnara	Schaeffler	6° Workshop AIT “Tribologia e Industria” Turin, Italy	2018

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NOx Emission Estimation Using Global In-Cylinder Pressure Signal for Diesel Engines	F.Lippens	IFPEN	Symposium for Combustion Control 2018	2018
High performance diesel engine beyond 100 kW/lit for E-class passenger car with quiescent combustion concept and optimum matched aftertreatment system approach for emissions well below Euro 6	L.Buergler	AVL	SIA ROUEN	2018
Holistic Diesel Combustion System Design – optimizing fuel-air mixing, heat transfer and combustion at low emissions level	P.Anselmi	IFPEN	SIA ROUEN	2018
The effects of combined hydrothermal and sulfur poisoning over Pt/Ba/CeZr/Al ₂ O ₃ Lean NOx Trap catalysts	Travis Wentworth, Marie Stenfeldt, Louise Olsson	Chalmers	ACS	2018
Analysing Engine Friction in View of the New WLTC Driving Cycle	Allmaier, Hannes, David E. Sander, Slavitsa Damjanovic, and Philippe Mallet	Vif	MTZ worldwide (Springer)	2018
Eco-driving Optimization Tool for Hybrid Vehicles with Low CO ₂ Emissions	Pavel Brynych, Jan Macek, Czech University of Prague	CTU	ATA	2018
Design of a fuel-efficient two-stroke Diesel engine for medium passenger cars: assessment of the best suited scavenging architecture, stroke-to-bore ratio and air-loop lay-out	Fano Rampanarico	Renault	TRA2018	2018
Lean and rich aging of Cu/SSZ-13 for SCR	Xavier Auvray	Chalmers	KCK report	2018

Table 5-2 List of DOI publications in scientific journals

DOI	Business and scientific Journal/Title	Year/date	Partner	Comment
10.4271/2017-01-0645	SAE International - Design of a fuel-efficient two-stroke Diesel engine for medium passenger cars: comparison between standard and reverse uniflow scavenging architectures	2017	IFP Energies nouvelles, Institut Carnot;	Volume nr. ISSN: 0148-7191
10.3390/lubricants5020009	Friction Reduction Tested for a Downsized Diesel Engine with Low-Viscosity Lubricants Including a Novel Polyalkylene Glycol	2017	Vif	MDPI 2017 ISSN 2075-4442

D8.3 – Summary book of all publications

10.4271/2017-24-0113	Experimental and Numerical Characterization of Diesel Injection in Single-Cylinder Research Engine with Rate Shaping Strategy	2017	CNR	SAE Technical Paper
10.4271/2017-24-0179	Diesel Engine Technologies Evolution for Future Challenges	2017	CRF	SAE Technical Paper
10.4271/2018-01-0166	Representation of Two-Stroke Engine Scavenging in 1D Models Using 3D Simulations	2018	CTU	SAE Technical Paper

4.2 Abstracts

Title: Impact of soot on selective catalytic reduction of NH₃, NH₃ oxidation and NH₃-TPD over Cu/SSZ-13 zeolite

Authors: Lidija Trandafilović, Chalmers

Journal: Yearly report KCK 2016

Abstract

When fuel is combusted in engine various products that are harmful to humans are created, such as NO_x, HC, SO_x, soot, etc. Some of the products, when inhaled, may cause cancer, asthma and cardiac problems [1]. Ammonia-Selective Catalytic Reduction (NH₃-SCR), where NH₃ is used as reductant for reducing NO_x, is one of the most efficient post combustion abatement technologies, commonly used for emission control in diesel engines. Among various materials used for NH₃-SCR, zeolites, and especially metal exchange zeolites, have proven to be particularly appropriate for the NH₃-SCR process with an exceptional activity and selectivity over a wide temperature range [2,3]. Moreover, Cu/SSZ-13 zeolites, based on the chabazite (CHA) topology, have a large surface area, high adsorption capacity, high thermal and hydrothermal stability [4]. SCR coated particulate filter is a device that captures soot and simultaneously is active for ammonia SCR. There are large advantages with using SCR coated filters, such as decreased volume and also better light off characteristics, since both the SCR function as well as filter function is close to the engine. The objective of this work is to study the effect of soot on SCR coated filters.

Title: The effects of catalyst aging on sulfur degradation over fully formulated Lean NO_x Trap catalysts

Authors: Travis Wentworth, Chalmers

Journal: Yearly report KCK 2016

Abstract

Lean NO_x trap catalysts are subjected to both hydrothermal aging and sulfur deactivation in real world environments. Studies have shown that hydrothermal aging can increase noble metal particle size and subsequently reduce the ability of the catalyst to oxidize NO. This results in reduced NO_x storage, and ultimately reduced NO_x conversion. Furthermore, literature has observed that the degree of sulfur deactivation varies with changes in catalysts parameters such as barium loading¹, this is an indicator that changing catalyst morphology via another mechanism such as hydrothermal aging could also change the degree to which the catalyst is sulfated. Because, both catalyst aging and deactivation due to sulfur occur in real world environments it is important to understand the effects of these two mechanism in conjunction.

Title: Model based combustion-chamber layout for passenger car Diesel engines

Authors: DI Alexander Machold, DI Ludwig Bürgler, DI Andreas Ennemoser, DI Markus Grubmüller, Dr. Håkan Persson, Dr. Ayolt Helmantel, Dr. Aristotelis Babajimopoulos

Journal: Conference Proceedings ATZ 4th 4th International Engine Congress 2017

Passenger Car Engines Program

Publisher: ATZ

Abstract

The development of the optimal combustion process is a challenge engineers have been struggling with for a long time. The optimization of all the different hardware parameters like combustion chamber geometry, swirl, nozzle flow, number of nozzle holes, tip protrusion and so on, is a big challenge and is currently performed with the use of single-cylinder up to full scale engine testing. More stringent legislation on emission control, growing system complexity and variant diversity make it especially challenging to develop an optimum combustion system.

Although tools like CFD are already well accepted and applied in the industry, there is still potential to better support the hardware development phase. Remaining efficiency potential needs to be exploited in an economic way.

In this paper we present a new approach to combustion process development. With high speed CFD simulation a large number of different hardware combinations (tens of thousands) are calculated. The results of this huge parameter study are used to set up a multi-dimensional DoE model using AVL's CAMEO tool. Finally the optimization within the model space for best fuel consumption / Soot emission trade-off can predict which hardware configuration is the most promising, but also which one should not be tested. Finally a validation on the test bed is required. By using this novel approach the most promising hardware for optimal combustion can be found swiftly and efficiently. This reduces the time required at the engine test bench thus significantly reducing the costs while allowing more parameters to be investigated.

The piston bowl and fuel injection system defined by 3D CFD was tested by VCC (Volvo Car Cooperation) on a single cylinder test bed and the findings of the CFD based layout could be confirmed.

Title: Assessment of Light Duty Diesel After-treatment Technology Targeting Beyond Euro 6d Emissions Levels

Authors: Andrew Auld, Andy Ward, Benjamin Hansen, Kenan Mustafa

Ricardo UK Ltd

Publisher: SAE World Congress 2017

Abstract

Since previous publications, Ricardo have continued to investigate the development of advanced after-treatment technologies through model based system simulation using an integrated model based development (IMBD) approach. This paper presents the results of the evaluation of after-treatment systems and management strategies for a range of diesel passenger cars. The targets of this study are applicable to Real Driving Emissions (RDE) legislation, but now targeting emissions levels beyond Euro 6d. The work was carried out as part of the EC Horizon 2020 co-funded REWARD (Real World Advanced technologies for Diesel engines) project. Owing to the wide variation in feed-gas properties expected over an RDE cycle, the results seen for current production system architectures such as Lean NOX traps (LNT) or actively dosed Selective Catalytic Reduction (aSCR) systems highlight the challenge to adhere to emissions limitations for RDE legislation whilst fulfilling stringent CO2 targets. Optimisation of both the after-treatment system configuration and control strategies are required. Vehicle simulation has been performed with a range of after-treatment system specifications and engine-out feed-gas properties. The work includes an assessment of exhaust thermal management with regards to catalyst performance. The results are evaluated considering a range of criteria including; emissions control capability, estimated system on-cost, packaging limitations, fuel consumption penalty and additional fluid consumption. After-treatment system recommendations are made that deliver appropriate emissions control for a range of legislative, RDE and urban cycles for a selection of light duty diesel applications.

Title: Design of a fuel-efficient two-stroke Diesel engine for medium passenger cars: comparison between standard and reverse uniflow scavenging architectures

Authors: Jeremy GALPIN, Thierry Colliou, Olivier Laget, Fabien Rabeau, Gaetano De Paola, IFP Energies nouvelles, Institut Carnot;

Journal: SAE International

Publisher: SAE World Congress 2017

Abstract

In spite of the increasingly stringent emission standards, the constant growth of road traffic contributes to climate change and induces detrimental effects on the environment. The European REWARD project (REal World Advanced Technologies for Diesel Engines) aims to develop a new generation of Diesel engines complying with stricter post Euro 6 legislation and with lower CO₂ emissions. Among the different technologies developed, a fuel-efficient two-stroke Diesel engine suited for C-segment passenger cars will be designed and experimentally evaluated.

One major challenge for two-stroke engines is the achievement of an efficient scavenging. As the emptying of the in-cylinder burnt gases and the filling by fresh gases is performed at the same time, the challenge consists in removing as much burnt gases as possible while avoiding the by-pass of fresh air toward the exhaust line. For the considered application, the uniflow scavenging architecture, which is featured by ports located in the bottom of the cylinder and valves in the head, is selected. Two possible arrangements for the intake and the exhaust are compared: either the standard configuration for which the intake is ensured by the ports and the exhaust by the valves or the reverse configuration.

Both standard and reverse configurations are first compared through OD system simulations, performed with LMS Imagine. Lab Amesim and then by 3D CFD simulations with CONVERGE. The standard configuration is favored, thanks to better ISFC performances, especially at low and medium loads operating conditions. In addition, the scavenging is strongly penalized for the reverse architecture due to the drag downstream the intake valves.

Title: Diesel Engine Technologies Evolution for Future Challenges

Authors: Marco Tonetti, Giorgio Rustici, and Massimo Buscema, CRF

Luca Ferraris, FCA Italy S.p.A.

Journal: SAE International

Publisher: ICE2017 – International Conference on Engines and Vehicles, Capri, Napoli, 10-14 September 2017

Abstract

Final Euro6d emission legislation with the new homologation cycle and Real Driving Emission requirements has set a strong challenge for the ICE Passenger Car applications.

Thanks to their well-known low fuel consumption characteristics, Diesel Engines can play a key role for the fulfillment of the European 2020 CO₂ fleet target but need to confirm their capability to fully control noxious emissions even in extreme operating conditions, while restraining the overall engine costs and complexity.

Title: Experimental and Numerical Characterization of Diesel Injection in SCRE with Rate Shaping Strategy

Authors: Ezio Mancaruso, Luigi Sequino, Bianca Maria Vaglieco, Istituto Motori - CNR

Cameretti, M., Univ of Napoli Federico II

Publisher: ICE2017 – International Conference on Engines and Vehicles, Capri, Napoli, 10-14 september 2017

Abstract

The management of multiple injections in compression ignition (CI) engines is one of the most common ways to increase engine performance by avoiding hardware modifications and after-treatment systems. Great attention is given to the profile of the injection rate since it controls the fuel delivery in the cylinder. The Injection Rate Shaping (IRS) is a technique that aims to manage the quantity of injected fuel during the injection process via a proper definition of the injection timing (injection duration and dwell time). In particular, it consists in closer and centered injection events and in a split main injection with a very small dwell time. From the experimental point of view, the performance of an IRS strategy has been studied in an optical CI engine. In particular, liquid and vapor phases of the injected fuel have been acquired via visible and infrared imaging, respectively. Injection parameters, like penetration and cone angle have been determined and analyzed. The data have been collected by running an

engine condition of the homologation cycle New European Driving Cycle (NEDC) with two values of the swirl ratio. Computational activities, aiming at the simulation of the in-cylinder phenomena and specifically the injection process starting from experimental data, have been performed by adopting the 3D Ansys-Fluent solver. In particular, the fluid-dynamic calculations performed in a 3D domain, allowed to describe the spray evolution in the combustion chamber and carrying out the spray characteristics such as tip penetrations, Sauter mean diameters and droplets distributions. Besides, the spatial vapor distributions allowed detecting the mixing rate and the regions where the first flame spots should appear. After a proper identification of the parameters of the atomization model by a comparison with the experimental results, the CFD model potentialities for the prediction of the main features of new injection strategies should be verified. Such combined experimental and numerical activity would be able to point out the potential of IRS strategy with reduced nozzle diameter to improve the air/fuel mixing.

Title: Friction Reduction Tested for a Downsized Diesel Engine with Low-Viscosity Lubricants Including a Novel Polyalkylene Glycol

Authors: David E. Sander, Christoph Knauder, Hannes Allmaier, Slavitsa Damjanović-Le Baleur, Vif and Philippe Mallet, Renault

Publisher: MDPI 2017

Abstract

With the increasing pressure to reduce emissions, friction reduction is always an up-to-date topic in the automotive industry. Among the various possibilities to reduce mechanical friction, the usage of a low-viscosity lubricant in the engine is one of the most effective and most economic options. Therefore, lubricants of continuously lower viscosity are being developed and offered on the market that promise to reduce engine friction while avoiding deleterious mixed lubrication and wear. In this work, a 1.6 L downsized Diesel engine is used on a highly accurate engine friction test-rig to determine the potential for friction reduction using low viscosity lubricants under realistic operating conditions including high engine loads. In particular, two hydrocarbon-based lubricants, 0W30 and 0W20, are investigated as well as a novel experimental lubricant, which is based on a polyalkylene glycol base stock. Total engine friction is measured for all three lubricants, which show a general 5% advantage for the 0W20 in comparison to the 0W30 lubricant. The polyalkylene glycol-based lubricant, however, shows strongly reduced friction losses, which are about 25% smaller than for the 0W20 lubricant. As the 0W20 and the polyalkylene glycol-based lubricant have the same HTHS-viscosity, the findings contradict the common understanding that the HTHS-viscosity is the dominant driver related to the friction losses.

Title: Vehicle demonstration of performance and economy of a comprehensive B/C class Diesel engine and aftertreatment system approach for emissions beyond Euro 6

Authors: AVL List GmbH Bürgler, L; Wieser M; Ofner H; Mallet, P; RENAULT; Gidney, J; JM

Publisher: TRA 2018

Abstract

Engines for A/B/C class vehicles place high emphasis on economic viability. Thus, many innovations focus on optimum system integration of cost effective technologies, which are individually optimized and controlled within the interrelations of engine, exhaust gas aftertreatment system and vehicle. The European project REWARD conducted such a comprehensive approach with a 1.6 liter diesel engine for a small SUV class vehicle. The core of this development is a new combustion concept which is combined with a specifically tailored aftertreatment system. The goal is the demonstration of an increased fuel economy and a reduction of emissions significantly below the Euro 6 limits under real driving conditions. These targets are demonstrated with a vehicle emphasizing that the improvements refer exclusively to the new engine and aftertreatment system development.

The approach focuses on conventional combustion parameters such as the optimum design matching of new combustion bowls with advanced fuel injectors, injection characteristics and a reduced in-cylinder charge motion (swirl). Outside of these core features further parameters refer to high-pressure/ low-pressure EGR and the charging system. The target is to minimize engine-out emissions and to provide specific exhaust characteristics which are optimum matched to particular aftertreatment system concepts.

The paper describes the comprehensive approach, compares various options and presents the performance of the final approach by tests with a demonstration vehicle.

Title: A 4-Cylinder High Performance Diesel Engine Concept for D/E-class vehicles featuring low fuel consumption and EU7 emission levels

Authors: Stefan Bohatsch, Volvo

Publisher: TRA 2018

Abstract

A completely new Quiescent (“Zero-Swirl”) combustion concept was developed with a low pressure drop fill intake port concept and a new stepped piston bowl. Increased injection pressure of up to 3000 bar and fast, accurate injection control allows optimal burn rate and emission formation. The valve system allows a second exhaust event which helps controlling the gas composition within the cylinder with fast response time. Along with high and low pressure EGR loops, it contributes to low engine out NO_x emissions in every running conditions. The charging concept is based on a permanent operating 2-stage turbo system with water cooled Air Inter Cooler to achieve the peak power level. It is supported by an electrical compressor for low end torque and response improvement. Furthermore, the Exhaust After-Treatment System was optimized to achieve the challenging NO_x targets and reducing exhaust back pressure to enable the high performance target. It includes close coupled LNT and SCRF with an additional under floor SCR. The AdBlue mixing area required specific development and lead to a new evaporator design and a complex shaping of inter-bricks parts.

Title: A tribological study of DLC systems for valve train application

Author: Ricardo H. Brugnaga, Schaeffler

Publisher: 6° Workshop AIT “Tribologia e Industria” 18-19 Aprile 2018, Torino, Italy

Abstract

In last years thin coatings have been increasingly used for power train applications, in particular diamond-like carbon (DLC) coatings are used in mechanical engine parts as valve train, fuel-injection components, piston- and cam-systems to enhance wear resistance and reduce friction in tribological contacts. At the same time, low viscosity oils have been becoming increasingly popular for combustion engines due to increasingly stringent environmental legislation concerning CO₂ reduction and preservation of natural resources. In present study, four different DLC coatings were investigated using different model tests and 0W30 engine oil as well as 0W20 low viscosity oil. Three different DLC coatings show a clear friction reduction in combination with low viscosity oil.

Title: Holistic Diesel Combustion System Design – optimizing fuel-air mixing, heat transfer and combustion at low emissions level

Authors: P. Anselmi, J. Galpin, G. De Paola

Publisher: SIA Rouen

Abstract

Facing more and more stringent emission standard, Diesel combustion requires a fine optimization of the combustion chamber for reduced pollutants and improved thermal efficiency. Combustion system design must act simultaneously on all the parameters that are closely related to the air-fuel mixing and combustion efficiency, i.e. injections spray features, air motion, heat transfer and piston bowl shape. Advanced 3D CFD simulations on CSI CONVERGE platform provided analysis of fuel and air mixing, and supported the combustion development of a Euro6+ PC Diesel engine, based on a Fiat 1.6 l Diesel engine application. The increase of the bowl diameter, reduction of the swirl number and nozzle holes diameter aim at the reduction of heat transfer to bowl walls, and increased combustion speed. Engine operation of reference and optimized combustion system has been optimized by means of ICE² software for Design of Experiment. Model responses highlight the improved emissions and fuel consumption trade-off that can be obtained under stringent emission limits and noise restrictions; while combustion and energy analysis show the potential heat transfer reduction that is obtained. Overall, the optimized combustion system allows reduced fuel consumption, at low NO_x emissions without compromising full load performances.

Title: The effects of combined hydrothermal and sulfur poisoning over Pt/Ba/CeZr/Al₂O₃ Lean NO_x Trap catalysts

Authors: Travis Wentworth, Marie Stenfeldt, Louise Olsson

Publisher: ACS

Abstract:

Lean NO_x Trap catalyst degradation is an important aspect of current automotive catalyst research. A comprehensive investigation of a fully formulated Pt/Ba/CeZr/Al₂O₃ Lean NO_x trap (LNT) catalyst after thermal aging and sulfur-induced degradations is conducted. Sulfation results in a lowering of the NO_x storage and also a significant increase in ammonia production. It is proposed that sulfur poisoning results in less ammonia being oxidized by the oxygen storage material, which can explain the increase in ammonia from the sulfur-poisoned samples. In addition, the hydrothermal aging prior to sulfation influences ammonia production. Moreover, sulfur regeneration experiments after the sulfation of thermally aged samples suggests that sulfur is first released from Pt and that the stability of these sulfur species increases with aging temperature. This is followed by sulfur release from surface barium sites in close proximity to platinum sites, and, at even higher temperatures, sulfur regeneration of more crystallized barium particles occurs, and, finally, bulk barium sulfates are decomposed. The experiments clearly show that more bulk barium sulfates are formed if sulfation is done on thermally aged LNT, which makes the LNT more difficult to regenerate. For this reason, these findings are important for regeneration strategies.

Title: Analysing Engine Friction in View of the New WLTC Driving Cycle

Authors: Allmaier, Hannes, David E. Sander, Slavitsa Damjanovic, and Philippe Mallet

Publisher: Sprinter Fachmedien Wiesbaden

Abstract

The new WLTC test cycle not only takes into account a large range of operating conditions of the engine, but also brings about fundamental changes in weighting operating states. Virtual Vehicle and Renault therefore use an innovative friction measurement and calculation method for the Energy dCi 130 engine in order to analyse engine friction in detail, particularly with regard to the new test cycle.

Title: NOx Emission Estimation Using Global In-Cylinder Pressure Signal for Diesel Engines
Authors: Ing. Frédéric Lippens, Ing. Maxime Jean, Dr.-Ing. Thomas Leroy, Ing. Jordan Rudloff
Publisher: Symposium for Combustion Control 2018

Abstract:

The aim of this paper is to use the entire information contained in the cylinder pressure signal in order to model NOx emissions, without using any other measurements. Statistical methods of functional analysis are used to reduce the number of parameters describing the cylinder pressure to few scalar. The NOx emissions are then related to these few scalars with different learning algorithms. Model is trained and validated on experimental data. Interestingly, the estimation catches the impact of variations of ambient condition on NOx emissions. Finally, a dispersion study using the specifications of an industrial pressure sensor shows the robustness of the estimation in an industrial application

Title: Representation of Two-Stroke Engine Scavenging in 1D Models Using 3D Simulations
Authors: Pavel Brynych, Jan Macek, Czech University of Prague
Publisher: SAE World Congress 2018

Abstract

The current 1D models of two-stroke engine scavenging use a scavenging curve, which determines dependence of burnt gas fraction in exhaust port on current burnt gas fraction in a cylinder [1]. This dependence eliminates classic dependence of charging efficiency on delivery ratio with the well-known phases of burnt gas perfect expelling, mixing with fresh charge or even short-circuit scavenging, i.e., direct escaping fresh charge in an exhaust port. They can be found using time-consuming 3D simulations of scavenging flow together with scavenging curves. The direct use of charging efficiency dependence is not possible during the integration of differential equations for 1D model, since it would need iteration during every integration step. The three described phases, depending on the amount of gas delivered through an inlet port, are present, nevertheless, at any two-stroke engine, although with different timing and intensity. The substitution of inlet flow mass by state variable, the mass fraction of burnt gas in a cylinder, is possible if pure fresh charge is delivered. Then, the mass fraction of burnt gas reflects integrated mass of fresh charge. If massive back-flow of burnt gas to inlet system occurs at the start of scavenging or if EGR is applied, the results from 3D simulation are useful only if the backflow or EGR level is the same in the 3D and 1D cases. Since 1D simulation is used to optimize port or valve timing by a fast way, this is not very often a case. Moreover, changing the pressure ratio over an engine occurs in optimization of the whole airloop with similar results for a backflow.

The paper proposes the way of using scavenging curves with reduced value of cylinder burnt-gas contents, so called scavenging progress variable, which makes the use of single result of 3D simulation possible for more variants of inlet timing. The reduction is based on a stepwise integrated burnt gas contents in fresh charge for every 1D simulated case. By this way, it accelerates the optimization process substantially.

The results are validated using dedicated 3D cases simulations

5 Acknowledgment

Disclaimer

This document reflects the views of the author(s) and does not necessarily reflect the views or policy of the European Commission. Whilst efforts have been made to ensure the accuracy and completeness of this document, the REWARD consortium shall not be liable for any errors or omissions, however caused.



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Appendix 1 dissemination actions list

Nº	Type of activities	Main leader	Title	Date (dd/mm/yyyy)	Place	Type of audience	Size of audience	Countries addressed
1	Website	UNR	www.project-reward.eu	30-8-2015	Worldwide	Other	> 500	World Wide
2	Other	AVL	Poster EUCAR projects Book 2015/2016	4-11-2015	Brussels	Industry	100 - 500	European
3	Press release	RIC	Press release REWARD	1-3-2016	EU	Medias	> 500	World Wide
4	Participation to a conference	UNR	TRANSPORT RESEARCH ARENA	16-4-2016	Warsaw	Industry	> 500	European
5	Participation in activities organised jointly with other H2020 project(s)	AVL	EUCAR Programme Board	6-9-2016	Brussels	Industry	20 to 100	European
6	Participation to a conference	UPVLC	Thiesel conference Valencia	13-9-2016	Valencia	Scientific Community (higher education, Research)	100 - 500	World Wide
8	Participation to a conference	CTH	EECAT	11-10-2016	Tianjin	Other	> 500	World Wide
9	Participation to a conference	CTH	AIChE Annual Meeting	13-11-2016	San Francisco	Scientific Community (higher education, Research)	100 - 500	World Wide
10	Participation to a conference	IFP	SAE World Congress	4-4-2017	Detroit	Industry	> 500	World Wide
11	Participation to a conference	RIC	SAE World Congress	4-4-2017	Detroit	Industry	> 500	World Wide
12	Participation to a conference	CTH	18th International Conference on Chemical Engineering and Heterogeneous Catalysis	21-11-2016	Paris	Scientific Community (higher education, Research)	100 - 500	World Wide
13	Participation to a conference	CTH	International Conference on Catalysis and Chemical Engineering	22-2-2017	Baltimore	Scientific Community (higher education, Research)	100 - 500	World Wide
14	Participation to a conference	AVL	ATZ 4. International Engine Congress 2017	21-2-2017	Baden-Baden	Industry	100 - 500	World Wide
15	Participation to a workshop	AVL	EUCAR PROGRAMME BOARD MEETING/EGVIA	6-9-2017	Brussels	Industry	20 to 100	European
16	Participation to a conference	AVL	1st conference on results from road transport research in H2020 projects by DG Research	29-30.11.2017	Brussels	Industry	100 - 500	European

D8.3 – Summary book of publications

17	Participation to a conference	IFP	http://www.sia.fr/evenements/93-sia-powertrain-rouen-2018	16.-17.5.2018	Rouen	Industry	100 - 500	European
18	Participation to a conference	volvo	TRANSPORT RESEARCH ARENA	17.4.2018	Vienna	Industry	101 - 500	European
19	Participation to a conference	CTU	SAE World Congress 2018		Turin	Scientific Community	101 - 500	European
20	Participation to a conference	CTH	AVL International Simulation Conference	27-29 June 2017	Graz	Scientific Community (higher education, Research)	100 - 500	European
21	Organisation to a Conference	IFP	Symposium for Combustion Control 2018	June 27 – 28, 2018	Aachen	Scientific Community	101 - 500	European
22	Participation to a conference	CRF	ICE2017 – International Conference on Engines and Vehicles	14-9-2017	Capri	Industry	100 - 500	European