EMFO - Abstracts of projects approved in the spring 2004

Optimised engine and exhaust aftertreatment system for heavy vehicles

Body conducting the research: Scania CV AB
Project duration: 2004 – 2008

The upcoming legislation Euro IV and Euro V requires significant reduction of the emissions of nitrogen oxides and particles from heavy vehicles. Already to meet these requirements many vehicle manufacturers choose to introduce exhaust aftertreatment. The alternative is to use exhaust gas recirculation (EGR). To meet the legislation following after Euro V it seems unavoidable that some kind of exhaust aftertreatment needs to be used, probably in combination with EGR.

The introduction of exhaust aftertreatment makes it possible to influence the emissions in both the engine and the exhaust aftertreatment. This, in turn, enables very low emission levels. A difficulty is however that the potential to influence the emissions in respective system differs depending on operating conditions. An important fact is that the conditions in the exhaust aftertreatment not only are influenced by how the engine is run, but also change considerably slower than in the engine. Treating the engine and the exhaust aftertreatment as an integrated system makes it possible to utilize these both parts optimally. Such an optimisation serves both environment and economy.

The objective of this project is to develop strategies of how to utilize the engine and the exhaust aftertreatment optimally, that legislation be followed with best possible operational economy. The approach is to create a complete model of the integrated system from models of each subsystem. The complete model is thus used to analyse and optimise the integrated system.

Studies of aging mechanisms of aftertreatment systems for diesel engines with the aim of developing methods for accelerated aging

Body conducting the research: Kompetenscentrum Katalys, Chalmers Tekniska Högskola
Project duration: 2004 - 2007

Increasingly tightening regulations for diesel-powered vehicles will call for the introduction of different aftertreatment systems in the next years. The oxidation catalysts existing today will be complemented with particle filters and, within a few years, NOx reduction systems. A critical issue is how these systems will perform under extended use. This is a central issue both regarding cost and emission of harmful substances. For example, the emissions of both NOx and particles will increase as these systems are aged and deactivated. With durable systems, one also minimises the need for costly replacements of the aftertreatment systems.

An important goal with this project is to develop aging cycles that can be used to test different aftertreatment systems without the need for field experiments. A lot can be gained from having an efficient cycle, e.g., the method can be used to rapidly evaluate various catalytic technologies and system designs for exhaust aftertreatment.

We will also increase the basic knowledge regarding deactivation. Field aged catalysts will be investigated regarding what properties of the catalysts that have been influenced. Further laboratory tests with model samples in model gases will be conducted.

Charging Research & Devolopment

Body conducting the research: SAAB Automobil Powertrain AB
Project duration: 2005 - 2008

A Charging Survey Report, a matrix that reflects different future scenarios and requirement on charging systems enabling high amounts of EGR, will be delivered. The report is an important input for the continuing project that will be carried through in cooperation with Royal Institute for Technology, KTH.

Two PhD students will pursue the research, one with the emphasis on 3D simulation, CFD and one with the emphasis on experiment. They will map out parts of the charging technique as well as turbine technique that are not yet known. The development of 1-D models, which are linked to 3-D models that will be produced within the project, will give an opportunity for predictive simulation. The linking of these models to a catalyst model will enable simulation of the catalyst light off.

The main purpose of the project is to develop a technique in simulation environment with good accuracy with no requirements for tests on physical hardware.

Research and development of efficient HC SCR-systems

Body conducting the research: Volvo Technology AB
Project duration: 2004 - 2007

The global objective is to reduce emissions of CO_2. This has resulted in an increased attention for diesel engine vehicles with effective exhaust aftertreatment especially regarding NOx and particles. One of the most attractive methods for NOx reduction, in diesel exhaust, is the use of vehicle fuel as reducing agent (HC-SCR). New research has shown that zeolite-based technologies and silver-alumina systems are very promising for HC-SCR.

The objective for this project is to find innovative solutions in order to increase the NOx-reduction for HC-SCR, combined with minimal fuel penalty. The focus of the project will be to reduce the negative impact of aromatic hydrocarbons, develop control algorithms for transient operation, improved HC dosing, demonstrate the positive impact of addition of hydrogen and hydrocarbon for NOx-reduction. The project is expected to improve low temperature conversion, durability and overall NOx-reduction for the promising catalytic system.

Screening and utilization of combustion sensors for reduction of fuel consumption, combustion noise and raw emissions

Body conducting the research: Volvo Car Corporation
Project duration: 2005 - 2007

Current diesel and gasoline combustion systems are today controlled indirectly with external response sensors, e.g. lambda sensor detecting exhaust oxygen content. In order to further reduce fuel consumption and engine out emissions of NOx, CO and Soot etc, new methods, using an in-cylinder combustion sensor and a sensor related algorithms, are needed.

Proposed project activities: Literature study of sensors and related algoritm concepts, experimental screening/signal evaluation/algorithm development of a set of sensor concepts will in first step be evaluated by single cylinder measurements. Three main sensor/algorism-sets will then be evaluated in a second step by multi-cylinder engine tests on both VTC and VCC prototype engines.

The project will result in a recommendation of the best combustion sensor/ algorithm-set that have proven the most promising emission reduction potential for both conventional and HCCI type Diesel and Gasoline combustion.

Quantification and characterization of particulate associated Polycyclic Aromatic Hydrocarbons (PAH) emitted from modern heavy-duty diesel engines and fuels.

Body conducting the research: Institutionen för Analytisk kemi, Stockholms universitet
Project duration: 2004 - 2007

Exhaust emissions from modern diesel engines and fuels will be characterized with respect to both regulated and unregulated exhaust components. Particulate associated Polycyclic Aromatic Hydrocarbons (PAH) including the well known genotoxic PAH benzo(a)pyrene will be determined in the exhaust samples. Development of sampling and analysis of particulate associated organic compounds will be made within the project. A aim with the updated emission factors obtained in the project is to be implemented and used in emission modeling.

In EMFO there are plans to build a database to get a platform of knowledge accessible through Internet. The project is a preliminary study to investigate the demands on and the conditions of the database.

Modeling and measurements of emissions from heavy duty vehicles

Body conducting the research: AVL MTC AB
Project duration: 2004 - 2007

Emission legislation and customer demands are leading the way to engines with lower emissions and fuel consumption. It is however difficult to estimate the reduction in real world emissions due to stricter legislation and updated vehicle fleets. The legislation controls the engine emissions in specified test conditions, while the real world emissions depend on the behaviour of the complete vehicle in different conditions (transmission, body, load, ambient conditions).

The project will develop models for the emissions from individual vehicles. The models include both engine out emissions and the tail pipe emissions after an after treatment system. The models are verified by tests of vehicles in chassis dynamometers. The models will be able to predict the total emissions from vehicles in different applications by using data collected from many driving conditions.

Preliminary study concerning an EMFO database

Body conducting the research: Väg- och transportforskningsinstitutet (VTI)
Project duration: 2004 - 2005

The database contains “hard data” as well as knowledge and models. A necessary demand is the suitability for two projects, “*Kritisk granskning och komplettering av Artemis-modellen”* and the present work with a new model for air quality.

Actions:
Discussions with the ordered concerning selective access to the database and the need for information about data quality.

Contacts with the two mentioned projects.

Investigation of the technical conditions; appropriate software, location of the database, how to up-date the database, security issues, etc.

Interviews with external users to investigate their wishes and needs.

A database structure is developed in order to increase the clearness in all discussions. A simple prototype is developed to illustrate the future database.

The composition and use of the Swedish car fleet – formulation of a forecasting model

Body conducting the research: Väg- och transportforskningsinstitutet (VTI)
Project duration: 2004 - 2005

Model based forecasts of future emissions are an important part of the work with the Swedish transport policy objectives about effect on climate and air pollution. In order for the calculated emissions to reflect the actual situation, input data on mileage, vehicles types and vehicle age must be representative of the region of interest. High quality forecasts of these variables is therefore of great importance when estimating future emissions.

The aim of this project is to formulate a forecasting model for the car fleet’s composition and vehicle use with respect to vehicle type, fuel system, age and standards.

The main objective of the model is to provide data forecasts for inputs to emission models. Another objective is to use the model to study behavioural aspects of car choice.

Implementation of a common EU road vehicle emission model for official statistics on emissions to air and follow-up of air quality directives in Sweden

Body conducting the research: IVL Svenska Miljöinstitutet AB
Project duration: 2004 – 2008

The project's aim is to implement the ARTEMIS road vehicle emission model in Sweden. Thereby a long-term, cost-effective national production of reliable and internationally harmonised emission data is achieved, for both international air emission reporting obligations and air quality assessments.

The project is carried out jointly by IVL, AVLMTC, VTI and Lund University.

In the project's first phase Swedish vehicle and activity data will be adopted for national air emission calculations with the model under the Kyoto-protocol in 2006. This phase also includes a critical review to identify potential shortcomings and a first verification of the model.

The project's second phase includes national R&D-efforts to further improve the quality of model calculations, through efforts to improve Swedish activity data, complementary emission factor studies, and further verification through dedicated real-world emission measurements.

In the final third phase a national plan for the long-term update of the model will be formulated.

EMMA 5: Effects of transient loads on the energy efficiency and formation of emissions from non-road diesel engines fueled with alternative fuels

Body conducting the research: Institutionen för biometri och teknik, Sveriges lantbruksuniversitet
Project duration: 2004 - 2007

The purpose of the present work is to study the effects of alternative diesel fuels on the energy efficiency and the engine exhaust gas emissions from non-road diesel engines. The studied fuel are Swedish environmental class 1 diesel fuel (EC1), EC1 diesel mixed with ethanol derivates, EC1 diesel mixed with RME and higher alcohol and a synthetic diesel fuel.

The project is conducted in two stages whereas fuel efficiency and emissions of carbon monoxide, hydrocarbons, nitrogen oxides and particulate matter are studied in the first stages for all four fuels. In the second stage, unregulated emissions and particle concentration and size distribution are studied for two fuels of which one is EC1 diesel.

Within the project, emphasis is placed on the effects of transient conditions and work cycles as such knowledge would be valuable in the evaluation process of different fuels as well as during the construction and adjustment of new engines and engine components. The knowledge will also useful in energy and life cycle assessments.

Fischer-Tropsch Fuels for Low Emissions in Diesel Engines

Body conducting the research: Combustion Engine Research Centre (CERC), Chalmers Tekniska Högskola
Project duration: 2004 - 2008

The project will investigate the influence of Fischer-Tropsch fuels on an advanced diesel combustion system. The main track is diffusion combustion but new systems will also be studies. The research will focus on minimizing harmful emissions. The application involves two research projects at Chalmers CERC will co-ordinate and KCK will perform in the end of the project an aftertreatment study. Participating industrial partners are Scania, Volvo Powertrain, Volvo Car, Saab Automobile Powertrain, and Statoil. The research is performed at the departments Materials and Surface Chemistry and Thermo- and Fluid Dynamics. Collaboration and exchange of ideas will take place between the different research teams within both university and industries.

Material and Surface Chemistry will in close co-operation with Statoil suggest suitable composition for the Fischer-Tropsch fuels to be tested as well as analyse and develop process parameters for key steps in the manufacturing process when using synthesis gas from biomaterials.

Thermo- and Fluid Dynamics will in close co-operation with the engine manufacturers optimize engine parameters particularly within fuel injection, combustion systems including valve systems, turbo-charging and EGR systems.

Blending of Bioalcohols in gasoline for Combustion Engines, Problem Inventory

Body conducting the research: AVL MTC Motortestcenter AB
Project duration: 2004 - 2005

In the next few years the use of recyclable fuels will increase remarkably. This depending on an EG-directive from May 2003 (2003/30/EG) for the promotion of alternative and other recyclable fuels. Existing knowledge of use, production and the supply of raw material for production of recyclable fuels, indicates that the use of alcohol in gasoline will most likely be prioritised in order to reach the goals.

The project includes a first step for increased use of alternative fuels and will focus on:

- A literature- and knowledge study to identify data and not documented experiences concerning emissions with alcohol / gasoline blends.
- Evaluate existing investigations and the relevance of the data.

Analyse and suggest what complementing studies of emissions are required in order to be able to, in a reliable way, judge how alcohol contents in gasoline fuels already today is effecting the total emission situation both regarding quality and quantity.

Aftertreatment and fuel upgrading system for DME-fuelled diesel engines

Body conducting the research: Chalmers Tekniska Högskola, Kompetenscentrum för katalys
Project duration: 2004 - 2007

Dimethyl ether (DME) is identified as one of the most promising alternative fuels for future transportation systems. An interesting system solution may be obtained by combining lean combustion of DME with lean exhaust gas aftertreatment of NOx using DME and/or hydrogen from a DME reformer as reducing agent. The hydrogen from the DME reformer may also in a future scenario provide a fuel cell-APU with hydrogen, which opens new exciting solutions for transportation systems of the future.

The project aims at creating a transportation solution with ultralow emissions, while maintaining the high efficiency of the Diesel engine. DME produced from biomass offers the possibility of a CO_2-neutral transportation system, and improved possibilities to meet the environmental goals of the Kyoto protocol. The project strengthens collaboration between universities and industry and involves Chalmers University of Technology (Competence Centre for Catalysis), the Royal Institute of Technology (Chemical Engineering and Technology), and AB Volvo.

WTW Heavy-duty vehicles

Body conducting the research: Ecotraffic ERD^3 AB
Project duration: 2004

A substitution of fossil fuels for renewable fuels will be essential for the transport sector on the long term. The project concentrates on heavy-duty vehicles, which is a neglected area in well-to-wheel (WTW) analysis. The project assesses fuels produced from natural gas and biomass. The results from this project are very interesting as basis and support for strategically important decisions concerning future fuels.

The overall project aim is to study efficiency and emissions of greenhouse gases in a lifecycle perspective for various motor fuels produced via gasification of biomass and natural gas. Direct use of biogas and natural gas are also considered. Vehicle simulations in Advisor® are carried out on 2-3 categories of heavy-duty vehicles in

relevant driving cycles for the vehicles. The possibilities to fulfil (presumed) emission limits after 2010 for various combinations of fuels and drivetrain concepts are assessed. The baseline reference is 10 ppm sulphur diesel fuel.