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Research Association for Combustion Engines e.V.
FVV | Research Association for Combustion Engines

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It's all about the system: FVV researches sustainable hybrid powertrains

Hybrid powertrains, in which the electric motor and the internal combustion engine work together, enable rapid CO_2 savings in road transport - provided that the powertrain system of such a vehicle is designed from the outset to operate as efficiently as possible. In the FVV's new hybrid research programme, engineers are working across company boundaries to develop the methods and technologies needed to achieve this.

Frankfurt/M., 14.03.2022 // The hybrid research programme initiated by the FVV Board in 2020 has now led to concrete projects dealing with the sustainable design of hybrid powertrain systems. The researchers are focusing less on specific technologies and more on their interaction. For example, the Technical University of Darmstadt is investigating in a project on how the theoretically infinite combinations of batteries, electric machines, motors, transmission variants and software-based operating strategy can be transformed into a modular system[1]. Such an approach should maximise the environmental benefits on the one hand, but on the other hand keep production costs low by reducing the number of variants and thus serve a high market acceptance. One of the researchers' goals is to develop a software programme that calculates modular architectures of the hybrid powertrain after entering the boundary conditions and takes the properties of the components into account. In doing so, the scientists are following an object-oriented approach from computer science, which should significantly shorten the computing time. The programme is to be shared with all companies collaborating in the FVV after the project is completed. »Medium-sized suppliers in particular can benefit considerably from the results,« says Martin Nitsche, deputy managing director of the research association.

Highly flexible hybrid operating strategies

The goal of every hybrid development is energy-efficient operation. At the same time, however, exhaust emissions must be minimised and a high level of driving comfort must be made possible. But in which specific situations do conflicting goals arise? And what does the high flexibility expected of the combustion engine mean for its technology? Researchers at RWTH Aachen University are trying to answer such questions in another project[2]. To do this, they are linking various simulation methods that can be used, for example, to include exhaust gas aftertreatment or thermal management. With a ›predictive travel management‹ it should be possible to take into account special emission zones as well as unforeseen events such as traffic jams. At the end of the research

project is the development of a manufacturer-neutral, holistic development methodology for hybrid powertrains, which simplifies the work on efficiency technologies, especially for small and medium-sized companies.

Carbon-neutral hybrid powertrains

Hybrid powertrains are carbon-neutral if the electric motor is operated exclusively with green electricity and the combustion engine with synthetic fuels such as green methanol. The FVV project ›ICE2025+‹, which was completed in 2020, had already shown that an efficiency of more than 40 percent can be achieved with methanol operation in almost all operating ranges of the combustion engine. At the best point, the engine optimised for hybrid operation even achieved more than 46 percent with the synthetic fuel. In the follow-up project ›ICE2030‹, which has now been started, a thermal efficiency of at least 50 percent is to be achieved[3]. To make this happen, the participating scientists from the universities of Aachen, Braunschweig, Darmstadt and Stuttgart are investigating whether the admixture of hydrogen makes extremely lean combustion with high stability possible. They also want to investigate how the high excess of oxygen affects the exhaust gas composition.

Other ongoing or planned research projects on hybrid powertrains and their operating strategies deal with the challenges that arise when the combustion engine only has to step in very rarely, but then very reliably. The phenomena under investigation include thermal management as well as, for example, acoustic perception in the interior. Martin Nitsche explains the relevance of this research as follows: »Many technical questions that have actually been solved, such as corrosion and operational stability, are posed in a completely new way in hybrid drives.«

As part of the hybrid research programme, the FVV is also testing a new award procedure. In the call-for-tender procedure, a group of experts only defines the goal at the beginning. Research and technology performers can define the methodological path themselves and propose corresponding projects. According to Nitsche, the new procedure has already proven its worth: »It allows us to make even better use of the specific know-how at the research institutions for our pre-competitive collective research.«

At its spring conference on 31 March 2022 in Würzburg, the FVV will dedicate a separate session with three presentations to the new research priority.

Notes on the research programme

1 | FVV Research Project No. 1428: Modular object-oriented architectures for scalable hybrid powertrains. Conducted at TU Darmstadt (Prof. Dr. Christian Beidl, Institute for Internal Combustion Engines and Powertrain Systems vkm). Completion expected by 31.12.2022.

2 | FVV Research Project No. 1433: Highly flexible combustion engines for hybrid vehicles. Conducted at RWTH Aachen University (Prof. Dr. Stefan Pischinger, Chair of Thermodynamics of Mobile Energy Conversion Systems tme). Completion expected by 28.02.2023.

3 | FVV Research Project No. 1434: Limits of SI engine efficiency in hybridised powertrains. Conducted at RWTH Aachen University (Prof. Dr. Stefan Pischinger, Chair of Thermodynamics of Mobile Energy Conversion Systems tme), TU Braunschweig (Prof. Dr. Peter Eilts, Institute of Internal Combustion Engines ivb), TU Darmstadt (Prof. Dr. Christian Beidl, Institute of Internal Combustion Engines and Powertrain Systems vkm) and University of Stuttgart (Prof. Dr. Michael Bargende, Institute for Automotive Engineering IFS). Completion expected by 31.01.2023.

Images

1 | Martin Nitsche, Deputy Managing Director of FVV

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About FVV

Our task is to keep the future open | The FVV creates knowledge-based insights into forward technologies promoting climate neutrality and zero emissions from sustainable energy conversion systems – collectively and always at a pre-competitive level. We have a clear fact-based compass and we are always open to the best solution from a technical, economic and environmental point of view. In doing so, we organise open-topic research along the value chains, bringing together companies with the same interests regardless of size and economic power. We network bright minds and benefit from their knowledge and experience. We think ahead and open up paths to the world of tomorrow for young talents. This is how inner drive and passion give rise to technological progress.

We are prime movers | In our innovation network, globally operating manufacturers of power systems, fuel cells, vehicle / aircraft / industrial engines and turbo machinery, as well as their suppliers and development service providers, conduct together with universities and other research institutions pre-competitive, collective research on future technologies. The goal is to operate energy converters – internal combustion engines, hybrids, turbines, compressors, turbochargers and fuel cells – with renewable energy sources in new (partially) electrified, integrated and digitalised energy conversion systems in a more efficient, cleaner and sustainable way - to the benefit of society, climate, environment and industry. The FVV has invested almost 1 billion euros in 1,500

research projects since it was founded in 1956.

Further information at www.fvv-net.de/en