

Media communiqué

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35th Empa Science Apéro

Environmentally friendly motors and drive systems – «made in Switzerland»

Our continuously growing population demands an ever greater degree of mobility. How this challenge can be met in an environmentally responsible way was explained by three specialists from research and industry at the 35th Science Apéro held recently at Empa. The event, entitled «Motors and Drives for the Future», gave them the opportunity to present alternative ideas and drive system projects using fossil fuels, which they hope will help enable environmentally friendly motors make the breakthrough into everyday use.

Martin Stoeckli of the diesel injector specialists DUAP AG in Herzogenbuchsee, began by explaining that conventional internal combustion engines are still far from optimized with regard to efficiency and clean emissions. “We need to further reduce both their fuel consumption and CO₂ output, as well as making them significantly more efficient,” he said, listing the critical aims. Of the total energy consumed by today’s motors only about 40 per cent is actually used effectively. In the transport sector this figure falls even lower, dropping to just 20 per cent, the balance being dissipated as waste heat. Stoeckli showed the audience how this situation could be improved by citing several examples of recent industrial developments.

IVECO Motor Research AG in Arbon, Switzerland, has working for some time on developing methods of reducing nitrogen oxide and particle emissions from diesel engines. Over the past fifteen years this has resulted in a drop in nitrogen oxide emissions of 86 per cent, and particle emissions falling by a remarkable 95 per cent. Wärtsilä Switzerland Ltd. in Winterthur is primarily active in the large diesel market, its products being used in large cargo ships among other areas. They have managed over the last 30 years to both increase the efficiency of their products and also implement new technologies to reduce their NO_x emissions. ABB has succeeded in increasing the power output of its engines considerably using a novel turbocharger, while DUAP AG has developed so-called common rail fuel injection systems which help engines used in earth-moving plant, locomotives, electricity generators and marine propulsion units to develop more power while simultaneously reducing fuel consumption and pollutant emissions.

The future challenges facing engine developers include the maintenance and enhancement of Switzerland’s research, technology and production capabilities, not to mention the frugal usage of resources. To meet them, in Stoeckli’s opinion, the engineering sciences as well as the entire higher education infrastructure in

the technical fields must be supported and nurtured, and the cooperative work between the technical universities and industry facilitated. "And Empa plays an important role in this process."

Petrol prices halved!

Novel motors and drive systems not based on fossil fuels were also a topic of discussion at the Science Apéro. Felix Buechi of the Paul Scherrer Institute (PSI) explained to the audience, for instance, which "alternative" energy supplies might be used in the future. There was, however, one condition that all of them had to meet – given the world's constantly increasing energy requirements, they had to be produced and delivered in a sustainable manner. "Between 1850 and 2000 worldwide energy consumption increased fifty-fold," Buechi told the audience, adding that an end to this trend was not in sight.

A range of different alternative energy sources are necessary in order to be able to replace fossil fuels, according to Buechi. "For example by using biomass alone one can replace only about a quarter of the fuel used in the EU." In the transport field hydrogen could make a more significant contribution than biomass, and for this reason the PSI has, in collaboration with Michelin, developed «HY-LIGHT», a fuel cell powered vehicle. This is capable of reaching an efficiency of over 0.6 at a constant speed of 80 kmph, an extraordinary figure for a road vehicle and equivalent to 2 liters of petrol per 100 km. The efficiency is particularly good at low engine speeds, three or four times better than a diesel under the same conditions. The vehicle's other innovative features include a light-weight chassis, the integration of the hydrogen tank in the floor and the fuel cell drive which uses hydrogen and pure oxygen.

Once alternative energy sources such as hydrogen and their associated technologies become established, fuel costs will drop significantly. "It costs us between 5 and 15 Euros to travel 100 km today. In the best case scenario, these costs will halve by the year 2020," forecasts Buechi. However to reach this goal, he added, it is important that efficiencies are raised yet higher and vehicle weights further reduced.

«Only half so much CO₂ allowed»

According to Christian Bach, Head of Empa's Internal Combustion Engines Laboratory, there is a low-carbon alternative fuel available – natural gas or biogas. The less carbon in the fuel, the less CO₂ emitted, and in the case of processed biogas (for example compogas) drive systems can actually be pretty much CO₂-neutral. Bach made use of the Swiss Federal Office for the Environment's Greenhouse Gas Inventory to show that road traffic is responsible for producing the greatest fraction of CO₂ emissions – 30% of the total – followed by domestic and industrial usage. In addition, contrary to the intended reduction in CO₂ emissions, over the past few years levels have actually increased. "There are only three means of rectifying this situation – by changing human behaviour, improving vehicle fuel consumption rates and by using fuels which release as little CO₂ into the atmosphere as possible. The first option is by far the most difficult one."

A natural gas powered automobile emits between 20 to 30 per cent less CO₂ and by using biogas this figure improves to 70%. Only fuels which have a high knock resistance and high combustion temperatures can be used to power car engines, Bach informed the audience. For low temperature applications such as heating buildings or hot water supplies other energy sources such as waste heat can be used. Methane, the main constituent of natural gas and biogas, is therefore practically the ideal fuel.

Because of the low energy density of natural gas, however, the range of gas-fuelled cars – about 300 to 400 km – is currently rather less than that of a petrol powered car of comparable performance. This apparent disadvantage could in fact turn out to be a blessing in disguise, forcing automobile developers to create more fuel-efficient drives. Otherwise gas-fuelled cars would hardly stand a chance in today's automobile market. "Because of this, gas-fuelled cars actually reverse the trend towards ever larger passenger cars, which will have an additional positive effect on CO₂ emission levels", explained Bach.

Currently Empa, together with the ETH Zurich and industrial partners, is developing a natural gas hybrid drive called «CLEVER» (for «Clean and Efficient Vehicle Research»), which for the same output power as a petrol fuelled engine, will use 20 per cent less fuel and emit 45 per cent less CO₂. "We urgently need vehicles which emit only half as much as today's petrol and diesel powered ones, otherwise we will never solve the problem", according to Bach.

In collaboration with the PSI and various industrial companies, Empa is also developing a vehicle called «hy.muve» (for «hydrogen driven municipal vehicle») to meet the needs of communal service organizations. Powered by a fuel cell drive, «hy.muve» is intended to make the jump from laboratory to practice. Christian Bach hopes that it will open doors for the use of hydrogen as a fuel, a very promising source of energy.

What is a Science Apéro?

The EMPA Academy provides a forum for debating current scientific and socially relevant issues through its Science Apéros. Held at regular intervals, these usually involve three or four speakers with backgrounds in research, politics and commerce, who present results and trends relevant to the selected topic seen from their particular point of view. After the round of presentations, a lively discussion usually ensues involving the audience who may or may not be well versed in the theme under consideration. This continues during the aperitif after the formal proceedings come to a close.

Science Apéros are open to specialists and the public alike. Entry is free and no prior registration is necessary.

The current calendar of events can be viewed at: www.empa-akademie.ch/veranstaltungen

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«hy.muve» fuel cell powered vehicle
(Bucher City Cat 2020 Municipal Services Vehicle)



«HY-LIGHT» fuel cell powered vehicle



DUAP fuel injector used in earth-moving plant, locomotives, electricity generators and marine engines