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PRESS RELEASE

MAHLE solutions for fuel cell drives in commercial vehicles

- Fuel cell systems portfolio featuring MAHLE's modular approach
- Enormous potential for heavy-duty vehicles and large cruising ranges

Stuttgart, September 11, 2018– Throughout the world, the number of vehicles equipped with fuel cell drives is increasing slowly but steadily. Large quantities are expected within the next five years, particularly from Asian manufacturers. However, new opportunities are also opening up worldwide for heavy-duty commercial vehicles. Promising avenues include weight savings and extension of the cruising range in comparison with battery-powered solutions. Fuel cell concepts may represent an attractive option for long-distance hauling, which requires heavy loads and large cruising ranges.

When designing commercial vehicles with a fuel cell drive, the high hydrogen storage pressures of around 350 bar (commercial vehicles) are not the only challenge. The extreme requirements in terms of thermal and media management and the sensitivity of fuel cell stacks to contamination and harmful gases in the air flow call for a perfectly harmonized arrangement of the fuel cell peripherals. MAHLE supports the development of commercial vehicles with fuel cell drives that are suitable for large-scale production—thanks to its competence in complete systems, thermal and air management, as well as filtration and electronics—and focuses on reducing manufacturing costs and improving operational safety. MAHLE is developing a modular fuel cell systems portfolio based on its current range of components. This is helping to reduce technological barriers and improve the suitability of vehicles with fuel cell drives for the mass market.

Air management for cold combustion

The air management of fuel cells places extremely high demands on the components used. To prevent damage to the cell, harmful gases such as SO_2, O_3, NO_X, and NH_3 as well as particles need to be separated reliably. For this purpose, MAHLE is developing a highly effective, multilayer filter medium. A substrate material ensures mechanical stability, a particulate filter layer removes NaCL, a molecular layer prevents NH_3 from entering the fuel cell, an activated carbon layer absorbs unwanted hydrocarbons, and an additional, specially impregnated activated carbon layer adsorbs SO_2, H_2S, and NO_x.

Fuel cells are also sensitive to oil admixtures. The electric compressor used to compress the supply air flow must therefore be oil-free. This also applies to the shaft bearing, as even small quantities of oil can cause irreversible damage. MAHLE develops an oil free compressor concept to meet these demands.

The water balance of a polymer electrolyte fuel cell significantly affects efficiency and service life. If the diaphragm dries out, this will lead to a gas breakthrough, while surplus water has the undesired effect of allowing the gases to freely enter the catalytic converter. Therefore, it’s not sufficient to filter the external air supplied to the fuel cell—its humidity must also be precisely controlled. For this purpose, MAHLE—together with affiliated partners and with funding from the German Federal Ministry of Economics and Technology—develops a flat membrane humidifier to ensure that the supplied air is humidified reliably. In the flat membrane humidifier, the exhaust and supply air are in cross flow and separated from the membranes. A moisture exchange takes place above the membrane surface.

Deionized coolant is used to cool the fuel cell, as it is only slightly electrically conductive and will not cause any undesirable current flow. As a result, the components used must be resistant to ionized water. To this end, MAHLE has developed a special process that makes the components very durable.

To ensure the non-conductivity of the coolant MAHLE has developed an ionic exchanger already in field use in different applications.

The specifications often require separation of water, gases, and water vapor downstream of the fuel cell—for esthetic reasons, no fluid water should escape from the exhaust air duct. MAHLE develops water separators that allow a controlled water disposal.

Vehicle acoustics also affect air management. In particular, noise from the e-compressor and from the air flowing along the air pathway must be attenuated, taking into account interactions between the systems components.

The result of this holistic systems approach is the plastic exhaust air pathway optimized by MAHLE for fuel cell vehicles. It offers a weight saving of around 70 percent in comparison with steel constructions and dramatically reduces the audible resonance in the 1,200–5,000 Hz range, while retaining as much design freedom as possible.

Thermal management

The use of fuel cells is giving rise to more complex cooling systems and larger coolant coolers. This is due to the need for three separate circuits for the fuel cell stack, the battery/electronics, and the electric motor, as well as the overall increase in waste heat and the reduced temperature in comparison with the combustion engine. A higher volume of coolant is required in order to compensate for the lower temperature differential between the internal and external temperatures.

In addition, as there is no belt drive, electric fans are required throughout. All components must also be resistant to the deionized coolant.

Vehicles with a fuel cell drive have a backup battery. The charging and discharging of batteries results in a loss of efficiency, with some energy being converted to heat. As lithium-ion batteries need to operate within a certain temperature range, battery cooling is also required here. This is achieved by a secondary circuit in which coolant flows through a cooling plate under the battery. After the heat has been absorbed, the cooling medium is cooled to the initial temperature in a chiller. The temperature reduction in the chiller is caused by the evaporation of another refrigerant circulating in a primary circuit.

Diagnosis and monitoring
Fuel cell stacks require continuous monitoring during running operation. This prevents damage and also means that crucial input variables, such as gas or air supply, can be controlled. The MAHLE Fuel Cell Monitor module has two microprocessors that process the signals from the fuel cell stack and provide feedback to the central control unit. When required, the voltage in the fuel cell stack can be discharged directly via a semiconductor module. The power distributor and discharge resistor should be housed on a cooling plate to ensure problem-free operation.

About MAHLE
MAHLE is a leading international development partner and supplier to the automotive industry as well as a pioneer for the mobility of the future. The MAHLE Group is committed to making transportation more efficient, more environmentally friendly, and more comfortable by continuously optimizing the combustion engine, driving forward the use of alternative fuels, and laying the foundation for the worldwide introduction of e-mobility. The group’s

product portfolio addresses all the crucial issues relating to the powertrain and air conditioning technology—both for drives with combustion engines and for e-mobility. MAHLE products are fitted in at least every second vehicle worldwide. Components and systems from MAHLE are also used off the road—in stationary applications, for mobile machinery, rail transport, as well as marine applications.

In 2017, the group generated sales of approximately EUR 12.8 billion with about 78,000 employees and is represented in more than 30 countries with 170 production locations. At 16 major research and development centers in Germany, Great Britain, Luxembourg, Spain, Slovenia, the USA, Brazil, Japan, China, and India, around 6,100 development engineers and technicians are working on innovative solutions for the mobility of the future.

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