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PRESSRELEASE

Lightweight design for commercial vehicle cooling systems in Euro VI applications

Hannover, September 2014 – The challenging limits in the Euro VI emission standard increase the performance requirements for the cooling system in commercial vehicles. With lightweight design and increased specific capacity of cooling components, MAHLE has been able to design the cooling system to meet these challenges without increasing weight. At the same time, the development measures have improved cooling capacity relative to Euro V systems without increasing fuel consumption.

In the extremely cost-sensitive commercial vehicle sector, transport efficiency is a significant factor in the purchasing decision. In addition to the purchase price and operating costs of a vehicle, the payload potential also contributes to this factor. The pressure is therefore great to develop efficient drive systems at reasonable cost and without increasing weight wherever possible. Accordingly, the introduction of the Euro VI emissions standard presents a great challenge as the drive's peripherals have become more complex while the measures for complying with NO_X and particle emissions requirements have a counterproductive effect on fuel consumption. Nevertheless, the new Euro VI vehicles have similar or even lower fuel consumption in comparison with Euro V versions, thanks to extensive advancements in drive technology. Despite increased efficiency, systems complexity, and performance, additional weight is not needed, as MAHLE impressively demonstrates with the cooling system for Euro VI applications.

As one of the engine measures taken to meet the Euro VI limits, cooled exhaust gas recirculation (EGR) has become nearly universal. Its main advantage is that it provides low specific fuel consumption levels with low NO_X emissions. This results, however, in greater requirements for cooling capacity without

increasing fuel consumption. This is possible with a cooling system that is up to 25 percent larger than in a Euro V system, with aerodynamic optimization. Extensive measures are needed, however, to achieve this system without increasing weight. Some of these involve lightweight design, others are an increased specific output of components.

The core of engine cooling is the radiator, which needs to dissipate waste heat from the engine to the ambient air. In addition to increased efficiency, significantly higher operational strength was also required. The temperature and pressure cycles increase both in intensity, driven by system pressures and pump power output, and in frequency, due to feedback control. At the same time, the target for service life of these products has risen to 1.6 million kilometers. With a significant increase in power density and lightweight design measures, increased weight associated with larger cooler surface areas was not only avoided but even overcompensated, despite the increased performance requirements. Optimization of the cooling air ribs and coolant tubes was required in order to increase capacity. Pressure-resistant multichamber tubes with thinner walls were developed to reduce weight while increasing strength. New tube penetration geometries were introduced in order to relieve the tube-to-floor connection, which is critical for strength. New production processes had to be developed for all of these individual components. The result of this extensive development work and the adapted production processes is an engine cooling system that supports compliance with Euro VI emissions standards and does not increase weight despite its significantly greater performance.

The charge air cooler required only a slight increase in size due to the introduction of Euro VI, because while the use of EGR does increase boost pressure and turbocharger exit temperatures, the air ratio is reduced. The higher temperatures and pressures, combined with VTG turbochargers, also cause a significant increase in loads. Similar to the radiator, here again the power density was increased and wall thickness reduced by optimizing each of the components.

The larger cooling module also means that a larger fan is required. Greater performance requirements can be applied while reducing weight by increasing CFD-based power density and introducing FEM-based structural optimization.

The EGR cooler is often an additional new component that necessarily means an increase in weight. The proven and robust technology of the winglet tube from MAHLE has been developed further as well. Pressure loss in the dirty condition is an important variable that drives cooler dimensions, so that even then the EGR rates required for reducing emissions can be maintained. Thanks to ongoing development of the winglet geometry, this pressure loss was reduced by 25 percent. The number of tubes could thereby be reduced by up to 15 percent.

Overall, the theoretical increase in weight resulting from the increased performance of the cooling system could be compensated for with measures such as lightweight construction and improved power density of all cooling components. MAHLE cooling components also prevent a theoretical increase in consumption of up to two percent in comparison with previous cooling systems in a Euro VI system. The overall system therefore sustainably contributes to transport efficiency.

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About MAHLE
With its three business units Engine Systems and Components, Filtration and Engine Peripherals, as well as Thermal Management, MAHLE ranks among the top three automotive systems suppliers worldwide. All of the group's nonautomotive activities are combined in the Industry business unit with products from the application areas of large engines, filtration, and thermal management for industrial purposes. The Aftermarket business unit serves the independent parts market with MAHLE products in OE quality.

MAHLE has a local presence in all major world markets. In 2014, some 64,000 employees at over 140 production locations and ten major research and development centers are expected to generate sales of around ten billion euros.

Further queries:
MAHLE GmbH
Corporate Communications/Public Relations
Pragstrasse 26–46
70376 Stuttgart
Germany

Ruben Danisch
Phone: +49 711 501-12199
Fax: +49 711 501-13700
ruben.danisch@mahle.com

Dr. René Lehnert
Phone: +49 711 501-40304
Fax: +49 711 501-44 40304
rene.lehnert@mahle.com