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PRESSRELEASE

Valve train technology for modern commercial vehicle engines

Hannover, September 2014 – Following the introduction of the Euro VI exhaust gas standard, no further tightening of emissions limits is expected for commercial vehicles in Europe in the near future. This does not mean, however, that technical development will stagnate. In the cost-sensitive commercial vehicle sector, the focus is once again on increasing efficiency. MAHLE demonstrates the requirements that this places on the valve train system, and what solutions are being developed.

Overall costs over the service life of a vehicle—and the closely related factor of efficiency in transportation—are now the primary drivers for new development in commercial vehicles. The primary focus is on further reductions in fuel consumption, e.g., by means of downsizing and downspeeding. The use of alternative fuels, such as compressed natural gas (CNG), may also be an interesting option. These changes affect the component stresses in the valve train system.

In order to reduce procurement costs, components must be kept as simple as possible. For example, low-cost alternatives are being sought for the exhaust gas aftertreatment system, which is currently very complex. New functionalities are also needed. This makes the introduction of valve train variability an attractive strategy.

Requirements and solutions in the valve assembly

The valve assembly, consisting of the valve, the valve guide, and the valve seat insert, is severely exposed to rising combustion pressures and temperatures, on account of its proximity to the combustion chamber. Measures are therefore needed to compensate for the temperature stresses. At the same time, they must meet the requirements relating to the

ongoing costs of a commercial vehicle. In order to reduce these costs further, enormous service life requirements of up to 1.6 million kilometers must be met, while service intervals are increasing to as long as 400,000 kilometers.

The introduction of nitrided intake valves represents a lower-cost approach than the chrome-plated valves commonly used today. The completely nitrided component needs only a blasting or polishing process during manufacturing. The low process temperature of nitriding limits the loss of hardness at the end of the valve stem. This means that greater specific loads can be handled without extensive efforts, while meeting the extended service life and service interval requirements. The nitrided intake valve is characterized by excellent wear protection, significantly increased fatigue strength, and robustness against thermomechanical fatigue (plating cracks).

Sodium-filled hollow valves, which can reduce valve temperature peaks thanks to the “shaker effect” of the molten sodium, can withstand thermal loads particularly well. The temperature in the hollow neck can be lowered by about 80 to 130 K. This reduces the overall wear in the system of the valve and valve seat insert, and can bring substantial advantages in gas applications in particular, as well as in challenging diesel applications.

The MAHLE EvoTherm® valve provides even greater protection against thermomechanical fatigue. This is an extension of the classic sodium-filled hollow valve, with an additional cavity in the valve head. The shaker effect of the molten sodium in the spherical cavity near the valve head smoothes out the thermal stresses to further increase the service life.

The valve guide is also subjected to greater stresses due to the higher temperatures. MAHLE has therefore developed a new material: the valve guide material PL S 131 is a Bainite matrix with uniformly distributed solid lubricants and wear-reducing hard phases. The material is easy to machine and provides

substantially improved wear resistance at high temperatures, very good tribological compatibility with chrome-plated and nitrided valve shafts, and excellent boundary lubrication properties in situations where lubrication is inadequate.

A new material has also been developed for the valve seat insert. Rising thermal loads require greater creep resistance at this location, in order to prevent the valve seat insert from falling out (“drop-out”). PL 510 consists of a martensitic matrix with a chromium-molybdenum-vanadium network and increased cobalt content. This gives the material high compressive strength and creep resistance at high temperatures, as well as good tribological compatibility with common valve and valve plating materials.

Lightweight construction and flexibility with assembled camshafts

MAHLE camshafts already contribute to weight reduction. Series production of an assembled camshaft for commercial vehicles has been running since 2012. Cast iron camshafts have long been used for light commercial vehicles, while medium to heavy commercial vehicles have primarily relied on forged steel camshafts. Assembled camshafts allow higher contact pressure between the cam lobe and cam follower in comparison with cast camshafts, and offer significant weight advantages of up to 50 percent over steel camshafts made from solid material or raw forgings. The great design flexibility of the assembled single parts also provides cost advantages with respect to materials and design. For example, very durable cam lobes are made of roller bearing steel and then inductively hardened, while the drive input and output elements can be made of lower-cost materials, as needed. Assembled camshafts for commercial vehicles from MAHLE therefore enable modern commercial vehicle engines to fulfill increasing requirements related to service life at a low cost, while simultaneously reducing weight and optimizing fuel consumption. A clear trend toward the use of assembled camshafts can be seen in the development of future commercial vehicle engines.

Expanded functionality with the MAHLE CamInCam®

Many medium- and heavy-duty engines on the market today still have OHV or SOHC valve trains. With MAHLE CamInCam® technology, these engines can have the functionality of a DOHC without requiring design changes to the basic engine or the cylinder head. With minimal changes to the package constraint, they also support functions that are increasingly in demand for improving engine efficiency:

- **Exhaust gas temperature management**: opening the exhaust valves sooner allows the exhaust gas temperature to be increased. Exhaust gas with a higher enthalpy allows SCR catalyst light-off, or regeneration of the particulate filter.
- **Miller cycle**: closing the intake valves earlier or later allows the effective compression ratio to be reduced, thereby lowering the combustion temperature and pressure. Part of the compression work is then transferred to the turbocharger (in combination with charge air cooling).
- **Variable internal exhaust gas recirculation**: modern engines use a secondary stroke to implement internal exhaust gas recirculation (EGR). The EGR rate is defined for every speed and load point, and is not flexible. A switchable or variable internal EGR system would improve the transient behavior of the engine by reducing the EGR rates and thereby ensure reliable compliance with emissions limits. This can be implemented with variable valve timing using the MAHLE CamInCam® system.

In summary, the MAHLE CamInCam® has great potential for further improving emissions, performance, and fuel consumption in commercial vehicles without a substantial increase in installation space.

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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