

Press release

MAHLE Powertrain collaborates with Liebherr to co-develop active pre- chamber technology for heavy-duty hydrogen-fuelled engines

- The specialist engineering consultancy supports Liebherr-Components product segment in the development of hydrogen-fuelled internal combustion engines
- Early results indicate MAHLE’s active pre-chamber technology is key to stable hydrogen ignition without reduced compression ratio
- Hydrogen engines offer a robust, carbon-neutral, heavy-duty powertrain solution

Liebherr Machines Bulle SA has announced early trial results using MAHLE Jet Ignition (MJI) in the development of hydrogen-fuelled internal combustion engines. It proved to be a successful ignition source for hydrogen without the need to reduce compression ratios, unlocking the potential of hydrogen as a carbon-neutral fuel for the heavy-duty engine sector.

Nussbaumen (Switzerland), 14. October 2021 - “The use of hydrogen as a combustion fuel has the potential for rapid de-carbonization of many heavyduty and off-road sectors,” says Mike Bunce, Head of Research for MAHLE Powertrain US. “A wealth of research over the past few decades has confirmed the compatibility of hydrogen with internal combustion engines. The challenge has been to get it to run with stable combustion without resorting to reductions in compression ratios to avoid engine knock and pre-ignition. Our common work with Liebherr suggests we have the answer.”

Hydrogen is a carbon-neutral fuel that is gaining renewed attention due to its increasing availability and the fact that it can be produced from renewable energy sources. As a fuel for proven and existing ICE technology in aggressive environments, hydrogen is ideally suited to the high load duty cycles with sudden load steps, heat, dust and vibration of heavy duty and off-road use. This is not the case for battery electric or fuel-cell powertrains.

The challenge is that hydrogen as a combustion fuel is highly prone to abnormal combustion, leading to engine knock and pre-ignition. Typically, this necessitates an inefficient reduction in engine compression ratio. However, a potential alternative is to depress combustion temperatures by using high levels of dilution, which is more conducive to stable running, but would require a high-energy ignition source. Originally developed for gasoline applications, MAHLE's pre-chamber ignition technology enables the use of highly dilute fuel/ air mixtures, making it ideal for use in hydrogen-fuelled engines. To achieve this, the MJ1 was adapted, mainly by modifying the pre-chamber in the cylinder head containing a spark plug, which ignites a fuel/ air mixture. The resulting gas plasma is forced through small orifices into the main combustion chamber to ignite the combustion mixture very quickly and uniformly.

Adaptation of the active pre-chamber to fit in Liebherr's H966 and H964 engines has shown, in a preliminary investigation, that this technology extends the stable dilution limit of the engine well beyond the capability of traditional ignition systems, with much more rapid and complete combustion.

"Together with Liebherr Machines Bulle SA, we have been able to tailor the active pre-chamber technology to the Liebherr heavy-duty engines, which leads to improving the combustion speed, performance and emission. Additionally, the technology will simplify the hardware architecture of the engines," explains Mike Bunce. "This has enabled us to mitigate the compression ratio de-rating risk associated with hydrogen, as well as reduce the fuel consumption. The expertise of Liebherr's engineering teams in the areas of heavy-duty combustion and alternative fuels research have both been major assets in this program," adds Bouzid Seba, Head of Predevelopment at Liebherr Machines Bulle SA, pointing out Liebherr's openness to technology and the Group's pursuit of different approaches to energy conversion as well as suitable fuels.

Some of the collaboration results to date were jointly presented at the 8th International Engine Congress in February 2021. The two companies are continuing their collaboration in order to push towards zero emissions vehicles that can meet the significant demands of the heavy-duty and off-road sectors.

About MAHLE



MAHLE is a leading international development partner and supplier to the automotive industry. The technology group is committed to playing an active role in transforming the mobility of the future by further optimising the combustion engine, driving forward the use of alternative fuels, and laying the foundation for the worldwide introduction of e-mobility and other alternative drives, such as fuel cells. The group's product portfolio addresses all the crucial aspects of the powertrain and air conditioning technology.

In 2019, MAHLE generated sales of approximately EUR 12.0 billion and is represented in over 30 countries with more than 77,000 employees in 160 production locations and 16 major research and development centres (last revised: 2019-12-31).

About MAHLE Powertrain

MAHLE Powertrain is a specialist in providing engineering services for the design, development and integration of advanced internal combustion engines and electrified powertrain systems. As a recognised expert in these fields, MAHLE Powertrain is engaged in the extensive research, development and application of new traditional and advanced drivelines into cost-effective, production feasible solutions for enhanced efficiency, improved fuel economy and lower emissions.

As a services subsidiary of the MAHLE Group, MAHLE Powertrain has eight technical centres strategically located in the UK, Germany, USA, China and Brazil and is well placed to provide solutions around the globe. It operates independently of the main group, when considering choice of components or technologies.

About Liebherr Machines Bulle SA

In the Canton of Freiburg (Switzerland), Liebherr Machines Bulle SA develops and produces combustion engines, as well as hydraulic components and splitter boxes. The high-quality components and systems are not only used within the Liebherr Group. Other manufacturers also integrate them into their own machines. The Bulle location is the Liebherr Group centre of excellence for the development of combustion engines.

About Liebherr-Components AG

In this segment, the Liebherr Group specialises in the development, design, manufacturing of high-performance components in the field of mechanical, hydraulic and electric drive and control technology. Liebherr-Component Technologies AG, based in Bulle (Switzerland), coordinates all activities in the Components product segment.

The extensive product range includes diesel and gas engines, injection systems, engine control units, axial piston pumps and motors, hydraulic cylinders, slewing bearings, gearboxes and winches, switchgear, electronic and power electronics components, and software. The high-quality components are used in cranes and earthmoving machinery, in the mining industry, maritime applications, wind turbines, automotive engineering or in aviation and transport technology. Synergy effects in other product segments of the Liebherr Group are used to drive continuous technological development.

About the Liebherr Group

The Liebherr Group is a family-run technology company with a highly diversified product portfolio. The company is one of the largest construction equipment manufacturers in the world. It also provides high-quality and user-oriented products and services in a wide range of other areas. The Liebherr Group includes over 140 companies across all continents. In 2020, it employed around 48,000 staff and achieved combined revenues of over 10.3 billion euros. Liebherr was founded in Kirchdorf an der Iller in Southern Germany in 1949. Since then, the employees have been pursuing the goal of achieving continuous technological innovation, and bringing industry-leading solutions to its customers.

Images



liebherr-H964-engine.jpg

Adaptation of the active pre-chamber in Liebherr's H966 and H964 engines has demonstrated that heavy-duty engines can be operated with hydrogen.



mahle-jet-ignition-unit-active.jpg (©MAHLE Powertrain)

MAHLE's active pre-chamber technology proves to be key to stable hydrogen ignition without reduced compression ratio.

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