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Press Release
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Significant improvement in the efficiency of diesel technology is within reach

Research project of the Thüringer funding program completed successfully: Joint project achieves a hydraulic high-pressure of 25,000 bar

The strict requirements of the EURO-6-Norm, which will be introduced for heavy goods vehicles in September 2014 and for passenger vehicles in September 2015, represent substantial challenges for vehicle manufacturers. Diesel engines need to be completely redesigned to meet the efficiency standards of the new norm. The efficiency of the aggregate can only be adequately improved by significantly increasing the pressure used to inject the fuel. A prerequisite for this is a corresponding high pressure test. In cooperation with the Material Research and Testing Institute Weimar at the Bauhaus University in Weimar (MFPA) and the company Siegert Thinfilm Technology GmbH, the high pressure specialist Maximator, which is based in Nordhausen, has taken a technological quantum leap: A pressure in excess of 25,000 bar was generated. The project was sponsored by the Thüringer funding program with the funding code 2009 VF 0039.

Test technology requirements

The upper limit of the carbon dioxide emissions, which was defined for compliance with the EURO-6-Norm, means that the diesel injection pressure in diesel engines needs to be increased from 2,000 to 3,000 bar. At an operating pressure of 3,000 bar, the diesel injection components (i.e. the common rail, high pressure pump, injectors, tubes, etc.) need to undergo a prior impulse test with up to 7,000 bar. The autofrettage technique, which improves the strength of the pressure-loaded parts, has been established for approx. two decades. The current standard autofrettage pressure levels of up to about 15,000 bar need to be significantly increased due to the required increase of the injection pressure to 3,000 bar. This is a completely new challenge in terms of enhancing the testing and series autofrettage procedure.

Test stand design at the limits of feasibility

To build a pressure intensifier – the component that generates the high pressure – various parts need to be connected to each other. State-of-the-art is a shrink connection, which is the only way to withstand pressure levels of this kind. To shift the limits of what is feasible, the MFPA and Maximator GmbH tested a number of high-strength steels. The main requirement made of these materials was high strength coupled with adequate ductility. To satisfy these requirements, the materials used need to have a high level of purity that is achieved by means of vacuum induction melting followed by remelting in a vacuum or inert gas. Steels were found that, in combination with hard metal components, are suitable for the generation of very high pressure.

Ideal high pressure fluid, testing of sensor concepts

The extreme pressure requires special fluids that retain their physical properties under the conditions in the test systems. In a series of tests, a high pressure fluid, which remained sufficiently fluid even under extreme pressure, was identified and approved.

The company Siegert TFT GmbH tested two high-pressure sensor concepts for measuring the generated extreme pressure on the pressure outlet. One of these sensors is based on an innovative highly-sensitive thinfilm layer structure made of a composite material comprising nano-nickel clusters and graphene-like carbon. The high sensitivity of the layer allows the design of rigid sensor construction that ensures its stability against high pressures of this kind. Alternatively, a concept for a membrane-free sensor was developed. An isostatic pressure-sensitive layer for generating signals is used on a ceramic base body that can easily withstand the high pressures, and is connected with very thin wires. The tests of the concepts established that the measuring technology almost approximated the required pressure.

The way forward

The consortium of Maximator, the MFPA and Siegert TFT was able to clear all fundamental barriers to the test-specific preparation of the EURO-6-Norm. As the global leader for autofrettage systems, Maximator was a major stimulus for the success of the research project. The development of test stands that can be used under the imperative conditions is an essential requirement for the advancement of the diesel technology.

Impact of the developed technology

Marketability and the transfer of individual technologies from this development are feasible in around six months. This would mean that Maximator would be able to supply this autofrettage with the possible extremely high pressure as a service in about 18 months. The improved injection of the fuel and the resulting greater surface will allow at least one litre of diesel to be saved for every hundred kilometres driven. Alternatively, at

the same fuel consumption rate, much higher engine performance is possible. At the end of the day, it is the buyer that decides which trend will take priority.

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The partners of the EU research project "Autofrettage pressures up to 25,000 bar": Maximator, Siegert TFT and the Materials Research and Testing Institute Weimar (MFPA).
On the lifting platform (left to right.): Dipl.-Ing. Markus Wedemeyer (Maximator), Dr. Ralf Koppert (Siegert TFT), Prof. Joachim Bergmann (MFPA) and Dr. Stefan Linne (MFPA). In front (right to left): B. Eng. Florian Pätzmann (Maximator), Thomas Bringmann (Maximator), Jürgen Gieseler (Maximator) and Sönke Roloff (Maximator).

About Maximator GmbH

Maximator GmbH is one of the leading suppliers in the high pressure, test technology, hydraulics and pneumatics sector. The employees develop, design, manufacture and market international products that are used in industrial systems across the world. In addition to high-pressure impulse testing systems, the company also manufactures bust pressure tests stands, leak test stands, autofrettage systems, high pressure pumps and high pressure compressors. The products and services from the company Maximator GmbH are used in the automotive industry, general mechanical engineering, chemicals, petrochemicals, oil and gas industries.

www.maximator.de

About the Material Research and Testing Institute Weimar (MFPA)

The Material Research and Testing Institute Weimar at the Bauhaus University Weimar is a non-university research institute and the official materials testing institute in the Free State of Thuringia. The established Materials and Parts Department specialises in developing, testing and characterising metallic and plastic materials as well as components. For many years the focus of the research and services in this department has been the testing and calculation of inner pressure tensile strength and its increase by means of mechanical and thermochemical procedures (e.g. autofrettage and case hardening), for instance as used in the diesel injection equipment. In its own high pressure and materials testing laboratory, fatigue strength tests are carried out for research and service tasks and are also assessed based on fractographic and material tests. Years of experience in this field also flowed successfully into the joint project "Development of 25kbar autofrettage systems".

www.mfpa.de

About SIEGERT TFT THINFILM TECHNOLOGY GmbH

The company Siegert TFT Thinfilm Technology GmbH was founded in 1992 and has more than 90 employees. Siegert TFT has its own procedural and product-specific know-how for its products, some of which was developed in funded R&D projects. The product range comprises thinfilm layer structures for electronic devices and sensors, precision resistance networks and single resistors, microsystem components, and temperature, pressure, force and acceleration sensors. Since 1995 Siegert TFT has manufactured pressure and force sensors with metal base bodies and thin film applications. All sensors belong to the high end of the global market. The Siegert TFT production facilities cover a floor space of 3,000 sqm, 500 sqm of these are clean rooms of the class 1000, locally of the class 100.

www.siegert-tft.de

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We would appreciate it if a specimen copy of any print or mention could be sent to Wassenberg.

Thank you!

Company contact:

MAXIMATOR GmbH

Dipl.-Wirt.-Ing. (FH) Christopher Schätz
Marketing Manager
Tel.: +49 3631 9533-3072
Fax: +49 3631 9533-3040
cschaetz@maximator.de

MAXIMATOR GmbH
Lange Straße 6
D-99734 Nordhausen

MFPA

Dr.-Ing. Stefan Linne
Abteilungsleiter Werkstoffe und Bauteile
Tel.: +49 3643 564-403
Fax: +49 3643 564-201
stefan.linne@mfpa.de

Materialforschungs- und -Prüfanstalt
an der Bauhaus-Universität Weimar
Coudraystraße 9
99423 Weimar

Siegert Thinfilm Technology GmbH

Dr.-Ing. Ralf Koppert
Head of the Research and Development Group
Tel.: +49 36601 858-63
Fax: +49 36601 858-11
ralf.koppert@siegert-tft.de

Siegert Thinfilm Technology GmbH
Robert-Friese-Straße 3
D-07629 Hermsdorf

Press:

Michaela Wassenberg

Tel.: +49 (0)911 / 598 398-0
Fax: +49 (0)911 / 598 398-18
m.wassenberg@wassenberg-pr.de

Wassenberg Public Relations für
Industrie & Technologie GmbH
Rollnerstr. 43
D-90408 Nürnberg