



Pressure strengthened engines

High pressure can be used to strengthen materials by changing their structure. These stronger materials have many applications, with one of the most important being in diesel injection engines, where stronger components are needed for more fuel efficient designs. However, until recently, the automotive sector couldn't ensure the accuracy of the high pressure process delivering this strength.

Europe's National Measurement Institutes working together

The European Metrology Research Programme (EMRP) brings together National Measurement Institutes in 23 countries to address key measurement challenges at a European level. It supports collaborative research to ensure that measurement science meets the future needs of industry and wider society.

Challenge

High-pressure technologies are increasingly being used to create more durable materials in industries such as petrochemical, pharmaceutical and automotive. This is of particular importance in the manufacture of diesel injection fuel systems: improving engine efficiencies to meet new EU vehicle emissions regulations, requires manufacturers to significantly increase the pressure used to inject fuel. In order for engines to withstand such increased pressures, the inner surfaces of components in diesel engines need to significantly increase in strength.

One solution is 'autofrettage', a technique which applies enormous pressure to a component, causing structural changes which give a strengthened finish. The pressures required for autofrettage and other high pressure manufacturing and testing techniques were beyond the upper limit of pressure calibration laboratories – around 1 gigapascal (GPa). Until recently, production engineers had no reliable, traceable method for confirming that engine components had been subjected to a sufficiently high pressure to produce the required strengthening. New calibration facilities capable of meeting demands for ever higher industrial process pressures were needed.

Solution

The EMRP project *High pressure metrology for industrial applications* developed a new high pressure facility capable of calibrating pressures of 1.6 GPa, suitable for techniques such as autofrettage.

Building equipment which could withstand such high pressures with durability was a challenge and the project took extensive materials measurements to understand how they responded to different pressures. This data was used to model the facility, which was then built. Rigorous testing validated its performance, which proved stable with low uncertainties.

The facility now provides calibration services for commercially available pressure sensors, enabling traceability transfer to the production line.

Impact

HBM, a global supplier of measurement instruments, has created the P3MB Blue Line Top Class transducer®, a calibrated, high pressure sensor which is giving confidence to their customers that pressures are being accurately applied in industrial processes. HBM has been able to calibrate this durable high pressure sensor as a direct result of the project. These 'Top Class' sensors can now be used as a transfer standard to calibrate HBM's own sensors and also as a tool to calibrate and verify customer instruments.

Another early adopter of the capability, Maximator GmbH, supplies autofrettage to the automotive industry. By calibrating its autofrettage systems at the new facility, Maximator is also able to provide the required confidence to its customers that its systems operate at the required pressures. This allows European manufacturers to confidently produce components for more fuel efficient diesel engine designs, and so ensure compliance with the latest EU emissions rules.

An immediate effect is to help carmakers develop engines with reduced exhaust emissions and greater fuel economy, which is essential for continuing competitiveness of European vehicle manufacturers and for reducing the environmental impact of vehicle emissions.

Metrology for high-pressure manufacturing

The EMRP project *High pressure metrology for industrial applications* developed a capability to measure pressures up to 1.6 GPa, from which industrial users can calibrate their pressure measurement devices. The standards and calibration procedures developed will allow European industry to use high-pressure techniques, including autofrettage, hydroforming and isostatic pressing, to manufacture durable, high-performance products and to meet challenging sustainability requirements.



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