European Metrology Research Programme

Delivering Impact

Under pressure: sensors for new engines

Accurately measuring pressure shocks generated by contained explosions is challenging. European automotive, aerospace and defence industries rely on measuring these types of dynamic pressure changes in developing new products. There is currently no traceable calibration method for dynamic pressure, and existing static sensor calibrations may not represent performance in dynamic pressure applications. Companies require reliable information on sensor performance in dynamically changing pressure extremes.

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

Dynamic pressure changes involving a near instantaneous shock wave are generated in many applications. For example, during the fuel ignition sequence of an internal combustion engine a rapid increase in pressure occurs from atmospheric to several hundreds of atmospheres. Even more extreme conditions arise when airbags inflate during rapid decelerations or when guns are fired and momentary pressure excursions of tens of thousands of atmospheres are possible. The safe operation of all of these relies on testing during design and production.

Sensors calibrated using static or very slowly increasing pressures may not have the same response to such rapidly fluctuating and extreme short-lived pressure excursions. New pressure calibration facilities are needed that are capable of producing shock pressures with greater similarity to in-service conditions to address growing industrial demand for more relevant traceability.

Solution

The EMRP project Dynamic: *Traceable Dynamic Measurement of Mechanical Quantities* validated a facility to provide accurate dynamic calibrations for pressure sensors based on shock tubes. This system generates a near instantaneous shock wave by increasing pressure at one end of the tube, until a separating diaphragm ruptures. The sensor under test is mounted at the other end of the tube, and experiences this well-characterised sudden pressure change. The standardised, controlled pressure increases in the shock tube underpin this traceable measurement, allowing a characterised and accurate calibration of the sensor under test, and recreating conditions more reflective of those in-service.

Impact

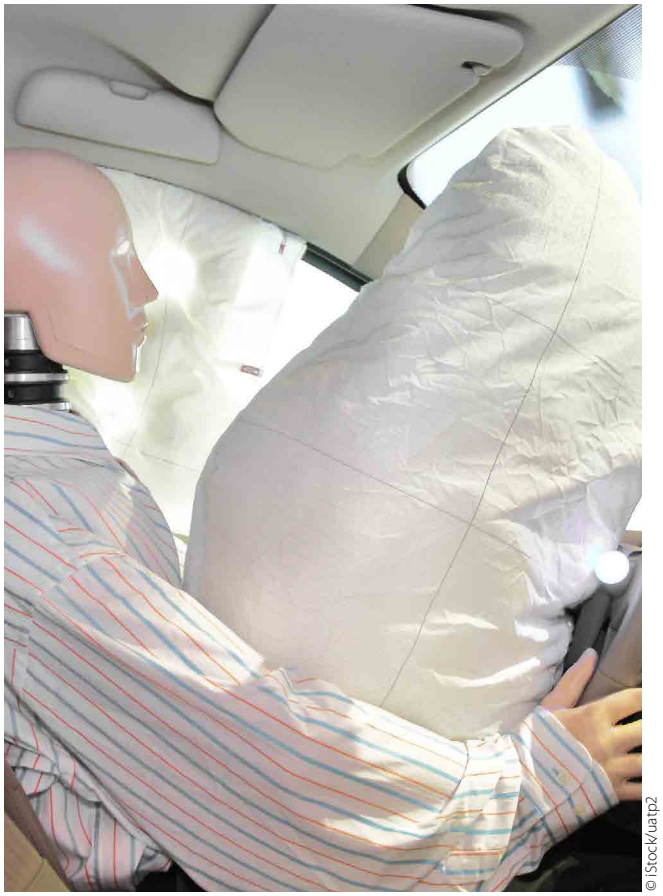
Kistler Instrumente AG, a global market leader in dynamic measurement technology, develop measuring systems and sensors that push the physical limits. As a manufacturer of dynamic pressure sensors, Kistler was keen to be one of the first users of the new calibration facility. The validated sensor performance data the calibration system provided to Kistler is supporting them in the extreme challenges posed by the applications of their sensors.

Accurate dynamic pressure measurement is key in the design of more fuel efficient and less polluting engines which will operate at higher pressures and temperatures than current models. Kistler is proposing to use the facility to characterise new prototype sensors during the design process, reassuring them that they perform to specification. Their sensor technology aims to support engine research and development aimed at enhancing efficiency and power, improving comfort, and reducing emissions. A key component in achieving these goals will be the assessment and comparison of measured engine parameters such as cylinder pressure for combustion analysis.

The shock tube calibration system provides improved confidence in sensor performance during rapid dynamic pressure excursions allowing companies to demonstrate that sensors meet their stated specification. More realistic calibration conditions particularly benefit customers in the gas turbine and combustion engine industries, where improved engines as a result of dynamic pressure sensor testing contribute to competitiveness.

Traceable Dynamic Measurement of Mechanical Quantities

The EMRP project *Traceable Dynamic Measurement of Mechanical Quantities* developed validated calibration devices to provide traceable dynamic measurements of force, torque and pressure. Traceable dynamic measurements help the automotive, aerospace and defence industries to design and operate safety critical ballistic systems more reliably and ensure the efficiency of dynamic systems such as car engines. The methods and devices developed by the project enable calibration under dynamic conditions closer to those experienced during operation, and provide important estimations of accuracy and uncertainty.



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