

Kistler News

Engine Research & Development / Engine Marine & Stationary



Continuous on-line monitoring of cylinder pressure for closed loop combustion control

Cylinder Pressure Measurement Cuts Fuel Consumption

Kistler boosts the efficiency and reliability of large marine and stationary engines through monitoring and control of the combustion process.

90 % of all goods transported are traversing the world's oceans every day in container ships, tankers and freighters. Marine cargo transport offers a green alternative to road and air transportation, but even on the high seas boosting efficiency and sustainable optimization of resource usage are key concerns. The International Maritime Organization (IMO) has set a target of achieving a 10 % increase in the efficiency of new ships by 2020, and CO₂ emissions per tonne are to be cut by 20 % across the entire industry. Today's shipping industry has to meet ever-greater business expectations and increasingly stricter regulatory requirements. One response to this has been more widespread use of a cutting edge engine technology that allows active control of the combustion process – closed loop combustion control (CLCC). Whenever monitoring and control of combustion in large marine and stationary engines is required, Kistler is on hand with proven, reliable solutions - customized as required for every customer, including the necessary certifications.

Cylinder pressure measurement is the crucial factor in CLCC for large engines - this provides on-line feedback information to the engine control system about the actual operating conditions in the combustion chamber. Analysis of data from CLCC systems in use today provides clear evidence on how the efficiency of

2-stroke or 4-stroke engines can be enhanced. Fuel consumption improvements of as much as 2 %, stability of emissions over long operating periods, and the ability to optimize maintenance intervals, all lead to short term operational cost savings for the engine operators. The advantages of this are even more evident when operating with mixed or variable quality fuels. The systems also provide longer term potential savings for customers; from the early warning detection of engine operating issues that could otherwise lead to very high repair costs, and from a general reduction in engine component wear that the elimination of high load combustion events made possible with CLCC can achieve.

Combustion Control in Continuous Operation with Reliable On-line Monitoring

Kistler has designed rugged piezoelectric cylinder pressure sensors to meet the special requirements of on-line combustion monitoring in marine and stationary engine installations. These long service lifetimes – installed on the cylinder head of low- and medium-speed engines – are the key to our success in this market.

Certified Industry Standard: Offline Diagnosis

Cylinder pressure also provides meaningful information about the condition of an engine when used as a regular maintenance basis – as an off-line diagnostic tool. All large engine classification companies specify regular cylinder pressure measurements as a standard – and this data provides the essential basis for maintaining

good fuel consumption. Peak pressures on large engines can be recorded periodically by Kistler's diagnostic equipment, with immediate evaluation using the software supplied with the products. This rugged equipment can be installed quickly and easily on the indicator valve on the engine and delivers accurate and reliable measurement data from sensors with proven long-term stability.

Reliable Sensor and System Expertise – from One Single Source

When a customer needs to monitor and control large engines, they need look no further than Kistler: we offer cylinder pressure sensors backed by all the service and system expertise necessary – allowing us to develop cost-effective solutions tailored to the needs of each specific customer. Jürg Stadler, Head of Kistler's Strategic Business Field Marine & Stationary, proudly explains, "Our many years of expertise in cylinder pressure measurement provide the basis for combustion control for many manufacturers of large engines, shipbuilders, shipping companies and power plant operators. One example is General Electric (GE) - this manufacturer of energy technology solutions in power generation, was so enthusiastic about our professional, customer focused service offering that the company awarded us GE's prize for innovative capacity and technology leadership in 2015."

For more information about Marine & Stationary, visit: www.kistler.com/engine-marine-stationary/

► Editorial



Dear Readers,

Now that about 25 years have passed since the start of globalization, one thing is clear: it's essential for all players in industry and business to take an active role in continuing to develop existing technologies and expanding specialist know-how. This is the only way to reconcile the requirements of a globally interconnected economy with the need to keep the environment intact.

In the large marine and stationary engine segment, we are proud to play our part by responding consistently to the market's needs with new and efficient solutions. Dependable products that ensure high operational reliability, and our constant striving for technical excellence: based on these cornerstones, we are still setting standards in sustainable resource optimization

Our commitment goes well beyond the development of durable, energy-efficient sensors and systems to optimize large engines. As a division of the Kistler Group, we offer professional advice and Kistler's worldwide service as part of our daily endeavor to boost your company's business success over the long term!

J. Stadler

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A New Generation of Uncooled Cylinder Pressure Sensors

An uncooled high-temperature piezoelectric cylinder pressure sensor that has been designed to operate reliably in challenging environments: that's the Type 6124A from Kistler.

Thanks to its high sensitivity combined with excellent thermodynamic characteristics, this sensor delivers high-precision signals and ensures accurate measurements throughout its long service lifetime. The plug-in design of the sensor makes it suitable for a varied range of installation methods, with or without a mounting sleeve.

New Crystal Guarantees Accurate Measurements

As technological progress gathers pace, measuring equipment has to meet ever more demanding standards and requirements. Application areas are becoming increasingly complex as time goes on, so sensors have to become more versatile and flexible.



A Perfect All-Rounder

Maximum flexibility is guaranteed thanks to the option of direct mounting. The Type 6124A plug-in cylinder pressure sensor can be used flexibly in a variety of applications. Its rugged structure makes it ideal for thermodynamic investigations and demanding measurement assignments in harsh conditions. What's more, this shoulder-sealing sensor is suitable for front-flush installation in the cylinder head. Additional mounting methods are possible thanks to a diverse range of accessories: for instance, the sensor can also be installed through the water channel with a mounting sleeve.

Because it is an uncooled sensor, the Type 6124A sensor is equally ideal for on-board deployment in road tests. It is also compatible for installation with Type 6125.

Key-Features

- Low thermal shock error and low acceleration sensitivity
- Very small linearity deviation, <0,3 %
- Minimal sensitivity change across the temperature range, <1 %
- Compatible for installation with Type 6125 pressure sensors
- High accuracy and excellent sensitivity

The Type 6124A piezoelectric cylinder pressure sensor uses a PiezoStar® crystal that can achieve very high sensitivity even with a compact sensor design. The sensor is optimally coordinated with the new crystal and its design affords greater pressure resistance, so thermal sensitivity deviations are very low and linearity is excellent. The benefits: high-precision measurements and maximum service lifetimes.

Good decoupling of the measuring element and an improved connection for the signal cable make the Type 6124A even more robust, and these are key factors in ensuring excellent signal quality.

Modular Absolute Pressure Sensor for Enhanced Versatility

The Kistler Type 4011A piezoresistive absolute pressure sensor is designed to operate reliably in challenging environments.

High-precision signal conditioning ensures excellent measurement accuracy throughout the longest possible service lifetime. Type 4011A consists of a basic module with a range of different adapters so therefore numerous mounting variants are possible.

The Talented All-Rounder in Kistler's Sensor Family

Sensors have to meet enormous requirements for measurement accuracy. They are used in areas of research and development that are becoming more complex as time goes on. This trend calls for flexible sensor solutions such as the Kistler Type 4011A. This sensor is an all-rounder: various adapt-

ers can be used with the basic model to meet an extremely diverse range of requirements. Five different sensor versions are available at present. For example, the Type 4011A can be used as a universal absolute pressure sensor to take measurements on exhaust systems with a cooling adapter – but it is equally suitable for use in the intake area, or for water pressure measurements. The Type 4011A opens up new possibilities for exhaust gas back pressure measurements.

One version is specifically designed for engines with an exhaust manifold integrated in the cylinder head; it can be mounted directly or with the help of a sleeve through the cooling jacket. The Kistler Type 4011A...DS includes

fully shielded cabling with kink protection. Together with the high-grade steel diaphragm, these features ensure maximum lifetimes, enhanced signal quality and increased functionality.

Maximum Compatibility

Type 4011A is the new member of the DS sensor family. Connectors, extension cables and amplifiers within the DS sensor family are mutually compatible. This means that Type 4011A can be used seamlessly with diverse piezoresistive amplifiers – so time can be saved on measurements, and less equipment is needed.

Thermal Sensor Monitoring Prevents Downtime

Thanks to the newly integrated temperature output, temperature information can be read from the load cell to monitor the sensor. This control function avoids sensor faults, thereby saving time that would otherwise be needed to replace the sensor and restart the system.



Key-Features

- Modular design
- Media-separated measuring element
- Digital temperature compensation and automatic sensor identification PiezoSmart®
- Complete shielded signal transmission
- Temperature output for sensor monitoring

KiBox Cockpit V3.0: Enhanced Flexibility for Mobile Combustion Analysis

Thanks to KiBox, information about combustion, injection valve actuation and ignition can be reliably captured, processed and viewed in the familiar INCA environment, among others.

The new KiBox Cockpit V3.0 can be extended to 16 channels with the help of two cascaded boxes – so it is even better prepared to handle test bench applications. Another plus: users themselves can program real-time calculations based on their own algorithms, so they can protect their know-how. A driver update also makes the KiBox Cockpit V3.0 compatible with the most recent INCA version (7.2), so it matches the latest stage of the application tool's development.

Specifically designed for onboard or test bench use, Kistler's compact KiBox complements our product portfolio for engine combustion analysis. It supplies detailed information about the combustion process, including time- or angle-based cylinder pressures and other relevant parameters for engine developers. Depending on the application, the innovative CrankSmart® system can be used – or alternatively, an optical crank angle encoder can be selected for angle sensing. All the key parameters for engine development are recorded with parallel calculation and output in real time. This information provides insights into the quality of combustion as regards performance, efficiency,

emissions and comfort. Results can be outputted synchronously with ECU data in ETAS INCA, VECTOR CANape or ATI VISION, to name a few examples.

More Channels to Enhance Versatility for Test Bench Applications

As well as cylinder pressures, test bench measurements very often include intake and exhaust pressures as well as any other signals. The eight channels available in the past were often inadequate for large-scale measurements. KiBox Cockpit V3.0 is designed for 16 channels, opening up new possibilities on the test bench. Two cascaded KiBox systems are used to make the additional channels available. Complete combustion analysis measurements are possible without external signal conditioning, because Kistler's piezoresistive sensors are used in the intake and exhaust channels together with a matching amplifier module in the KiBox. As well as combustion investigations, these innovations also allow users to perform gas exchange analyses.

User-Programmable Calculation to Protect Know-How

Until now, knock intensity or the heat release rate were determined with standard calculators. Now, individual optimization of engine characteristics is supported by the simple standalone

integration of a company-specific calculation algorithm. The benefit: your know-how stays in your company. The algorithm's source code (based on Matlab Syntax) can be entered directly in the KiBox® Cockpit 3.0 software. Calculations by programmed calculators take place in real time on the hardware, so they can even be used to prevent engine damage in standalone operating mode.

INCA Update Improves Compatibility

Kistler has always offered updates for the KiBox free of charge: the latest software update (V2.1) upgrades the KiBox for direct use on the test bench in addition to the mobile onboard application. KiBox Cockpit V3.0 is now equipped with the latest driver for integration in INCA V7.2 by ETAS. This ensures that all the products are compatible with one another – and all of them incorporate the same state-of-the-art. The equipment is quickly ready to measure and simple to operate – and that's guaranteed!

For over half a century, Kistler has been a leading developer of innovative, application-oriented measuring systems for engine development. The new KiBox will be available from fall 2016 onwards. For more information about KiBox, www.kistler.com/kibox



KiBox Cockpit V3.0: New with 16-channel option.

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