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1 / 2 *Application areas of our sensors are combustion engines, gears, automotive, wind power stations, compressors, generators*

SENSORS FOR OIL CONDITION MONITORING

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In combustion engines, wind energy gears, turbines, compressors or power transformers and many other industrial applications it is often desired to monitor the condition of the used lubricating oil on-line or on-site in order to avoid downtimes or delays caused by standard laboratory analysis.

Based on Fraunhofer IMMs know-how in micro-optics and micro-fluidics sensors for on-line or on-site oil monitoring are developed for the different applications. The sensors are typically characterized by a compact design. By the use of LED's or miniaturized, thermal emitters and filters, the spectroscopic sensors do not require any integrated spectrometer.

Application fields for oil monitoring

- on-line detection of contaminants like water, soot, or oxidants
- on-line or on-site determination of the Total Base Number TBN or Total Acid Number TAN
- on-site measurement of oil color index
- on-line measurement of viscosity or viscosity index
- on-line detection of density

Online monitoring of lubricating oil condition

Lubricating oils are high grade products representing the life elixir of combustion motors and generators. Regular monitoring of lube oils is essential for long life motor operation, especially if the amount of applied lube oil is large, as in maritime vessel engines, leading to high replacement costs.

The online sensor system which was developed within the EU-funded project POSSEIDON allows a complete on-board-analysis of the

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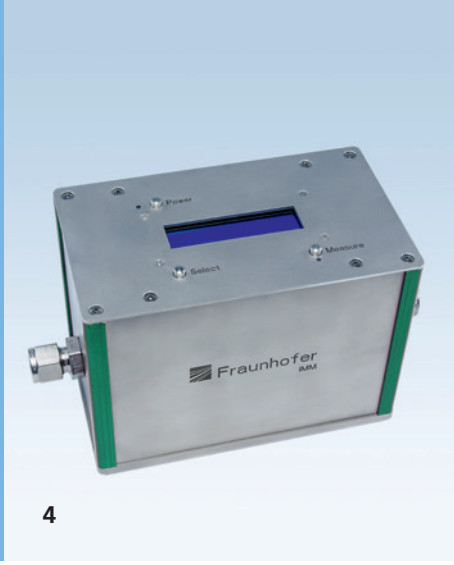

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oil's current condition while it is operating. Main parts of the online sensor system are NIR-sensors, which detect contaminations (e.g. water, soot) as well as the total base number (TBN) through transmission- or ATR-cells and micromechanical sensors for viscosity measurement via shearing force (Fig. 5). Partners were developing particle-detecting-sensors.

Automatic color index measurement

The ColorCheck device (Fig. 3) automatically measures the color index of mineral oils after DIN ISO 2049:1996. This is a characteristic number between 0 and 8 and is calculated from the ratios of red, green and blue intensity fractions of a transmission spectroscopy measurement in the visible region of the spectrum.

The device replaces manual determination of the color number based on visual comparison of the sample by a laboratory technician. The advantages of the automation are results independent from the laboratory technician skills and high throughput due to a measurement sample time of only 20 seconds.

Lab-on-a-Chip microtitrator for potentiometric TAN determination in raw, refined and used oil products

A multichannel Lab-on-a-Chip-System was developed, that allows for flow-through "continuous" titration. It is based on a simultaneous data acquisition working principle providing on-line results during operation. The resulting titration curve is continuously pending, thereby showing the true status of the sample (i.e., concentration) during operation. The typical response time for concentration change in the system is in the range of approx. 20 seconds. Notably, the reagent as well as the sample consumption is considerably low with approx. 3 ml/h. The chip-based continuous microfluidic titrator (Fig. 4) can be used in on-line process control in chemical industry as petrochemical application, e.g., quality control of raw and refined materials (according to ASIM D664/IP177).

Furthermore, the microfluidic chip technology offers the development of mobile autonomously working devices for classical discontinuously working titration that can be operated by non-trained personnel. The chip and the electrodes used are produced by rapid-prototyping processes and are disposable. This type of mobile microtitrator represents a useful tool for point-of-use application for quality control of used oils and lubricants

Quantitative detection of asphaltenes in crude oil

In chemical analysis precipitation is an often used sample preparation technique either to eliminate unwanted substance from the sample or to isolate the target. Fraunhofer IMM offers a microfluidic total analysis system including a sampling device where the latter is successfully done. Starting from a crude oil sample asphaltenes are precipitated by adding heptane and after washing they are resolved with toluene and optically analyzed. A wide variety of crudes with asphaltene content in the range from 0.1 to 15 % were fully automatically analyzed and a relative error in weight of <1.2 % was found.

3 *Color index measurement system ColorCheck*
4 *Multi-parameter oil sensor*
5 *Viscosity sensor with magneto-strictive vibrating pin*