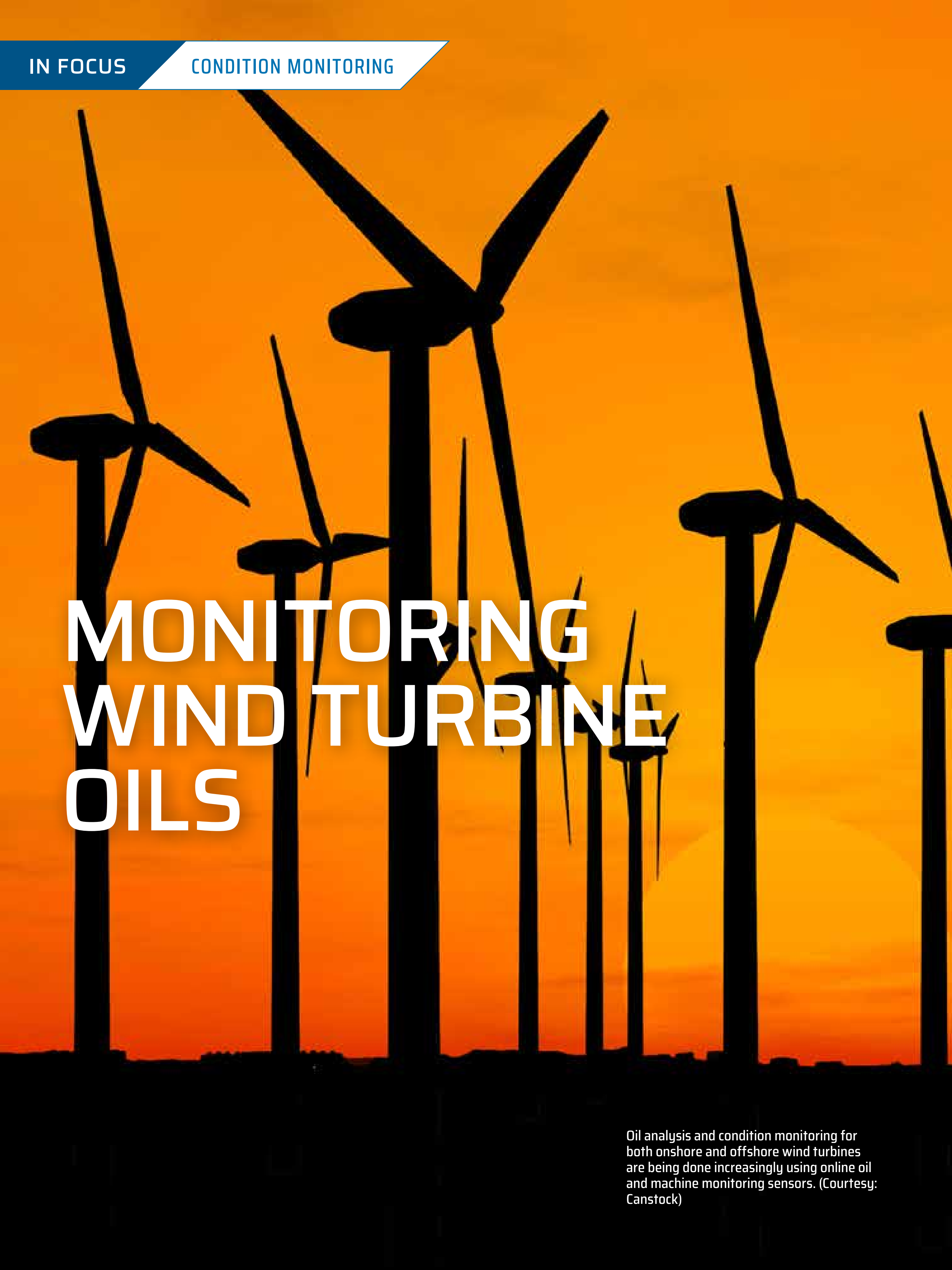

MONITORING WIND TURBINE OILS

Oil analysis and condition monitoring for both onshore and offshore wind turbines are being done increasingly using online oil and machine monitoring sensors. (Courtesy: Canstock)

Oil analysis and condition monitoring for wind turbines is being done using online sensors.

By R. DAVID WHITBY

Most wind turbines tend to be in remote locations, making physical access to the gears, bearings, and control systems difficult and not always practical. Condition monitoring programs for wind turbines generally include time-scheduled oil analysis. Unfortunately, servicing of wind turbines is often limited to specific times each year. When the first large wind turbines were installed more than 20 years ago, oil samples were only taken every six months or so. Trend analysis for important oil quality parameters was difficult and erratic.

Consequently, oil analysis and condition monitoring for both onshore and offshore wind turbines are being done increasingly using online oil and machine monitoring sensors, similar to those being used in automotive engines and marine systems. The oil sampling intervals are thereby reduced from every six months or so to either daily or continuously. This allows a more precise trending of important oil and machine parameters.

OIL PROPERTIES

The most important oil properties that need to be monitored for wind turbines are:

- Viscosity.
- Acid number.
- Oxidation.
- Water content.
- Additive contents, particularly phosphorous.
- Elemental contents, particularly wear metals.

All these can now be done using electronic sensors from a number of suppliers. Bosch has developed a multifunction oil-condition sensor, which determines oil level and oil condition. The oil level information enables the system to be monitored for leaks. The oil-condition sensor constantly measures the oil's viscosity, permittivity, conductivity, and temperature. The measured viscosity and permittivity (or dielectric constant) are the primary values supporting the oil-condition evaluation. A novel microacoustic device determines the viscosity. This device uses the piezoelectric effect to electrically excite high-frequency mechanic (or acoustic) vibrations at a sensitive surface.

When this sensitive surface comes into contact with the oil, the electrical device parameters, such as oscillation frequency and damping, are changed according to the oil's mechanical properties, especially viscosity. In contrast to conventional viscometers, the microacoustic sensor does not contain any moving parts.

Oil degradation and wear metals can be detected using a dielectric sensor, and several companies, including Mercedes-Benz and Delphi Corp., now use these devices for online oil monitoring. Wear metals and particulate contaminants also can be detected using online optical particle counters. When particulate contents start to trend upward,

Oil degradation and wear metals can be detected using a dielectric sensor. (Courtesy: Canstock)

An online sensor developed by the Technical University of Munich has been found to be able to provide test results for acid number, oxidation, water content, phosphorous, silicon, zinc, and copper that agree closely with those obtained by conventional FTIR. (Courtesy: Canstock)

more detailed oil sampling and analysis are required.

SPECTROSCOPY VS. SENSORS

In a conventional oil analysis laboratory, Fourier Transform Infrared (FTIR) spectroscopy can be used to monitor oxidation, water content, and additive elements. An online sensor developed by the Technical University of Munich has been found to be able to provide test results for acid number, oxidation, water content, phosphorous, silicon, zinc, and copper that agree closely with those obtained by conventional FTIR.

The sensor consists of a collimated infrared light source, a cuvette, a Linear Variable Filter (LVF) and a linear pyroelectric detector array with application-specific integrated circuit (ASIC). The LVF is a spectral device that uses a Fabry-Pérot structure to provide virtually constant resolution over the required wavelength region.

Compared to conventional FTIR spectrometers, the LVF spectrometer has a reduced resolution and a limited spectral range. It operates in a range of about 1,800 cm^{-1} to 900 cm^{-1} at a wavelength dependent resolution of about 36 cm^{-1} at 1,800 cm^{-1}. (Standard FTIR spectrometers normally operate in a wavelength range of 4,000 cm^{-1} to 500 cm^{-1} at a spectral resolution of 4 cm^{-1} or better.) Even so, the new sensor has been shown to provide acceptable correlation with laboratory test results, using data from several hundred oil samples. Extracting the oil quality parameters from the measured infrared spectra requires sophisticated data processing, using a multivariate regression model.

INTERNET ACCESSIBLE

Data from all these sensors, all of which can be fitted to the bypass filtration line of a wind-turbine gearbox, can be fed into Internet-based data analysis systems, allowing electrical system maintenance management to track the condition of an entire array of wind turbines in real time and receive email alerts when emerging problems are identified.

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