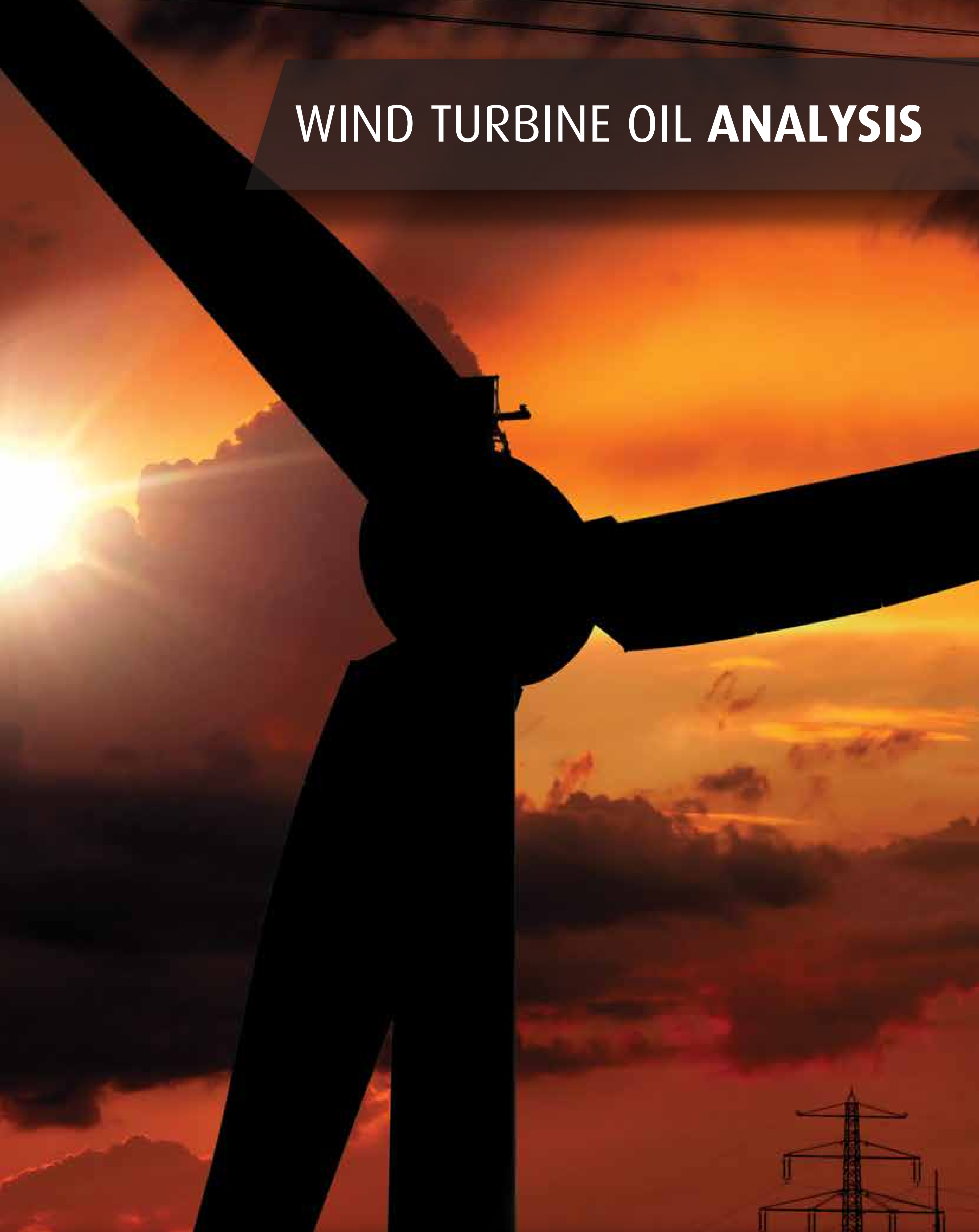
WIND TURBINE OIL **ANALYSIS**



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Wind Turbine Oil Analysis

Wind power is the world's largest growing energy source thanks to advancing wind turbine technology. Wind turbines have the potential to generate enough power to meet the growing need for electricity, and simultaneously reduce consumption of water and emission of pollutants such as carbon dioxide. However, barriers to widespread acceptance of wind turbines include their reliability, costs of operation and maintenance of the equipment relative to alternative means of power generation.

As the growth in wind energy continues, the average size and capacity of wind turbine generators is also increasing. With this increase in size comes an increase in the cost of operation, and specifically the cost of repairs, downtime, and unscheduled maintenance.

The estimated life span of wind turbines is about 20 years, compared to conventional steam turbine generator units that have averaged 40 years. The failure rate of wind turbines is about three times higher than that of conventional generators. Therefore, reliability is essential to the success of wind energy systems and this requires appropriate condition monitoring.

The wind turbine gearbox is the most critical component in terms of high failure rates and down time. These premature gearbox failures are a leading maintenance cost driver that can substantially lower the profit margin of a wind turbine operation as they typically result in component replacement.

Oil analysis, along with other condition monitoring tools, offers the potential to effectively manage gearbox maintenance by detecting early damage as well as tracking the severity of the damage. It is for this reason that most OEMs recommend routine oil analysis as part of an effective maintenance strategy.

Reasons to analyse wind turbine oils

- Wind turbine gearbox warranties generally only last for two years, therefore maintenance programmes are vital to ensure the turbine operates for the recommended 20 years.
- Predictive maintenance prevents expensive replacement costs and down-time.
- Oil change procedures remove only 70% of the used oil, new oil then mixes with the residual used oil containing contaminants and wear metals.
- Analysis is recommended by OEM manufacturers.

Wind Turbine Oil Test Profiles

Viscosity @100°C ASTM D7279 and @40°C ASTM D7279

Viscosity is the most important physical property of a lubricant, and is defined as a fluid's resistance to flow. This in turn determines the thickness of the oil film that prevents contact between metal surfaces. Trending of viscosity data is important, as deviations from the norm may indicate base oil degradation, additive depletion or the use of an incorrect lubricant.

Viscosity Index (VI) ASTM D2270

The viscosity index characterises the effect of temperature on an oil's viscosity and is of particular importance in applications where operating temperatures vary significantly.

Karl Fisher Moisture ASTM D6304

Water contamination is detrimental to any lubricant and can shorten the service life of a gearbox by accelerating wear. The Karl Fisher method for determining moisture content is recommended, as even small amounts (<500ppm) of water contamination can contribute to micro-pitting which is a recognised failure mode in wind turbine gearboxes. Water can be damaging to both the oil and the component.

Total Acid Number (TAN) ASTM D974

The total acid number is a quantitative measure of acidic compounds in the oil that are generated as a result of oxidation, and the formation of acidic degradation by-products.

PQ (Particle Quantifier) Index OEM supplied method

The ferrous debris monitor or PQ (Particle Quantifier) gives a measure of the total ferrous content of the oil sample and from this measurement the total amount of ferrous (iron) debris can be determined irrespective of the size of the particles.

Oil cleanliness ISO 4406

Wind turbine manufacturers have increasingly focused on oil cleanliness, which has a huge impact on the lifetime of bearings and the performance of the gearbox. Particle counting involves measuring the cleanliness of the oil and can also be used to evaluate the effectiveness of lubricant filters. The numbers of particles per milliliter of oil are counted in a variety of size ranges starting at four micron and going up to 100 microns. The total number of particles greater than four, six and 14 microns is assessed and given range numbers that indicate the cleanliness of the oil according to the ISO 4406 method.

ICP spectroscopy (wear, contaminants and additive concentrations) ASTM D5185

The spectrometer measures the concentration of wear metals such as iron, oil additives like phosphorus and contaminants such as silicon in the oil.

Fourier Transform Infrared (FTIR) oxidation ASTM D7414 and nitration ASTM D7624

The FTIR produces an IR spectrum that is often referred to as the 'fingerprint' of the oil, as it contains specific features of the chemical composition of the oil. The IR spectrum can be used to identify types of additives, trend oxidation and nitration by-products that could form as a result of high operating temperatures and thermal degradation caused by aeration/foaming.

Microscopic Particle Examination (MPE) in-house method

An MPE is performed by filtering the oil through a five-microns membrane patch and examining any debris present under a microscope. The membrane patch is examined for wear, contamination and colour, and a matrix describing the concentration and size of debris is recorded.

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