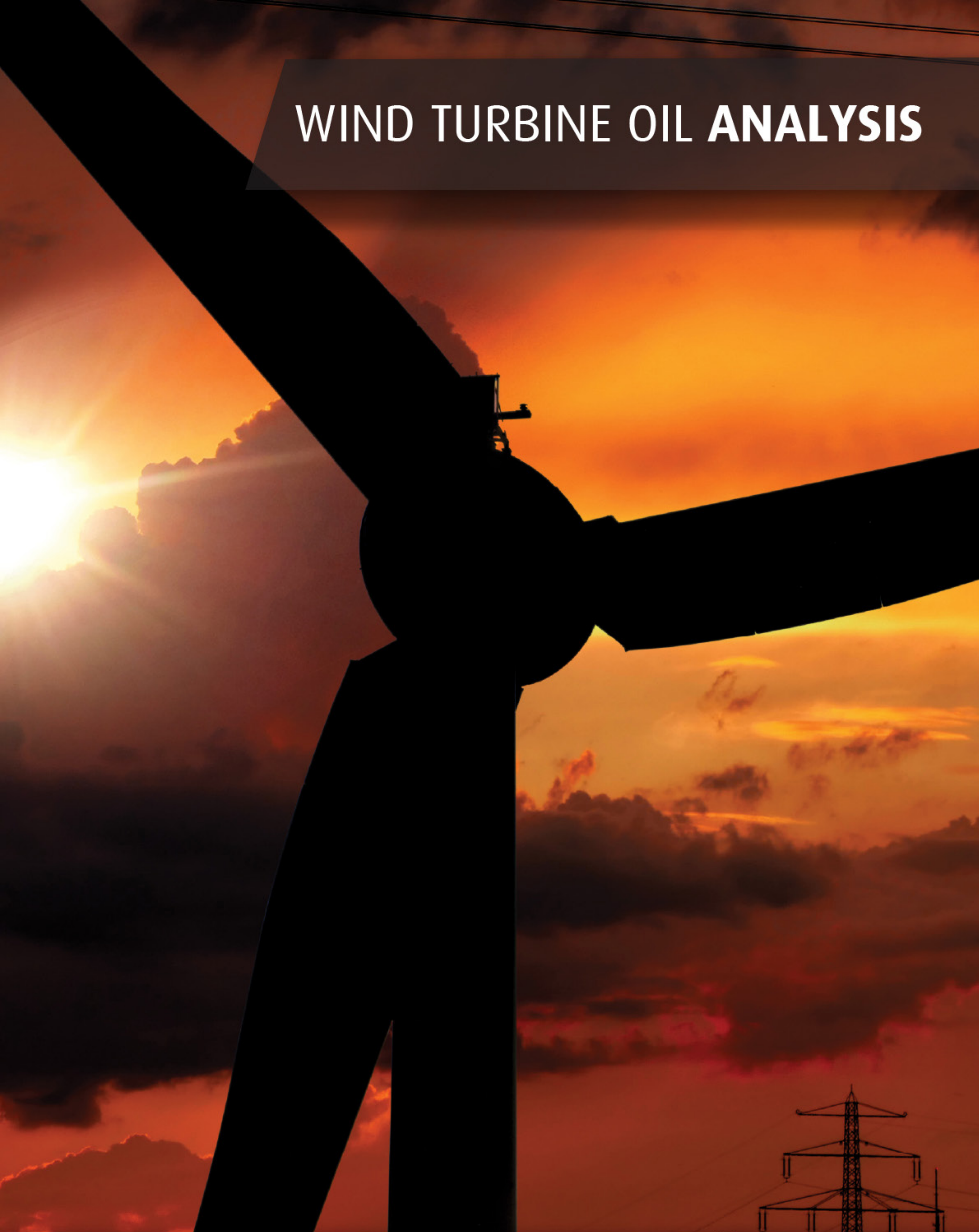
WIND TURBINE OIL **ANALYSIS**



WEARCHECK®
Condition Monitoring Specialists

Testing and Analysis | Lubricant-Enabled Reliability | Asset Reliability Care

www.wearcheck.co.za

GEARBOX AND HYDRAULIC 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 Oil

- Wind turbine gearbox warranties generally only last for 2 years, therefore maintenance programmes are vital to ensure the turbine operates for the recommended 20 years.
- Predictive maintenance prevents costly 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.

GEARBOX AND HYDRAULIC OIL ANALYSIS

Wind Turbine Test Profile

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 millilitre of oil are counted in a variety of size ranges starting at four micron and going up to 100 micron. The total number of particles greater than four, six and 14 micron are 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 micron 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.

Advanced Oil Analysis Kit

All tests performed as per standard/routine kit with the addition of:

Remaining Useful Life (RULER) ASTM D6971
The RULER test is a proactive technique used for measuring anti-oxidant depletion rates and calculating their remaining useful life. This test is ideally suited to monitoring gearbox oil degradation caused by exposure to elevated temperatures and oxidation. RULER is often utilised to establish optimal oil drain intervals.

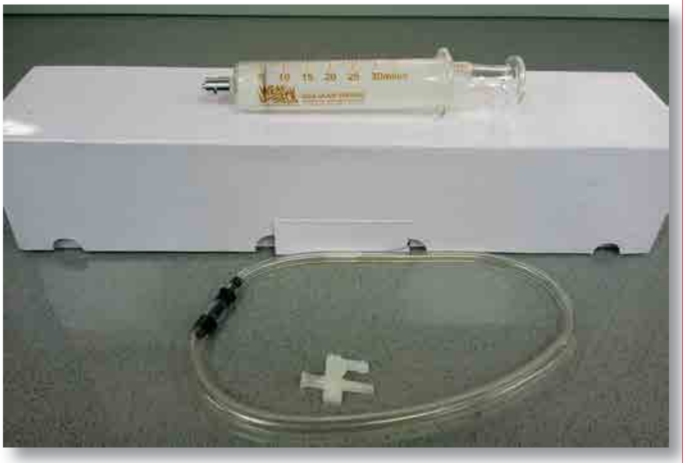
Foaming characteristics ASTM D892
This is a multi-stage test used to determine the oil's tendency to entrap air and cause oil foaming as well as the ability of the oil to dissipate the foam (foam stability).

Foaming is a serious cause for concern in wind turbine gearboxes as it can lead to oxidation, reduced oil film strength and cause excessive wear.

TRANSFORMER OIL ANALYSIS

We have witnessed an immense growth in the number of wind and solar farms in South Africa over recent years, but this has not been without its challenges. Through our testing programmes, specifically in the area of dissolved gas analysis (DGA, WearCheck has played a integral role in improving the performance of transformer design in the wind industry.

WearCheck's ISO 17025 accredited laboratories and the introduction of glass syringes for sampling have increased the accuracy and repeatability of transformer oil test results allowing for better decision making and maintenance of these critical transformers.



WearCheck's glass syringe for transformer samples

Suggested Testing Profile

TEST TYPE	DESCRIPTION	INTERVAL
Karl Fischer Moisture (ASTM method D6304)	*Determination of the moisture content of the oil*	*6 monthly*
Dielectric Strength (IEC method 60156)	*Determination of the break-down voltage of the oil and will indicate contamination by water and particles.*	*6 monthly*
Acidity (ASTM method D974)	*Determines the acidity and indicates the oxidation and break down of the oil*	*Yearly*
DGA - Dissolved Gas Analysis (ASTM method D3612)	*Determination of the various gases and their concentration dissolved in the oil and gives an indication of the internal workings and faults within the transformer*	*3 to 6 monthly. Depending on previous sample results. Fingerprinting and trend analysis via DGA is vital to ensure optimized testing intervals and reliability ratings.*
DP - Predicted DP (ASTM method D5837)	*Degree of polymerization gives an indication of the strength of the paper in the transformer i.e. amount of life used.*	*At first, every alternative year. Once the mid-life point is reached, the interval transformer i.e. amount of life used.*
Additives: when applicable *Inhibitor (inhibited oil)* *Passivator (passivated oil)*	*The percentage of additives left in the oil. The additives are depleted after some time as the chemical reactions take place in the transformer. These need to be topped up to ensure continued protection against adverse chemical reactions.*	*Every alternative year at first, when values get low the interval can be decreased.*

Due to the adverse and unique operating conditions of wind turbine transformers, the testing interval between samples is generally much shorter than for normal distribution transformers.

The variable loads create harmonics and overheating and due to tank constraints, the cores cannot be oil impregnated under vacuum, resulting in the formation of voids in the insulating paper and thus partial corona discharges. This results in the formation of large amounts of stray gassing which will be dissolved into the oil creating specific fault fingerprints that can be interpreted and diagnosed.

WearCheck's dedicated transformer oil analysis online platform has been specially designed to put access to analytical data and diagnostic interpretation, including recommendations, at the fingertips of role players in this market.

Head Office KwaZulu-Natal
No. 4 The Terrace,
Westway Office Park,
Westville, KZN, 3629
PO Box 15108,
Westmead, KZN, 3608
t +27 31 700 5460
e support@wearcheck.co.za
w www.wearcheck.co.za

WEAR CHECK
Condition Monitoring Specialists

South African Branches
Bloemfontein +27 51 101 0930
Eastern Cape +27 41 360 1535
Gauteng +27 11 392 6322
Middelburg/Witbank +27 13 246 2966
Northern Cape +27 66 474 8628
Rustenburg +27 83 938 1410
Western Cape +27 21 001 2100

ds105 - October 2022