TRANSFORMER OIL **ANALYSIS**

Transformer Oil Analysis

Condition assessment of power transformers

Power transformers are expensive and critical equipment in power systems and play a significant role in the transmission and distribution of electricity. As with all equipment, transformer failures do occur, and there are many degradation mechanisms operating in components and sub-systems that will ultimately limit the useful operating life.

Transformer asset managers generally aim to achieve the required levels of safety and reliability from their fleet of transformers at minimum cost. Knowledge of condition is therefore essential for efficient transformer asset management decisions. Without this information only the most basic activities are possible - such as time-based maintenance, replacement before end of life, or repair after failure.

WearCheck's transformer fluid analysis data is analysed by experts to provide recommendations on remedial actions based on relevant standards and expert knowledge.

There is a range of transformer tests available at WearCheck:

Transformer tests:

These tests are recommended for a basic fleet assessment of the transformer's active part-solid insulation degradation:

- Dissolved gas in oil test
- Oil quality results including moisture and acidity
- Estimated or measured moisture in cellulose
- Furans analysis
- Polychlorinated biphenyl (PCB)
- Dissipation Factor (DDF/Tan D) or Power Factor (PF) of the major (main) insulation
- Specified additives (restricted to inhibited and or passivated oils)
- Corrosive sulphur in oil test

Complementary tests:
- Particles (counting and sizing)
- Metals in oil
- Sediment and sludge
- Inhibitor and Passivators
- Environmental contaminants
- Specialist furanic tests (DP)
- Diagnosis of tap changers and diverters test data
- Gassing Tendency of the oil.

On-Load Tap Changer (OLTC) maintenance

WearCheck's transformer maintenance division has developed a special OLTC programme to optimise maintenance systems based on our transformer diagnostic tests. Spending the maintenance budget where it's needed, makes financial sense.

Condition-based maintenance is an effective cost-saving tool. Focus your maintenance efforts where evidence proves it is required.

The benefits of OLTC assessment
- A diagnostic programme that does not require equipment outages, thus enabling work management flexibility
- Identifies problem before failure to reduce system outages
- An irreplaceable aid in prioritising maintenance functions
- Reduces time-based maintenance and the associated expense. Why waste time and money maintaining well-working OLTCs?
- Reduces overall costs of maintenance by being selective. Less intrusive than internal visual inspection

Oil type

The oil type in a transformer will determine the oil and dissolved gas analysis (DGA) level specification. The oil type is extremely important for the correct diagnosis.

Furanic Testing of Transformer Oils

In South Africa, the single biggest cause of transformer failure is due to the deterioration of the insulating paper inside the transformer. Ten years ago, the average lifespan of a transformer in South Africa used to be 45 years, today it is only 12.5 years.

In the past it was necessary to take an actual paper sample from the transformer to determine the level of deterioration. The DP value (Degree of Polymerisation) is an index that measures the degree of degradation of the paper - the higher the value, the lower the level of deterioration.

This test was highly invasive and in the majority of cases the paper was sampled from the wrong region, giving results that looked better than they actually were. Furanic testing of transformer oils has been developed over the years and this test can now determine a DP value from the oil sample without having to sample the insulation medium itself.

Our laboratory tests for the following furanic compounds in the oil:

Furanic compound	Indicated problem
5-hydroxymethyl-2-furaldehyde (5H2F)	Oxidation
Furfuryl alcohol (2FOL)	High moisture content
2-furaldehyde (2FAL)	Overheating
2-furyl methyl ketone (2ACF)	Lightening strike (rare)
5-methyl-2-furaldehyde (5M2F)	Severe, local overheating

The natural breakdown of the paper insulation medium also produces the following gases:
• Hydrogen (H_2)
• Carbon monoxide (CO)
• Carbon dioxide (CO_2)

The ratio of carbon monoxide to carbon dioxide has been used as an indication of paper breakdown. The ratio should be between 3 and 11. However, this test has become unnecessary with the advent of furanic testing.

Paper insulation is the one component that will break down over time and will determine the lifespan of the transformer. With maintenance of the transformer and regular testing of the oil to detect water ingress and acid formation, this process can be slowed but never entirely stopped.

Furanic testing is very accurate compared to the actual testing of the paper, but the test can be influenced by the following:
• Furanic compounds will only be generated in the oil if the transformer is on-line

• Purification of the oil will remove furanic compounds from the oil and result in a much higher DP value than is actually the case. If purification has taken place recently then use the current DP value, DGA (Dissolved Gas Analysis) and other oil analysis parameters as a new baseline and resample in a further one to three months.

• If the oil has been changed, the new oil will not contain any furanic compounds so a new baseline will need to be established and their production rate determined.

• Time between sampling and testing - this should be a short as possible.

Furanic Testing of Transformer Oils

An accurate diagnosis of furanics cannot be carried out on one sample; this can only be done with regular oil testing to determine a trend and should include DGA, moisture content, acidity and dielectric strength as well as the furanic test. It is also recommended that corrosive sulphur and TAN (TAN Delta) be determined at least once a year.

Note that a low DP value does not necessarily mean that the transformer is going to fail immediately.

If the DP value is below 200 (see table below for DP values and their meanings) then:
• The transformer is in a critical state and additional stresses must be avoided.

• No further filtration work can be done on the oil as any disturbance of the insulating medium might cause failure.

• The transformer will still have a limited lifespan but this will depend on the other tests (such as DGA) in addition to

Category	Predictive DP Value	Interpretation
1	<200	Critical - failure may occur and transformer will need to be replaced
2	200-250	Urgent - regular testing recommended to determine DP production rates, DGA and oil testing also recommended
3	260 - 350	Caution/Urgent – resample on a three monthly basis to monitor DP production rates
4	360 - 450	Caution - resample on a three monthly basis
5	460 – 600	Caution - resample on a six to twelve monthly basis
6	>610	Normal - sample yearly

Contact Details

South African Offices & Laboratories

Head Office
Unit 4, The Terrace, Westway Office Park,
Westville, KwaZulu-Natal
t : +27 31 700 5460
e : support@wearcheck.co.za

Bloemfontein
Unit B, 4 Milner Road
Waverley, Bloemfontein
t : +27 51 101 0930
e : support@wearcheck.co.za

Eastern Cape
8 Van Wyk Road,
Westering
t : +27 41 360 1535
e : support@wearcheck.co.za

Gauteng
30 Electron Avenue,
Isando
t : +27 11 392 6322
e : support@wearcheck.co.za

Middelburg & Witbank
Unit 7a Nungu Industrial Park
13 Mandela Drive, Middelburg
t : +27 13 246 2966
e : support@wearcheck.co.za

Northern Cape
4 Peace Haven, Hendrik Van Eck Street,
Kathu
t : +27 66 474 8628
e : support@wearcheck.co.za

Rustenburg
221A Beyers Naude Street,
Rustenburg
t : +27 83 938 1410
e : support@wearcheck.co.za

Steelpoort
R555 Road, Block B6,
Steelpoort Mining Park
t : +27 71 269 1332
e : support@wearcheck.co.za

Western Cape
Unit 33, Prosperity Park, 10 Computer
Road, Montague Gardens, Cape Town
t : +27 21 001 2100
e : support@wearcheck.co.za

International Offices & Laboratories:

Botswana (Agent - Sound Principles)
Plot 54014, Gaborone West,
Garaone
t: +267 311 6829
e: support@wearcheck.co.za

Ghana
Adjacent PanAfrican (Zen Yard), Akyempin Road,
Tarkwa
t: +233 54 431 6512
e: supportgh@wearcheck.com.gh

India
#16 - B Kamokoti Nagar Main Road, Pallikaranai,
Chennai, 600 100, Tamilndau
t : +91 44 4557 5039
e : nissar@wearcheck.co.in

Mozambique
Bairro Chitata, VILA de Moatize,
Tete
t : +258 84 697 7006
e : supportmz@wearcheck.co.mz

Namibia
Unit 14, Lafrenz Industrial Park – Erf R/E 26 W,
Rendsburger Street, Windhoek
t: +264 81 229 6926
e: support@wearcheck.co.za

Pakistan (Agent - Feasible Solutions)
A-3/6 Phase II, Regency Apartments near Musken
Chowrangi, Gulshan-elqbal, Karachi
t: +971 6 740 1700
e: support@wearcheck.co.za

UAE – Dubai
Plot 271, Sector 18
Al Jaraf Area, Ajman
t : +971 674 01700
e : operations@wearcheckpm.com

Uganda (Agent - API Technical Services Limited)
Plot 8, Luthuli Drive
Bugolobi
t : +256 78 529 6994
e : support@wearcheck.co.za

Zambia
Plot 3717, Prescott Road
Light Industrial Area, Kitwe
t : +260 212 210 161
e : support@wearcheck.co.za

Zimbabwe
23 Amby Drive, Amby, Harare
t : +263 24 244 6369
e : evanm@wearcheck.co.zw