Transformer Chemistry Services[TCS]

THE LEADER IN CONDITION ASSESSMENT

Specialists in Testing, Diagnostic for the Electrical Power Industry

PREDICTIVE MAINTENANCE THROUGH TRANSFORMER OIL ANALYSIS

INCREASING YOUR PROFITS AND PRODUCTIVITY

TCS
Overview

TCS is an independent laboratory and consulting firm that specializes in diagnostic testing of insulating materials used in high-voltage electrical equipment.

Established in 1992 as the first commercial laboratory to offer gas-in-oil and Furanic analysis in South Africa.
Chemical Reactor

That just happens to Transform Electricity
In the event of failure, the force applied to the structure may approximate 360 PSI due to the steep wave front and high velocity, representing a loading sufficient to distort the container or shear the holding bolts and possibly cause a transformer oil fire.

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TRANSFORMER FAILURE MODE

Figure 1.76 - Transformer failure rate "Bathtub Curve": (A) is failures due to infant mortality; (B) is constant failure rate (random); and (C) is failures due to aging. (R. Sahu, "Using Transformer Failure Data to Set Spare Equipment Inventories"-1980).

Importance of Transformer Maintenance
Modern Transformers

The increased stress require more frequent and improved Condition Monitoring

The fault free operation of power transformers is of major economic/safety importance to power utilities and industrial consumers of electricity.
The application of Dissolved Gas Analysis (DGA)

The insulating oil is capable of dissolving gases in the event of developing faults in the transformer.

These gases are extracted from the oil→

Analysed by the sophisticated technique of Gas Chromatography.

Diagnosis methods are utilised to diagnose the type and severity of the fault occurring in the transformer.
Dissolved Gas (DGA)

Universal accepted method of choice to locate incipient thermal and electrical faults

DGA methodology and applicability have evolved significantly since its inception 30 years ago.

There are various interpretation Codes for diagnosis

*The interpretation should be left to a specialist and his advice and recommendations should be followed.*

*The incorrect diagnosis can lead to costly Transformer failure*
Sapref Petroleum Refinery

Voltage: 6.6 kV
Rating: 1250 KVA

Diagnosis: Partial Discharge (Corona)
Condition Code 4

Findings: The core of the transformer was found to be delaminating due to corrosion caused by high humidity (73 ppm water in oil)

Savings: R Hundred Thousand range possible R Million range if the Transformer failed with Fire

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Tongatt-Huletts Refinery
6.6 kV 1000 KVA

Conduction and Ionisation (Partial discharge)
Cellulosic Degradation impending insulation failure

OVERHEATED CELLULOSE

| CARBON MONOXIDE (KEY GAS) | 92.0% | Combustibles |
| Hydrogen                  | 6.7%  | Combustibles |
| Methane                   | 1.2%  | Combustibles |
| Ethane                    | 0.01% | Combustibles |
| Ethylene                  | 0.01% | Combustibles |
| Acetylene                 | 0.01% | Combustibles |

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UMGENI WATER

Voltage: 11/6.6 kV      Rating 5000 KVA

**Analysis/Diagnosis:**

**Condition Code 4**

The DGA indicated a Thermal Fault 300-700 Deg C

**Findings:** Various Copper to Aluminium (bi-metal) connection’s were found burned

**Savings:**

The transformer was repaired at the Manufacturer cost, i.e First year warranty

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NORDBERG SMELTER

FURNACE 10 TON

Voltage: 11 kV/5250v
Rating: 3000 KVA

The DGA analysis indicated a Discharge of High Energy (Arcing)

Condition Code 4

Note: The Electrical tests - Meghom Meter (Insulation Resistance) passed

Caution: In the event of a unit trip conduct a DGA before Re-energising
ESKOM: Chivelston Substation
Voltage: 400/275 kV Rating: 400MVA

**Diagnosis:** The Dissolved Gas Analysis indicated a Thermal Fault Of High Temperature $>700$ DegC
*Note: Calculated time to Buchholz activation: 2 years*

**Findings:** The core of this shell form transformer was found to delaminating

**Savings:** R Million Range
The Distribution losses had the transformer failed would have been catastrophic (50% of KZN affected)
HILLSIDE ALUMINIUM
Interconnector
Voltage: 132 kV   Rating:90.8/93.5MVA

Analysis/Diagnosis: The Interconnected system Tripped on Buchholz 6 months after energising. The manufacturer suspected a Corona Fault on the cable housing The DGA analysis indicated a Thermal Fault (300-700 degC) in the Bottom Chamber. CONDITION Code 4

Findings: Burnt connections in the Bottom Chamber due to non-conforming quality control during installation

Savings: By accurately diagnosing the fault type and location the manufacturer saved significant time and equipment to effect repairs. The smelter saved minimum down time on production

The savings achieved were in R Millions Range
**Analysis/Diagnosis**

The DGA analysis at 21/07/1997 indicated a Thermal Fault.
The maintenance contractor recommended Power-on oil purification. i.e highly dangerous and irresponsible as further damage is likely, with additional costs to the transformer owner.

The DGA analysis 30/04/1997 indicated a Discharge of High Energy (Arcing).

*The transformer was having Power-On oil purification at the time of the Buchholz Alarm.*
Voltage: 33/11/6.6 kV      Rating: 15 MVA

Analysis/Diagnosis
Discharge of High Energy due to failed Off-load Tap changer

Findings
All phases had burning
The inner contact ring of the center phase had failed.

Note: The center phase of the tap changer was directly below the pipe from the conservator tank. i.e. Flow of oil was over this point

Savings: In excess >R 300 000
The transformer was repaired on site and returned to service
Case Study 3 Faults: Mondi Merebank
Voltage: 33kV  Rating: 30 MVA

Unit Trip 11/01/1999
DGA: Thermal Fault High Temperature
Sent to works facility for repairs

DGA: 27/11/2000 Indicates Thermal Fault
CONDITION CODE 4
See DGA graph range
Dissolved Gas Graph

Burnt CT

Burning HT

Burnt Internal Connection

Purification To Degas
Analysis/ Diagnosis:

The oil was sampled to monitor the internal condition following energizing after repairs of a previous fault. The DGA analysis indicated a Thermal Fault in the main tank.

Findings:

The center and outside connections were burnt due to bad contact between the copper bar and the bushing stud. Closer inspection shows that stud/hole diameter of the copper bar was oversized so that only the points of the connection nut were making contact. This reduced the area of contact required for normal current flow conditions.
Burnt connection found within the windings. Note: Windings removed at Repair facility.
Hillside Aluminum

22 kV Reactor 1075 KVAR

ANALYSIS/DIAGNOSIS

THERMAL FAULT OF OF HIGH TEMPERATURE RANGE > 700 Deg C

IEC 599: GAS PRODUCTION RATES

CONDITION 4 - Ethylene (C2H4) - Significant

FINDINGS: Burning on the Resistor

CAUSES: Fourth Harmonic being amplified causing the transformer to be subjected to 10 times its rated current (milli seconds) i.e Design Fault System

SAVINGS IN THE MILLION RANGE

or in the Billion Range due the knock on effect

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