

EXPERIENCE IN CONDITION ASSESSMENT
AND FAULTS DETECTION OF ELECTRICAL
TRANSFORMERS & ROTATING MACHINERY



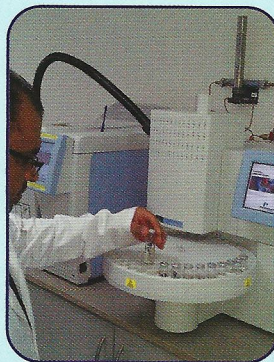
REZILABS is a member of the Rezayat Group and has many years of experience in preventive maintenance services on electrical transformers and rotating machinery. Located in the Kingdom of Bahrain, it specializes in providing efficient solutions to the electrical power system problems using advance condition assessment techniques. REZILABS scope of services cover:

- Transformer and Lubricating Oil Testing
- Evaluation and Recommendation
- Condition Assessment
- Visual Inspection
- Training Courses



Transformer oil testing provides relevant information to assess the transformer condition and to identify the type of the fault and problem source. Most of the testing is carried out accordance with standard IEC, ASTM, ISO, NAS, IEEE & DIN procedures. Our comprehensive testing services include the following oil analyses:

1. Dissolve Gas Analysis (DGA)
2. Corrosive Gas Analysis (H₂S, COS & CH₃SH)
3. Equilibrium Gas Pressure @ 0°C, 20°C & 40°C
4. Gas Bubbles Possibility
5. Gas Composition of Free Gas Phase
6. Acidity (TAN)
7. Moisture Content KF
8. Relative Humidity in the Oil
9. Peroxide Number (PXN)
10. Bromine Number (BN)
11. Olefin Bonds Number (OBN)
12. Interfacial Surface Tension (IFT)
13. Breakdown Dielectric Voltage (BDV)
14. Power Factor (tan δ) and Resistivity (p)
15. Antioxidant Additive Content (BHT)
16. Sediments and Soluble Sludge
17. Oxidation Stability
18. Turbidity Test
19. Corrosive Sulfur Mercaptan (RSH)
20. Cu/Cu₂S Deposition (CCD)
21. Dibenzyl Disulphide (DBDS)
22. Copper Corrosion by Copper Strip
23. Wear Metals ICP (~20 Elements)
24. pH-Value of the Oil (Acid Strength)
25. Passivator Additive Content
26. Degree of Polymerization (DP-value)
27. Estimated DP-value by Stebbin Method
28. Theoretical DP-value using Operating Parameters
29. Furfural Content (5 Furanic Compounds)
30. Absolute Humidity in Cellulose
31. Colour ASTM
32. Appearance
33. Density@ 20 °C
34. Flash Point
35. Fire Point
36. Pour Point
37. Refractive Index
38. Viscosity, kinematic @ 40 °C
39. Viscosity, kinematic @ -40 °C
40. Particle Count
41. Oil Quality Index (OQIN)
42. Finger Print (GC/ FTIR)
43. Poly Cyclo Aromatic (PCA)
44. Polychlorinated Biphenyl Analysis (PCB)
45. Remaining Lifetime of Transformer





Analysis of lubricating oil properties, contaminants and wear debris provides important information about the condition of the internal parts of rotating machinery. The benefits of lubricating oil analysis is that it predicts a rotating machinery's service life. REZILABS has the capability to carry out the following oil analyses:

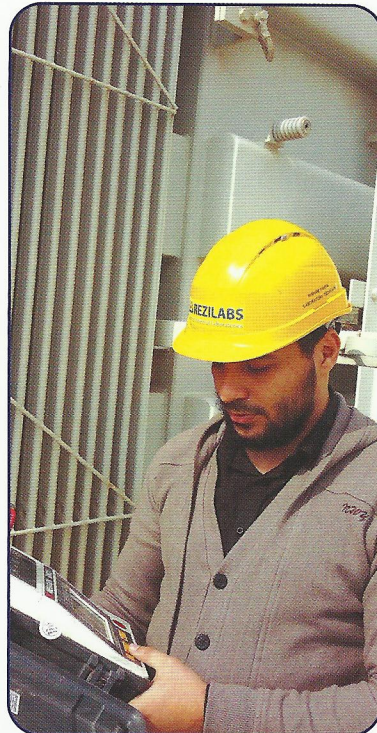
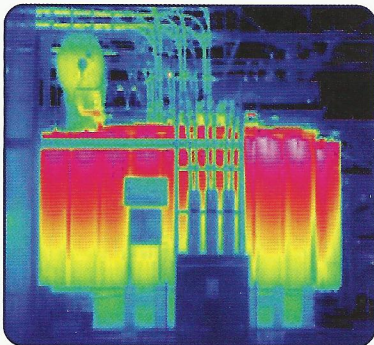
1. Total Base Number (TBN)
2. Insoluble Contamination
3. CI Content
4. Asphaltene Content
5. Saponification Number (SN)
6. Varnish Potential Testing - MPC
7. Emulsion Test (Water Separability)
8. Inhibitor Content
9. Carbon and Ash
10. Viscosity, kinematic @ 40 °C
11. Viscosity Index
12. Wear Metals ICP (~20 Elements)
13. Particle Count
14. Acidity (TAN)
15. Moisture Content KF
16. Flash Point



Visual Inspection



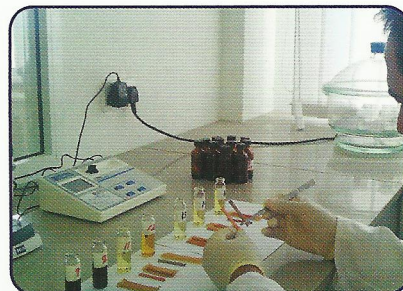
Visual inspections of the outer surface of the electrical power systems provide vital information for condition assessment and also complement to the oil analysis programs. Examples of visual inspection parameters are: corrosion deposits, oil leaks, noisy pumps, cooling system condition, hot spots detection using IR camera, temperature indicators and other physical components. REZILABS trained professionals will inspect your electrical power systems and provide you their insight.



Development & Research



Development of the transformer diagnostic methods by our scientific team is part of REZILABS's strategy to continue to be a unique and quality laboratory in the area. We usually deliver technical seminars of the latest scientific researches to our clients. The latest research article by our team is "Effects of acid strength (pH-value) of the transformer oil on the copper sulphide deposits rate" - REZILABS paper in the Conference of Middle East Electricity exhibition 2012.



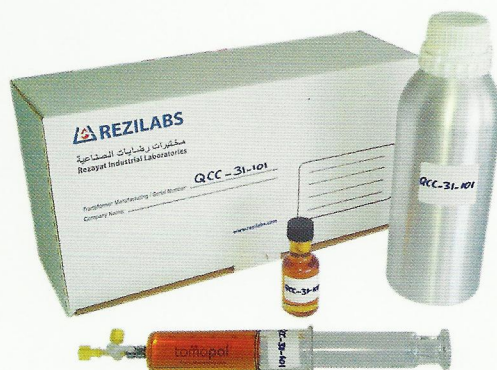
Oil Sampling



We provide oil sampling services according to the standard method IEC 60567 by our trained technicians and we can also offer training to your staff in the correct method of collecting oil samples.

Our Sample Kit Box Contains:

1. Aluminum bottle, 1 liter, for general oil analysis.
2. Small glass bottle for moisture test.
3. Glass syringe, 50ml, for Dissolve Gas Analysis (DGA).
4. "Data Form" and "Sampling Instructions Document".



Analysis Report

Results from oil analysis are used as a means to evaluate the oil quality by comparing them with a benchmark limit. Interpretation methods are then applied to indicate if any variation in the results is a consequence of thermal or electrical faults. We offer recommendation services based on our extensive knowledge gained throughout many years of experience in the electrical power sector. The database utilized are available online by our application program to download the report and save all the information and data of your equipment. Privacy is ensured so that the data owned by one party can only be read by that same party.



REZAYAT COMPANY FOR INDUSTRIAL SERVICES

Sample No: 10145
Report Date: 2011-11-01



RECOMMENDATION
New oil sample in case of any fault th Partial Discharge is



REZAYAT COMPANY FOR INDUSTRIAL SERVICES

Sample No: 10145
Report Date: 2011-11-01



ANALYSIS REPORT

CLIENT ADDRESS

Company Name : ~~XXXXXXXXXXXXXXXXXXXX~~
Contact Person : ~~XXXXXXXXXXXX~~
Mobile : ~~974 25082828~~

E-mail : ~~XXXXXXXXXXXXXXXXXXXX~~
Address : ~~XXXXXXXXXXXXXXXXXXXX~~
Tel./Fax : ~~974 25082828~~

TRANSFORMER DATA

Serial No : ~~XXXXXXXXXXXXXXX~~
Type : ~~XXXXXXXXXXXX~~
Manufacture Name : HTT
Manufacture Country :
Manufacture Year : 2000
Station Name :
Location : Polyethylene Substation
Operated Rate Power : 4.7 MVA

Lead:
Operating Period :
Phase No :
Tension, HV/LV : 11275/4X220KV
Oil Type :
Oil Weight : 3200 Kg
Cooling Type : ONAN
Tap Changer : Oil-Load, Connected
Sealing System : Conservator

SAMPLING DATA

Sample Man Name : Vishnu Nair
Sampling Date/Time : 2011-10-02
Arrival Date : 2011-10-12
Sampling From : Bottom
Oil Temp :
Winding Temp :
Ambient Temp : 40 deg C
Ambient Humidity : 20 %
Reason for Sampling : Routine PM

DISSOLVED GAS ANALYSIS(DGA)

Test Name	Value	Unit	Method	Normal Limit	Caution Limit
Hydrogen(H2)	47	ppm (STP)	IEC60567	<60	>150
Oxygen(O2)	8075	ppm (STP)	IEC60567	-	-
Nitrogen(N2)	66634	ppm (STP)	IEC60567	-	-
Carbon Dioxide(CO2)	2845	ppm (STP)	IEC60567	<5100	>13000
Carbon Monoxide(CO)	378	ppm (STP)	IEC60567	<540	>900
Acetylene (C2H2)	<0.5	ppm (STP)	IEC60567	<3	>50
Ethylene (C2H4)	8.1	ppm (STP)	IEC60567	<60	>280
Ethane(C2H6)	141	ppm (STP)	IEC60567	<40	>110
Methane(CH4)	51	ppm (STP)	IEC60567	-	-
Propane (C3H8)	12	ppm (STP)	IEC60567	-	-
TCG (Total Combustible Gases)	161	ppm (STP)	IEC60567	<753	>1580
CO2/CO	623.0	-	IEC60599	-	-
O2/N2	7.5	-	IEC60599	-	-
Equilibrium Gas Pressure @ 0C	0.12	hPa	In-house	< 1013	-
Equilibrium Gas Pressure @ 40C	937	hPa	In-house	< 1013	-
Equilibrium Gas Pressure @ 77C	774	hPa	In-house	< 1013	-

EVALUATION

Ethane value is over caution limit and methane is slightly over normal limit. Comparing with historical data shows a trend in these gases generation. The Equilibrium gas pressure value indicates no risk to form free gas bubbles.

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Training Courses



We offer training courses for engineers, chemists, technicians & management staff. The aim of the training is to enrich and advance participants' knowledge and skills. The courses will be conducted at a 5 star hotel in the GCC, Nederland or Sweden. In-house training course can also be arranged. Certificates will be issued by REZILABS Academic to all participants.



Our Courses Titles:

1. Power Transformer Diagnostic Methods, Maintenance and Lifetime Extension
2. Gas Turbine Maintenance, Operation & Trouble Shooting
3. Pumps & Compressors Maintenance, Operation & Trouble Shooting
4. Vibration Measurement & Analysis
5. Valves and Pipefittings Technology & Maintenance
6. Machine Bearings Technology - Plain Bearings & Rolling Element Types
7. Basic Theory & Application of Mechanical Seals Applied to Industrial Machinery
8. Lubrication Technology, Maintenance & Trouble Shooting
9. Transmission Gearbox Technology, Maintenance & Trouble Shooting
10. Rotating Equipment Alignment
11. Basic of Correlation between Laboratory Results and Refinery Operation
12. Analytical Chemistry Methods and Instrumental Techniques
13. Laboratory Safety Management and Health Protection Aspect of OSHA Certificate
14. Basic Spectroscopy Techniques (UV, IR, NMR & MS) and Molecule Identification
15. Advance Laboratory Supervision and Management Skill for Laboratory Personal
16. Basic Chromatography (GC & HPLC) Technique and Application
17. Liquid Chromatography Operation, Calibration, Maintenance and Trouble Shooting
18. Gas Chromatography Operation, Calibration, Maintenance and Trouble Shooting
19. Best Practice of Statistics Method and Measurement Uncertainty for laboratory Work
20. Quality, Accreditation And Good Lab Practice - ISO 17025 Requirements

N.B. The details of the courses overviews are available at www.rezilabs.com/company/courses/

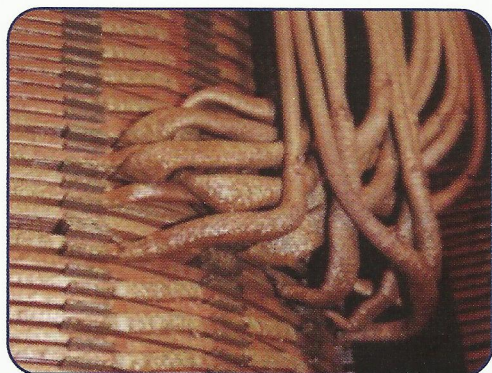
Why Oil Analysis Service?

Power Transformers in electricity networks are designed to operate for around twenty five years fully loaded. Most transformers can still be in service and in a good status beyond their design life once a condition monitoring program is carried out regularly.

Several gases can be formed inside the transformer during overheating. These gases such as hydrogen, methane, ethane, ethylene, acetylene and carbon oxides are either completely or partially dissolved in the oil. Production of high ethane amount at odd levels indicates the possibility of thermal fault. While production of extremely high acetylene and hydrogen amounts indicates arcing fault. Transformer fires can be due to various fault factors i.e. internal arcing or overheating external bushing connections.



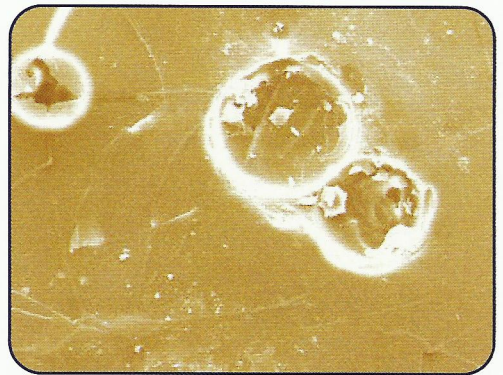
Organic compounds of insulating oil and paper are the most exposed parts to the thermal stress. Oxidation products such as acid, peroxide and water are undesirable aspects due to their ability to decrease electrical insulating assets. Failure of transformers due to oxidation processes is a major concern for transformer owners. In the figure, the sludge deposit on the winding is a consequence of oxidation.



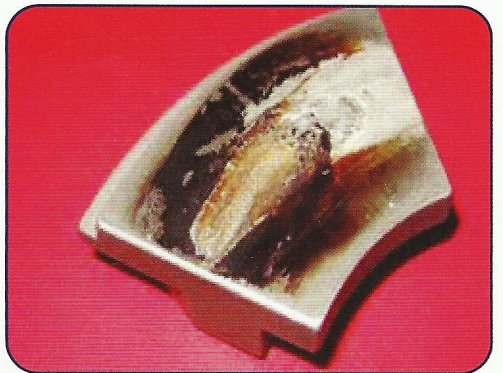
Copper Sulfide (Cu_2S) deposits inside oil-filled electrical transformers are currently the most probable sources of failure which can occur without prior evidence of an incipient fault. Many factors can accelerate the formation of the deposits depending on the type and quality of insulating oil. Dibenzyle disulfide (DBDS) is one of many different stable sulfur compounds that can be present in the transformer oil and that can be decomposed, even at low temperatures, into active corrosive sulfur Mercaptan which in turn can form copper sulfide deposits-, in the presence of copper ion.



Usually the paper is made of cellulose material which is a polymer glucose ring. Degradation level of the paper can be measured by DP-value test which provides an accurate data to calculate remaining lifetime of the transformer. DP-value can be measured directly by analysing a piece of the insulating paper or indirectly using the value of furfural compound in the oil. Furfural is one product of the paper degradation process, as well as carbon oxides and moisture. Paper with DP-value <150 can be considered as the end of life criterion for the transformer, see the figure.



Lubricating oil analysis can provide a useful tool to the condition assessment program of rotating machinery. Particles of rust in the oil tend to stabilize emulsions and foams and also act as catalysts that increase the rate of oil oxidation. In the case of escaping the foams from bearings adjacent to a generator may be drawn into the collector ring and cause damage to the system. In the figure, is a thrust pad bearing from a steam turbine, demonstrating the effects of overheating and suffering from deposit formation and partial melting of the white metal lining.





Mr. Rob van Dijk, KEMA Manager Asset Management (right), and Mr. Ramsey Jadim, REZILABS General Manager sign the cooperation contract.

- ▶ REZILABS and KEMA have signed a cooperation agreement to perform transformer condition assessment projects in the Middle East. KEMA located in Nederland, is a world-wide leading company in energy consulting, testing & certification.
- ▶ REZILABS is an ISO 9001 certified company. As such, we have been recognized by the Bureau Veritas Group as an organization committed to management quality efficiency and training documentation services.
- ▶ REZILABS is registered with the Institute for Interlaboratory Studies (IIS)-Nederland for Round robin test.
- ▶ REZILABS has applied for ISO 17025 Accreditation with the Dubai Accreditation Centre(DAC).
- ▶ REZILABS has applied for ISO 14001 Environmental Management System with the Bureau Veritas Group.



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