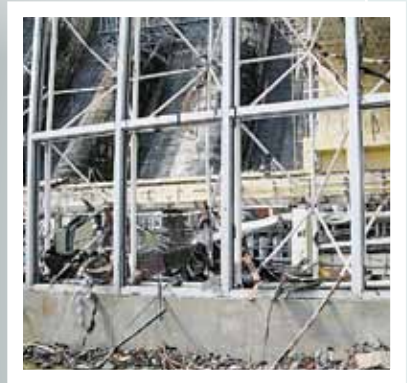
- INTERFACIAL TENSION
- ACID NUMBER
- DISSOLVED GAS ANALYSIS
- COLOR TEST
- MOISTURE TEST
- DIELECTRIC TEST
- VISUAL AND SEDIMENT EXAM

Coastal Switchgear & Controls Inc.

ELECTRICAL MAINTENANCE & TESTING

Oil Testing

Protecting Your Electrical Assets and Your People



An oil-filled transformer explosion at Russia's Sayano-Shushenskaya power plant in Siberia collapsed the turbine hall ceiling, killing 11 people. **Regular oil testing might have revealed high levels of combustible gases in the oil** — proof that atmospheric gases were degrading the oil's ability to insulate the internal windings from the external enclosure.

In 2009, three pedestrians, walking along the street in downtown Newark, were hospitalized with second- and third-degree burns after flames shot up through the ground from a subterranean oil transformer explosion. **Again, regular oil testing could have saved both financial and personal injuries by revealing high levels of combustible acetylene and methane gases** — telltale signs of internal arcing and overheating. While catastrophic explosions like these may be rare, faults and downtime from untested insulating oil are not. According to government statistics, the U.S. Bureau of Reclamation had 23 oil-filled power transformers fail within 25 years, five of which resulted in fiery explosions.

To help the electrical industry avoid costly downtime and equipment failures while extending the reliability of electrical transformers, tap changers, circuit breakers, rectifiers and other oil-filled electrical assets, **Coastal Switchgear & Controls Inc.** offers their **Oil Testing & Analysis Laboratory** services to the industry, providing timely turnaround and accurate testing of mineral, silicone, FR3 and Envirotemp insulating oils. Each report includes test values, trends over time and recommended repair and remedial actions. These quality services — available 24 hours a day on an emergency basis — include preventive maintenance and recommendations from Coastal Switchgear's two in-house analysts, who offer a combined 50 years of experience in transformer oil analysis, testing and chemistry.

Seven Tests for Insulating Oils

The majority of oil-filled electrical equipment failures can be avoided with a solid preventive maintenance program that includes **regular testing** of the insulating oils. Preventive maintenance programs that include regular oil testing, recommended filtering, and dehydration greatly reduce the threat of electrical catastrophes while extending the reliability of your valuable electrical assets. By identifying contamination levels of combustible gases, water, and particulates in insulating oils, experienced oil testing laboratories can identify chemical and material changes indicative of hidden conditions that can lead to equipment failure, and suggest corrective actions.

Coastal Switchgear & Controls Oil Testing Lab performs the seven most common tests for evaluating the insulating capability and dielectric integrity of insulating oils:

ACID NUMBER
REVEALS OIL DETERIORATION DETRIMENTAL TO INSULATION

INTERFACIAL TENSION
REVEALS OIL SLUDGING

COLOR COMPARISON TEST
REVEALS INHIBITOR BREAKDOWN, OXIDATION

MOISTURE TEST
REVEALS CELLULOSE DEGRADATION, OXIDATION

DISSOLVED GAS ANALYSIS
REVEALS CORONA, LEAKS, ATMOSPHERE INTRUSION, ARCING

DIELECTRIC TEST
REVEALS BREAKDOWN OF INSULATING PROPERTIES

VISUAL AND SEDIMENT EXAM
REVEALS PARTICULATES AND CARBON BUILD-UP

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ACID NUMBER TEST

The Acid Number test measures the relative quantity of acidic components in an oil sample by measuring the amount of potassium hydroxide (KOH) in milligrams required to neutralize a 1-gram sample of insulating oil. (Neutralization means to return the pH to a 'neutral' reading, or 7.) New and used petroleum products can contain acidic constituents in the form of additives, such as Rust and Oxidation inhibitors (R&O), as well as products from oxidation, such as rust, and contamination from compounds in the atmosphere mixing with the insulating oil. Based on ASTM standard D 664-95, the Acid Number is used as a guide for quality control of insulating oil and as a measure of how much the oil has degraded from electrical stress.

INTERFACIAL TENSION (IFT) TEST

Coastal Switchgear's Oil Testing Lab uses the Du Nouy method (ASTM D971) to determine the oil sample's Interfacial Tension value. Interfacial Tension refers to the tension, or strength, of the interface between two liquids — oil and water — that do not mix. Interfacial Tension, which is expressed in dynes per centimeter, is affected by the presence of soluble polar contaminants from solid insulating materials, such as windings, that make their way into the insulating oil. The more polar contaminants, the lower the IFT number, and the lower the insulating quality of the oil.

COLOR COMPARISON & SEDIMENT TESTS

The Color Comparison and Sediment Check tests complement the Acid Number and Interfacial Tension tests to evaluate the insulating capability — or deterioration — of petroleum-based oils. The technician visually compares the color of an oil sample to a calibrated color wheel while looking for cloudiness, particles of insulation and products of metal corrosion or other undesirable suspended materials. Suspended particles, moisture, and oxygen all lead to excess heat generation, which will accelerate the oxidation and deterioration of insulating oil. In short, the darker the color, the more cause for further investigation and possible remediation, such as oil filtering, dehydration and, possibly, replacement.

MOISTURE TEST

Water may be the single most damaging compound to electrical equipment. Coastal Switchgear uses a precision Mitsubishi Chemical Analytech CA-21 Moisture Meter to measure moisture content in oil samples in parts per million (ppm) based on the ASTM D-1533B standard. High moisture content is damaging to oil insulation and can come from a variety of atmospheric and internal sources, which is why Coastal Switchgear uses moisture readings in conjunction with multiple other tests to generate maintenance recommendations in its final test report.

DISSOLVED GAS ANALYSIS (DGA) TEST

The most sensitive and comprehensive technique used for evaluating the health of oil-filled electrical equipment is Dissolved Gas Analysis (DGA). Under abnormal electrical or thermal stress, insulating oils release small quantities of gases, including Hydrogen, Methane, Ethane, Ethylene, Acetylene, Carbon Monoxide, Carbon Dioxide, Nitrogen and Oxygen. Some of these gases, such as acetylene and hydrogen, are highly combustible, while most pose a threat to the health of electrical equipment at excessive levels. DGA measurements can help experienced analysts distinguish between overheating (pyrolysis) and arcing in a variety of oil-filled equipment. Information from the analysis of gases dissolved in insulating oils is a critical part of a successful preventive maintenance program.

DIELECTRIC STRENGTH TEST

Coastal Switchgear's DTS-100D Series High Voltage dielectric test instrument can perform Dielectric Strength tests using either ASTM D-877, or ASTM D-1816 for the most accurate readings. Dielectric Strength is a measure of insulating oil's ability to withstand stress as measured by the time it takes for an arc to jump across two electrodes submerged in the oil sample. The power frequency breakdown voltage of a liquid is reduced by the presence of contaminants such as cellulosic fibers, conducting particles (rust, wear metals, etc.), dirt and water. A low result in this test method indicates the presence of significant concentrations of one or more of these contaminants in the oil being tested. However, a high dielectric breakdown voltage doesn't necessarily indicate the absence of all contaminants; it may merely indicate that the concentrations present in the oil being tested are not large enough to affect the average breakdown voltage, which is why Coastal Switchgear uses a number of tests to comprehensively evaluate an oil's insulating capability.

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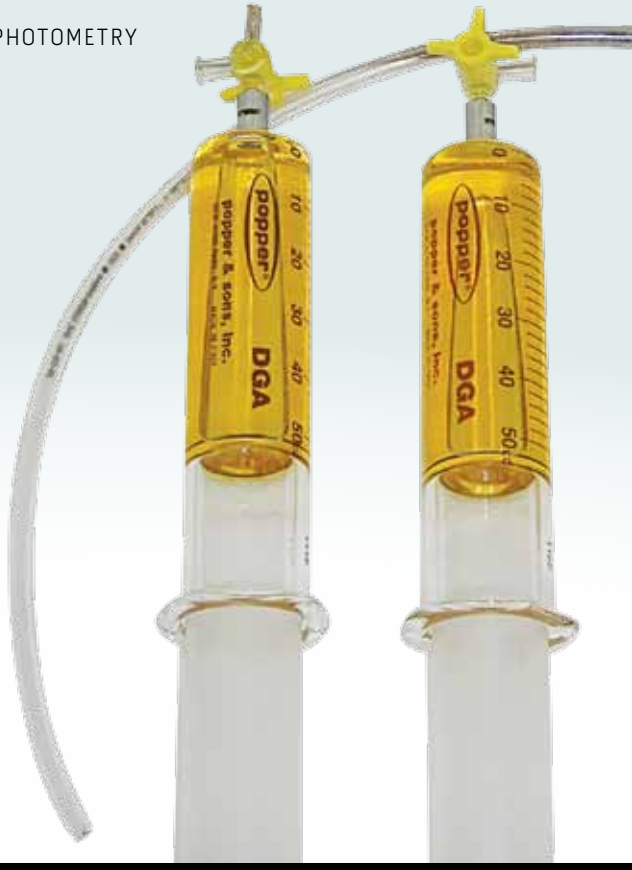
ELECTRICAL MAINTENANCE & TESTING

Maintenance Prescriptions You Can Trust

Using these seven oil tests, **Coastal Switchgear's** lab analysts can use their more than 50 years of combined experience to identify hidden faults, supercharge your preventive maintenance program and extend the reliability of expensive electrical equipment. In rare circumstances, additional testing may be required, which is why Coastal Switchgear's Oil Testing Lab can also provide additional testing:

- FURANIC COMPOUNDS — INDICATIVE OF CELLULOSE DEGRADATION
- DEGREE OF POLYMERIZATION OF INSULATING
- DISSOLVED METAL ANALYSIS, USING INDUCTIVELY COUPLED PLASMA SPECTROPHOTOMETRY
- POLYCHLORINATED BIPHENYLS (PCB) ANALYSIS
- POWER FACTOR TESTS AT BOTH 25C AND 100C
- SPECIFIC GRAVITY
- PASSIVATOR INHIBITOR TEST
- CORROSIVE SULFUR TEST
- PARTICLE COUNT TEST, USING ISO CODE 11171
- TEMPERATURE AND VISCOSITY TESTS, AND
- WEAR DEBRIS USING ANALYTICAL FERROGRAPHY



As a full electrical service shop, **Coastal Switchgear** also offers oil filtering, transformer repairs, dehydration, testing, oil sampling and vacuum fill services to help you correct insulating oil deficiencies and ensure safe, productive operation of critical electrical equipment.

If you have any questions about how oil testing can prevent unscheduled downtime, improve preventive maintenance and avoid costly failures, **contact Coastal Switchgear & Controls Inc.** at **1-800-219-9038,** or visit our website at **www.coastalswitchgear.com.**

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