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- Home
- About Us »
- Services »
- Line Card
- Employment
- Quote

Transformer Oil Testing

You are here: Home » Services » Transformer Oil Testing

Transformer Oil Testing

NPM Services offers a full line of transformer diagnostic tests to determine the integrity and serviceability of insulating fluids. Transformer Oil Testing is a cornerstone of an asset management program.

Our transformer oil analysis lab can is capable of conducting the following tests:

Dielectric Strength:

This test measures the voltage at which the oil electrically breaks down. The test gives a good indication of the amount of contaminants (water and oxidation particles) in the oil. We use ASTM Test Method No. D-877. The acceptable minimum breakdown voltage is 30kV for transformers 287.5kV and above, and 25kV for high voltage transformers rated 287.5kV. If the dielectric strength test falls below these numbers, the oil should be reclaimed.

Interfacial Tension (IFT):

This test (ASTM D-791-91), is used to determine the interfacial tension between the oil sample and distilled water. The oil sample is put into a beaker of distilled water at a temperature of 25C. The oil should float because its specific gravity is less than that of water, which is one. There should be a distinct line between the two liquids. The IFT number is the amount of force(dynes) required to pull a small wire ring upward a distance of 1 centimeter through the wall/oil interface. Good clean oil will make a very distinct line on top of the water and give an IFT number of 40 to 50 dynes per centimeter of travel of the wire ring. As the oil ages, it is contaminated by tiny particles (oxidation products) of the oil and paper insulation. These particles extend across the water/oil interface line and weaken the tension between the two liquids. The more particles, the weaker the interfacial tension and the lower the IFT number. The IFT and acid numbers together are an excellent indication of when the oil needs to be reclaimed. It is recommended the oil be reclaimed when the IFT number falls to 25 dynes per centimeter. At this level, the oil is very contaminated and must be reclaimed to prevent sludging, which begins around 22 dynes per centimeter. If oil is not reclaimed, sludge will settle on windings, insulation, etc., and cause loading and cooling problems discussed in an earlier section. This will greatly shorten transformer life.

Acid Number:

Acid number (acidity) is the amount of potassium hydroxide (KOH) in milligrams (mg) that it takes to neutralize the acid in 1 gram (gm) of transformer oil. The higher the acid number, the more acid that is in the oil. New transformer oil contains practically no acid. Oxidation of the insulation and oils forms sludge and precipitate out inside the transformer. The acids attack metals inside the tank and form soaps (more sludge). Acid also attacks cellulose and accelerates insulation degradation. Sludging has been found to begin when acid number reaches 0.40; it is obvious the oil should be reclaimed before it reached 0.40. It is recommended that the oil be reclaimed when in reached 0.20 mg KOH/gm, transformer oil testing is an easy way to analyze whether your oil needs to be reclaimed.

Oxidation Inhibitor:

Moisture is destructive to cellulose and even more so in the presence of oxygen. As an approximation if you double the moisture you halve the life of the transformer. As was discussed, acids, are formed that attack the insulation and metals which form more acids, causing a viscous cycle. Oxygen inhibitor is a key to extending the life of transformer. The inhibitor currently used in Ditertiary Butyl Paracresol (DBPC). This works sort of like a sacrificial anode in grounding circuits. The oxygen attacks the inhibitor instead of the cellulose insulation. As this occurs and the transformer ages, the inhibitor is used up and needs to be replaced. The ideal amount of DBPC is 0.3% by total weight of the oil (ASTM D-3487).

Power Factor:

Another core component of transformer oil analysis is power factor testing. Power factor indicates dielectric loss (leakage current) of the oil. A high power factor indicates deterioration and/or contamination by-products such as water, carbon, or other conducting particles: metal soaps caused by acids(formed as mentioned above); attacking transformer metals; and products of oxidation. Transformer oil analysis labs typically test the oil at 25C and 100C. The typical limit for power factor should be less than 0.5% at 25C. If the power factor is greater than 1.0% at 25C, the oil may cause failure of the transformer; replacement of reclaiming would be required. Above 2%, the oil should be removed from service and reclaimed or replaced because equipment failure is a high probability.

Furans:

Furans are a family of organic compounds which are formed by degradation of paper insulation (ASTM D-5837). Overheating, oxidation, and degradation by moisture content contribute to the destruction of insulation and form furanic compounds. Transformer with more than 250 parts per billion (ppb) should be investigated because paper insulation is being degraded.

Moisture Content:

Perhaps the most important test in a transformer oil analysis program is the moisture content. Moisture, especially in the presence of oxygen, is extremely hazardous to transformer insulation. Each test result should be examined carefully to see if water is increasing and to determine the percent saturation that is in the paper insulation. Never allow the percent saturation to exceed 30% without drying out the transformer. Each time moisture is double in the transformer life is cut in half. For service ages transformer rated less than 69kV, results up to 35ppm are considered acceptable at 60C. For transformers between 69-288kV, 25 ppm at 60C is acceptable. Transformers greater than 288kV should be less than 20 ppm at 60C.

Transformer Oil Processing-Vacuum Filling

Today’s state-of-the-art electrical equipment requires the need for a high degree of insulating fluid purification. Such requirements call for the removal of

moisture, gases, solid particulate matter and traces of chemical contamination from the insulating fluid.

Moisture content is recognized as one of the main causes of variation in the electrical properties of insulating materials, both from a chemical and physical point of view. Even in small amounts, moisture can accelerate the aging process.

Under these circumstances, it is important to start initially at the factory with a dry insulation system and pure, dry and degasified dielectric liquid during transformer impregnation and the qualification tests. Later, the same care must be taken during installation in the field and after every maintenance check, requiring exposure of the insulating system to the environment.

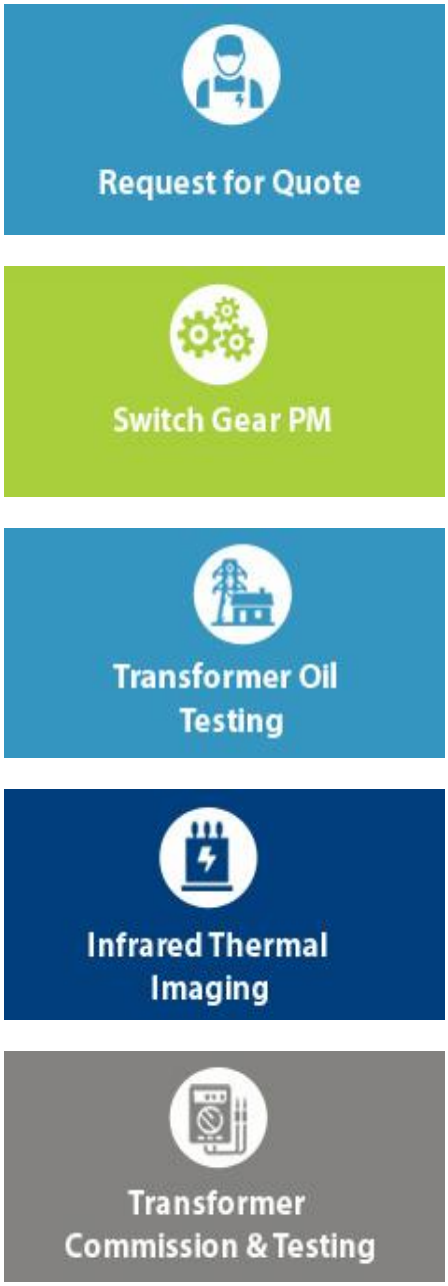
NPM Services, Inc. uses a Transformer Oil Processing unit, developed by Baron USA, our unit upgrades new insulating liquids and reclaims used dielectric oils through filtration, vacuum dehydration, degasification and clay treatment (when necessary).

Our Transformer Oil Processing unit system includes filters with a 0.5-1.0 micron nominal filtration rating for the removal of particulate. Our High Vacuum Process removes dissolved water, free and absorbed air and other gases.

If needed, Fuller's Earth Filters provide corrective treatment for removal of the products of oxidation, dissolved varnish and gums and other traces of chemical contaminants.

Our Transformer Oil Analysis System with High Vacuum Pumps provide fast and complete transformer dry-out and fill with clean, dry and hot oil under vacuum conditions. BA Interstage Oil Condensers provide a continuous system for removal of light-end oils for vacuum system protection during transformer dry-out processes.

Reclamation specifies that manufacturers dry new transformers to no more than 0.5% M/DW during commissioning. In a transformer having 10,000 pounds of paper insulation, this means that 10,000×0.005=50 pounds of water (about 6 gallons) is in the paper. This is not enough moisture to be detrimental to electrical integrity. When the transformer is new, this water is distributed equally through the transformer. It is extremely important to remove as much water as possible. When the transformer is energized, water begins to migrate to the coolest part of the transformer and the site of the greatest electrical stress. This location in normally in the lowest one-third of the winding. Paper insulation has a much greater affinity for water than does oil. The water will distribute itself unequally, with much more water in the paper than in the oil. The paper will partially dry the oil by absorbing water out of the oil. Our oil transformer oil processing unit will heat the oil and the paper and is well suited for removing moisture from both paper insulation and from the oil itself.



Annual Preventative Maintenance

- Infrared Thermal Survey.
- Switchgear cleaning and lubrication.
- Breaker contact resistance testing.
- Operation and inspection of Pringle and Bolted pressure switches.
- Visual inspection of cables.
- Transformer visual inspection and oil sampling.

Electrical Testing (Every 2-3 Years)

- Electrical testing of circuit breakers.
- Electrical testing of transformers.
- Operational testing of ground faults.
- Insulation testing of cables.
- Contact resistance of fuses.