Sampling of Oil-filled Power Apparatus Instructions

WHY SAMPLE?

For in-service liquid filled electric apparatus, sampling of the liquid dielectric provides a method to determine the condition of the solid and liquid insulation as well as the operating condition of the apparatus without opening or de-energizing the apparatus. Sampling provides a means to check the condition of oil in storage whether it be new or used, to determine if it complies with specifications such as TOPS, ASTM D 3487, IEC 60296, IEEE C57.106, or company specifications. Sampling can also help to determine: 1) if accidental mixing of different dielectric liquids has taken place; 2) if the method of transportation contaminated the dielectric liquid; and 3) if the handling equipment to transfer the dielectric liquid contaminated the product.

WHAT IS A GOOD SAMPLE

Simply put, a good sample is one that is representative of the content of the bulk liquid insulation. Since samples are usually retrieved from a drain valve or the attached sampling cock, preparation of that area is important to obtain a good sample. Cleaning the drain valve inside and out and the sampling cock is the first step in avoiding sample contamination. Cleaning the outside of the drain valve is just as important as cleaning the inside. The dirt and debris falling off the outside of the valve into the sample container during the sampling process can contaminate many samples. A lot of the contamination in the apparatus consists mostly of water and particles (paper fibers, metal particles, etc.) and over time will settle out on the bottom of the apparatus near the drain valve. This material needs to be flushed out of the system to get to the bulk liquid insulation. It is necessary to remove at least 1 to 2 liters of liquid from the drain valve, cap the drain valve, and then flush out the sampling cock before proceeding with sampling. On occasion, 2 liters is not sufficient, especially when sampling a non-energized transformer or certain OCBs and LTCs. Specific sampling techniques and precautions, especially those dealing with low volume electric equipment, are detailed in the Doble Reference Book on Insulating Liquids and Gases, ASTM Practices D 923 and D 3613.

LAB TESTS MOST EASILY AFFECTED

Analytical tests most easily affected by sampling are dielectric strength and water content. This is due to the fact that the apparatus drain valves are usually at very low points in the tanks, were debris and water accumulation occurs. Water can also be present as a result of condensation that occurs in the drain valve, which is also due to the position of the drain valve on the tank. Other analytical tests easily affected by sampling are dissolved metals, particulate metals, particle counts, dissolved gases-in-oil, and power factor.

The concentration of metals, whether dissolved or in a particulate state, are especially impacted by the amount of cleaning performed on the drain valve and the amount of flushing that is performed. Debris that settles to the bottom of the apparatus and subsequently into the drain valve can consist of metal particles. In addition, just the simple fact of removing the drain-valve plug or opening the sampling cock will create particulate metals. The same is true of retrieving a sample for particle count were valve debris, whether inside or outside, can severely skew the results. Of serious consequence are the debris, soot and grime that exist on the outside of the drain valve especially in industrial locations. This debris can be easily transferred to the sample bottle while the sampling process is taking place. Thus, this validates the importance of cleaning the outside of the valve prior taking the actual sample.

Dissolved gas-in-oil analysis is another test impacted by sampling, drain valve components and sampling materials. When galvanic fittings (zinc coated) are used in the drain valve assembly such as the drain plug, galvanic reaction with water can cause very high levels of hydrogen to be produced. If this residue is not flushed out adequately then it will be transferred to the sample and included in the analysis, causing a level of concern that is not warranted. In addition, galvanic plumbing fitting such as nipples can have the same effect. Brass, bronze, stainless

steel or black iron should be the only material used. In addition, drain valve assemblies should not be composed of dissimilar metals as corrosion can result which may end up in the sample.

Debris, water and other ionic contaminants also affect the power factor test when these materials increase dielectric loss thus in turn increasing the power factor. Incompatible inorganic and organic materials from the drain-valve stem packing or drain-plug sealants can also have the same effect on the power factor.

PRACTICES FOR SAMPLING INSULATING LIQUIDS

There are a number of practices that clearly define the proper way to retrieve samples from electrical apparatus or storage containers. These practices have been developed over many years and have incorporated the expertise of many individuals

- Doble Reference Book on Insulating Liquids and Gases
- ASTM D 923: Standard Practice for Sampling Electrical Insulating Liquids
- ASTM D 3613: Standard Practice for Sampling Electrical Insulating Oils for Gas Analysis and Determination of Water Content
- IEC 60475: Method of Sampling Liquid Dielectrics
- IEC 60567: Guide for the Sampling of Gases and of Oil from Oil-filled Electrical Equipment and for the Analysis of Free and Dissolved Gases

STEP BY STEP PRACTICES FOR SAMPLING

Getting Started

1) Make sure to have all the appropriate tools, gear, bottles and syringes to do the job
2) Obtain the necessary permits or permission if necessary
3) On smaller units, it may be required to de-energize the equipment, perform this task according to OSHA guidelines
4) Some companies require a tailgate meeting prior to work, follow this protocol if required.
5) Before entering the substation, survey the area to make sure everything seems to be in order and that there are not massive leaks or other problems such as vandalism. Call your supervisor if problems exist.
6) Make sure you have the proper clearances before entering the substation especially for vehicles
7) Upon entering the substation, many companies require personnel to call in, follow your company guideline
8) Determine which electrical equipment requires sampling.
9) Position your equipment and personnel at the first piece of equipment to be sampled.
10) Survey the area around the transformer and the transformer itself, checking for:
    a) tripping or stumbling hazards on the ground
    b) unsecured electrical dangers
    c) inspect the transformer for:
    d) leaks (flanges, gaskets, pumps, valves, etc.)
    e) rust
    f) peeling paint
    g) fans, pumps, and gauges that may not be working
    h) if the unit is a free breather conservator, the condition of the silica get or the drycol breather
11) Provide this information to the proper personnel
12) Make sure all electrical dangers are secured

Taking the Sample

1) Make sure the ambient conditions are such that a good sample can be taken. Taking a sample in a driving rainstorm, snowstorm or when it is 100% humidity is not appropriate.
2) Absolutely make sure there is positive pressure on the transformer prior to starting. If there is no gauge, or the gauge does not seem to be working, follow the procedures in ASTM D 923 for determining positive or negative pressure. If negative pressure exists, DO NOT SAMPLE. Adding nitrogen to the transformer may be necessary

3) For mineral oil, silicone, high temperature hydrocarbons, vegetable oils, esters, and non-chlorinated synthetic hydrocarbons sample from the bottom drain valve
4) Prepare the area under and around the drain valve for possible spills with plastic and absorbent materials. Sampling is a messy job, be prepared for it.
5) Determine the PCB concentration of the transformer (look for the sticker) if possible and sample accordingly following company guidelines for sampling and disposal of waste materials.
6) Prior to actually taking the sample, record all the appropriate information (including the top oil temperature) for the sample and make sure the sample containers are accurately marked.
7) Clean off the outside of the valve with a rag to remove as much dirt and grime as possible.
8) Once positive pressure has been established, make sure the valve hand wheel is closed and remove the drain valve plug. In most cases there will be residual oil behind it, be prepared to catch it in a pan.
9) With a rag , thoroughly clean the inside of the valve with a lint free cloth paying special attention to the bottom of the inside of the valve where all the dirt, grime and water collect. A toothbrush works great on the threads of the valve.
10) Reinstall the drain plug, open the valve hand wheel and open the sampling port on the side of the valve if there is one. Remove about 1/3 quart of oil and then close it back up. DO NOT USE IT TO TAKE THE ACTUAL SAMPLE. This procedure is only to clean the small tube out at the bottom of the valve.
11) Close the hand wheel on the valve and remove the drain plug again and be prepared to catch residual oil. Clean the inside of the valve and valve threads again.
12) Install a brass, bronze or stainless steel bushing adapter to hose barb (1/4 inch tube) to the drain valve.
13) Attach a ¼ inch vinyl tube to the hose barb and slowly open the valve to let oil run out. Throttle the valve back and forth a couple of times to knock out any trapped water and grime.
14) Remove at least 2 quarts (sometimes as much as 5 quarts is required) of oil to flush the valve clean. This oil is waste and should be collected in a waste bucket.
15) After flushing, remove the vinyl tubing (this tubing can be reused but just for flushing) and install new tubing.
16) Open the valve and let the oil run into the sample bottle. Tilt the sample bottle and let the oil run down the sides until it is 1/3 full. Close the valve. With the oil in the bottle, gently swirl it and then dump it into the flush oil. Repeat this procedure 2 more times.
17) After the last rinse of the bottle, fill the bottle at a moderate rate as done with when rinsing. Fill as follows;
    a) Glass: fill to within 1 inch (2.5cm) of the top and then cap.
    b) Plastic or metal: fill to overflowing and then cap
18) After the bottle(s) are filled, attach the syringe and flush the syringe 3 times before taking the sample (Follow already prepared guidelines for taking a sample with a syringe)
19) Close the drain valve.
20) In certain cases, where an apparatus is of low volume, additional make-up oil will have to be added. This should occur at this time with the unit de-energized. Follow company procedure for performing this task.

Cleaning-up

1) Make sure to shield the samples from the light as photo-degradation can occur fairly quickly.
2) Check the bottle caps again for tightness. If the syringe develops bubbles after sitting for some time, do not release the bubbles as they are part of the sample.
3) Make sure all the sample labels are tightly secured with the appropriate bottle and syringe.
4) Take the samples to the vehicle and the flush oil bucket to either the vehicle or to the next transformer if additional transformers are to be sampled.
5) Remove the reducing adapter and hose barb from the drain valve. Be prepared to catch any residual oil.
6) Clean out all the oil residue from inside the valve.
7) Install the drain plug using a pipe sealant. Teflon pipe tape is recommended as it does not clump up and it is easier to remove the next time. Do not use or install galvanic fittings on a transformer.
8) Make sure the side sampling port is also adequately secure. Check the valve hand wheel to make sure it is secure in the closed position one more time.
9) Wipe up any oil residue from the valve, apparatus, pad and ground. Dispose of this and the other waste generated according to company procedure.
10) Remove all tools and equipment from the area.

11) Inspect the area around the apparatus one more time to make sure nothing was left behind. Make sure the area is cleaner that when you started.
12) Secure the substation upon leaving and notify the appropriate personnel if required to do so.
13) Take or ship the samples to the lab for analysis.

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