FORTUNA® DGA
Glass Syringe Set

Set for Dissolved Gas Analysis, etc.

- acc. to IEC 60475 - method of sampling insulation liquids
- acc. to IEC 60567 - sampling of gases & analysis of free & dissolved gases
- acc. to ASTM 3613 - sampling insulating liquids for gas analysis & determination of water content.
About sampling of transformer oil

For in-service oil filled electric transformers, sampling of the oil provides a method of determining the condition of the solid and oil insulation as well as the operating condition of the transformer without opening or de-energizing the transformer. Sampling provides a means to check the condition of oil in storage, whether it is new or used and to confirm that it complies with company specifications.

An oil sample has to be representative and maintain the properties and contents of the bulk oil insulation present in the transformer. Periodical testing of the oil in the transformer is needed to ensure repeated performance and long life of the apparatus. Correct sampling of the oil to be tested is the FIRST factor which will ensure accurate results for the oil.

While sampling the representative oil one must check for foreign matters including water droplets, sediments, suspected clear fibers, headspace air etc. Critical initial on-site visual inspection for the presence of any foreign matter in the oils should be carried out at the time of sampling itself. Identifying a poor sample and the decision to resample should be carried out prior to the leaving the on-site. Outages due to faulty transformer oil analysis could have an adverse and cumulative effect on the electricity supply.

Tests includes:
1. Dissolved Gas Analysis
2. Water Analysis
3. Dielectric dissipation factor
4. Particles
5. Breakdown voltage
6. Other chemical and physical tests

Sampling of transformer oil by syringe as per IEC 60475 section 4.2.2

1. Sampling equipment required as per IEC 60475 Section 4.2.2.1

Graduated DGA syringes are of a size suitable for an adequate oil sample volume and equipped with a three-way plastic valve made of Nylon. The use of syringes with matching piston and barrel is preferred when carrying out DGA sampling in order to allow the piston to flow freely with oil volume variations, and to avoid pressure and vacuum build-up in the syringe and breakage during handling. Plastic syringes should not be used. When using plastic three-way valves, a new valve should be used each time an oil sample is taken and not re-used, as it may be contaminated with the previous oil sample and lose its gas seal when used several times.

NOTE: Priming the piston with clean, degassed oil has been found useful to avoid the formation of bubbles along the piston when introducing the oil sample for DGA analysis. The use of a low viscosity water-soluble lubricant has also been found to be useful for DGA. The size of sample required depends on the likely concentration of gas in the sample, the analytical techniques and the sensitivity required.

Transport containers (padded carrying cases), are designed to hold the syringe firmly in place during transport while allowing the syringe plunger freedom to move and prevent its tip from contacting the container whatever its position during transportation. Cardboard boxes with removable inner cardboard flaps with inside foam packing that hold the barrel in place have been found to be convenient for that purpose and also suitable for transportation. When sampling for DGA, the syringe should preferably be transported in the vertical position, piston upwards, to avoid the formation of bubbles in the oil.

2. Sampling procedure as per IEC 60475 Section 4.2.2.2

a) The electrical equipment is connected as shown in Figure a and its sampling valve (5) opened.

b) The three-way valve (4) is adjusted (position A) to allow 1 l to 2 l of oil to flow to waste (7).

c) The three-way valve (4) is then turned (position B) to allow oil to enter the syringe slowly (Figure b). The plunger should not be withdrawn but allowed to move back under the pressure of the oil.

d) The three-way valve (4) is then turned (position C) to allow the oil in the syringe to flow to waste (7) and the plunger pushed to empty the syringes to ensure that all air is expelled from the syringe, it should be approximately vertical, nozzle upwards, as shown in Figure c, confirm that the inner surfaces of the syringe and plunger are completely oiled.

Key
1. Syringe
2. Stopcock
3. Flexible connecting tubing
4. Three-way valve
5. Equipment sampling valve
7. Waste vessel
11. Blank flange
e) The procedure described in steps c) and d) is then repeated until no gas bubble is present. The three-way valve (4) is then turned to position B and the syringe filled with oil (Figure d).

f) The three-way valve (2) on the syringe and the sampling valve (5) are then closed.

g) The three-way valve (4) is turned to position C and the syringe disconnected (Figure e).

h) When sampling for DGA, if the oil taken from the electrical equipment is hot, place the syringe in its protective box in the vertical position, standing on the piston and with the syringe tip upwards, until the oil has slowly cooled down, then install the syringe back into the holding flaps of the protective box for transportation. This will prevent the formation of bubbles in oil.

Label the sample carefully.

**NOTE 1:** It is good practice to avoid contamination of the outer surface of the plunger and inner surfaces of the syringe by dust or sand. Such particles can affect the sealing properties of the syringe. This kind of contamination can come from wind-swept dust or from the handling of the syringe.

**NOTE 2:** In the case of sealed transformers, if a bubble appears in the syringe directly after sampling, it is recommended to resample.

**Storage & transportation of transformer oil sample as per IEC 60475 Section 4.3**

Some of the dissolved oxygen present in the oil sample may be consumed and hydrocarbons and carbon oxides formed by oxidation. This reaction is accelerated by exposure to light, therefore sampling devices made of transparent materials i.e. glass syringes should be protected by placing them in the box for transportation i.e. padded carrying case.

In any case, the analysis should be carried out as soon as possible after sampling to avoid oxidation reactions and gas losses or pick-ups from the sampling devices. Oil syringes should be placed in sealed boxes to fully eliminate the risk of formation of bubbles for important DGA oil samples during transportation in planes, due to reduced pressure and over-saturation of gases in the oil. The syringe plunger should be allowed to move in order to prevent air ingress in case of oil volume variations.

**Advantages of taking transformer oil samples with the FORTUNA® DGA kit**

- Easy flushing prior to sampling and clear visual inspection
- Free from suspended particles and impurities: when oil samples are collected in the syringe, contaminants such as suspended solids or free water, if any can be seen in the syringe, have to be avoided. These oils can be expelled immediately and fresh oil samples can be taken so as to take suitable samples back to the lab for accurate test results. This cannot be seen in side other containers such as vacuum bottles.
- Easy adjustment to avoid direct contact with air: if the sample comes in contact with humid air, the readings of the oil samples will show high atmospheric gases and high moisture hence not providing for accurate results. The syringe is liquid tight and can hold the oil sample in the syringe preventing it from coming into contact with any air. If there is a small leak in the sampling tubing or connections, vacuum bottles will draw air into the sample, which will not be seen inside the bottles. If any bubbles are seen in the syringe, they can be expelled immediately. Any extra air will be seen and expelled thus maintaining integrity of the collected sample.
- Integrity: any contraction and expansion in the sampled oil, will move the plunger backward or forward without having any air bubble formation.
- Easy identification of colour of the oil sample and easy identification in case of need for resampling.
- Protection from direct sunlight/diffused light: the oil collected in the glass syringes is protected from direct sunlight by packing the syringe filled with the oil in the padded carrying cases.
- Easy handling & convenient transportation.
- First choice under IEC regulations 60475 & IEC 60567, consistent & accurate reading of test results.
Features of the FORTUNA® Glass Syringes for DGA

- made of heat resistant borosilicate glass, confirm to ISO 594/1; 595/2
- material and construction is resistant to breakage from shock and sudden temperature changes
- It is annealed and tested until free of internal strain, to withstand repeated washing with hot water.
- reinforced at Luer Lock tip and barrel base, the points at which most breakage accurs
- Syringe cylinder plunger fit is leak proof and meets the requirements of Federal Specification GG-S-92 lb/A-A-54840/ISO 7886 for any leakage or backflow and for smooth plunger movement.
- in compliance with IEC-60567, IEC-60475 and ASTM-D 3613
- The plunger is individually ground and fitted to barrel for smooth movement with no back flow.
- The barrel rim has reinforced flanges and is flat on both sides to prevent rolling and is wide enough for convenient finger tip grip.
- The syringes are available in universal fit or custom fit design. The custom fit syringes are uniquely numbered for matching.
- The syringes metal Luer Lock tips meets the specification of the American National Standards for Medical Materials luer taper fitting performances ISO 594.
- The fitting is made from chrome-plated brass and fits all female Luer Lock fitting.
- The syringe is clearly marked with appropriate graduations.
- For a long lifetime of accuracy and legibility graduations and logos are permanently fused on to the glass.
- The syringe plunger is coloured bevelled rimed to facilitate dosage measurement.

Labelling of Oil Sample as per IEC 60475 section 4.4

<table>
<thead>
<tr>
<th>Transformer or other equipment</th>
<th>Sampling</th>
</tr>
</thead>
<tbody>
<tr>
<td>Customer</td>
<td>Sampling date</td>
</tr>
<tr>
<td>Location</td>
<td>Sampling point</td>
</tr>
<tr>
<td>Identification number</td>
<td>Sampling person</td>
</tr>
<tr>
<td>Manufacturer</td>
<td>Reason of analysis (routine or other)</td>
</tr>
<tr>
<td>General type (transformer, generation or transmission, instrument, industrial), reactor, cable, switchgear, etc.)</td>
<td>Transformer non-energized, off-load energized or on-load</td>
</tr>
<tr>
<td>Rated MVA</td>
<td>Oil temperature when sampling</td>
</tr>
<tr>
<td>Voltage ratio</td>
<td>Humidity: dry - wet - fog - indoors</td>
</tr>
<tr>
<td>Type and location of OLTC</td>
<td>Date of commissioning</td>
</tr>
<tr>
<td>Date of commissioning</td>
<td></td>
</tr>
<tr>
<td>Oil</td>
<td></td>
</tr>
<tr>
<td>Type of oil (mineral or non mineral)</td>
<td>Weight (or volume) of oil</td>
</tr>
<tr>
<td>Product name</td>
<td>Date of last oil treatment</td>
</tr>
</tbody>
</table>

List of test as per IEC 60475 section 4.2.1.5

<table>
<thead>
<tr>
<th>Oil Test</th>
<th>Oil Volume (ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dissolved gases</td>
<td>25 - 100</td>
</tr>
<tr>
<td>Water</td>
<td>20</td>
</tr>
<tr>
<td>Dielectric dissipation factor</td>
<td>200</td>
</tr>
<tr>
<td>Particles</td>
<td>100</td>
</tr>
<tr>
<td>Breakdown voltage</td>
<td>500-1000</td>
</tr>
<tr>
<td>Other chemicals and physical tests</td>
<td>250</td>
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<tr>
<td>All tests</td>
<td>1000-2000</td>
</tr>
</tbody>
</table>

Set for Transformer Oil Sampling Instruments for DGA:

1. Glass syringe: 20, 30, 50, 100 ml
2. 3-way Nylon stopcock
3. Tygon® tube with connector
4. Padded Carrying Cases
5. Un-vented Male Plug Cap

Accessories          Art. No.
3-way-Nylon stopcock  7.151-02
Tygon® tube with connector 7.151-03
20 ml Padded Carrying Case 7.151-41
30 ml Padded Carrying Case 7.151-44
50 ml Padded Carrying Case 7.151-45
100 ml Padded Carrying Case 7.151-51
Un-vented Male Plug Cap 7.151-01

FORTUNA® DGA Glass Syringe Set (3-way-Nylon stopcock, Tygon® tube, plug cap, padded carrying case)

<table>
<thead>
<tr>
<th>Capacity</th>
<th>Art.-No.</th>
<th>grad.</th>
<th>approx. outer Ø piston</th>
<th>approx. outer Ø barrel</th>
<th>approx.barrel collar Ø</th>
<th>approx. length of syringe</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 ml</td>
<td>7.150-41</td>
<td>1.0 ml</td>
<td>20.06 mm</td>
<td>23.40 mm</td>
<td>32.75 mm</td>
<td>151.00 mm</td>
</tr>
<tr>
<td>30 ml</td>
<td>7.150-44</td>
<td>1.0 ml</td>
<td>22.42 mm</td>
<td>25.70 mm</td>
<td>36.75 mm</td>
<td>170.00 mm</td>
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<tr>
<td>50 ml</td>
<td>7.150-45</td>
<td>2.0 ml</td>
<td>27.45 mm</td>
<td>32.35 mm</td>
<td>44.00 mm</td>
<td>178.00 mm</td>
</tr>
<tr>
<td>100 ml</td>
<td>7.150-51</td>
<td>5.0 ml</td>
<td>36.22 mm</td>
<td>40.00 mm</td>
<td>55.00 mm</td>
<td>223.00 mm</td>
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</tbody>
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