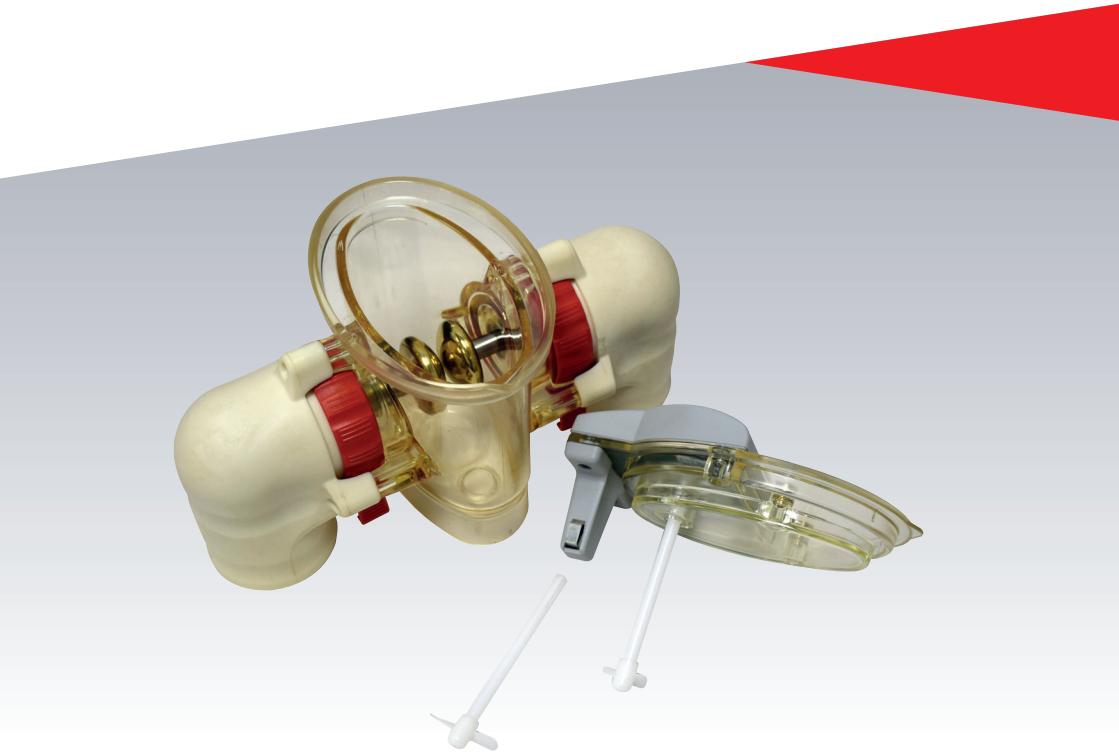
Megger



Oil Testing

OTS vessel preparation and elimination of the effects of moisture and contamination

Application Note

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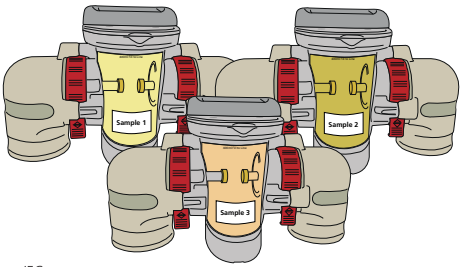
When unexpected results are experienced in testing the dielectric breakdown of oil samples the cause can often be traced to insufficient attention to one or more of the following key elements of vessel preparation:

1. Storing and subsequent cleaning
2. Setting the Electrode Gap
3. Ensuring thorough rinsing of the test vessel and then **immediately** filling the vessel with the oil sample to be tested.
4. Exclusion of all air from contact with the oil sample and prevention of air/ moisture contamination; (particularly relevant when using an impeller to stir the insulating oil sample).
5. Selecting the optimum stirring option for the insulating oil sample and test standard required.

Any of these elements have the potential to cause an un-expected drop in breakdown voltage level. Therefore it should be verified that each aspect has been properly considered and implemented.

Taking each of these elements in turn:-

1. **Storing and subsequent cleaning**



IEC

Fig 1: *IEC Storing oil samples*

IEC 60156 recommends that a separate test vessel assembly is used for each type of insulating fluid that is to be tested. The standard requires that the test vessels are filled with dry insulating fluid of the appropriate type, then covered and stored in a dry place.

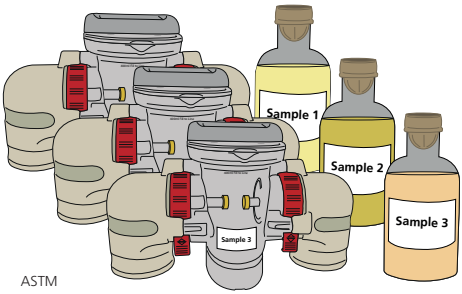


Fig 2: *ASTM Storing oil samples*

ASTM offers an alternative option of storing the vessels empty in dustfree cabinet.

Immediately prior to testing, vessels stored full of oil must be drained and all internal surfaces, including the electrodes, rinsed with fluid taken from the sample to be tested.

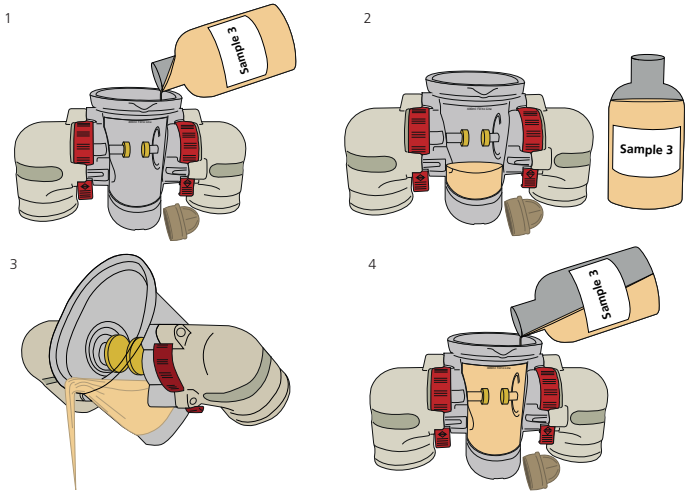


Fig 3: *Preparing the vessel*

The vessel should then be drained again. Swiftly and carefully fill with the test sample, taking particular care to avoid the formation of bubbles. If the vessel was stored empty, or if it is to be used for a different type of fluid from that with which it was filled during storage, it should be cleaned with an appropriate solvent before rinsing and filling.

ASTM D1816 specifies the use of a dry hydrocarbon solvent such as kerosene, which meets the requirements of D235. Solvents commonly used include acetone and, in the USA, toluene. Toluene is banned in Europe.

Solvents with a low boiling point should not be used as these evaporate rapidly, cooling the vessel and giving rise to the risk of condensation.

Use lint-free clean-room wipes to clean the vessel. Do not use paper towels as they may introduce particles that hold moisture, causing breakdown values to be dramatically reduced.

Touching the electrodes or the inside of the vessel should be avoided and during cleaning, the electrodes should be checked for pitting or scratches that may cause breakdown voltage values to be decreased. Remember that the rules of cleaning apply to all parts that will come in contact with the oil sample during testing.

2. **Setting the electrode gap**

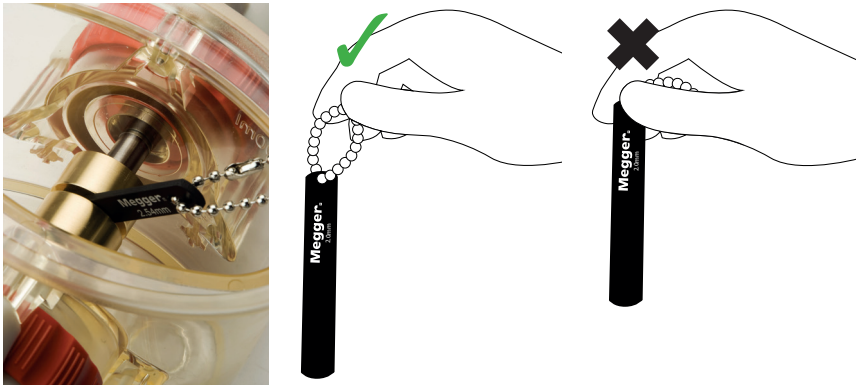


Fig 4: *Megger electrode gap gauge*

Setting the electrode gap accurately is very important; the results obtained are only valid if the gap is correct. A big problem is movement of the electrodes after the gap has been set and for this reason, many users of oil test sets check the electrode gap frequently – sometimes before every test. A better solution is to use test sets where the electrodes can be locked in position, such as the instruments in Megger's latest OTS range.

Megger recommends the use of flat, smooth gap gauges. The latest Megger gauges have a black anodized coating, which not only provides a smooth surface but also shows when the gauge is worn, as the shiny aluminium starts to show through the coating.

When setting the electrode gap using the Megger gauge - See Figure 4

- Ensure the gap is set in an empty vessel and before pouring in the sample to be tested to avoid contaminating the sample with the gap setting process.
- Hold the gap gauge with the key chain and place between the electrodes. This enables better view of the gap gauge and prevents the gauge being forced into the existing electrode gap.
- Carefully adjust the electrode gap without over tightening. The gap gauge should just be able to slide between the electrodes with little force required to move it, while it is held from the chain. If force is required over tightening has resulted and the electrodes must be adjusted to release this and rechecked ensuring that only a light force is needed to move the gauge.
- Finally remove the gap gauge. This should continue to move with barely a detectable drag between the electrodes.

When setting the electrode gap, it is very important that the gap gauge barely touches the electrodes, with only the slightest drag as it passes between them when held vertically in such a way as to minimise friction. Any significant pressure could result in the electrodes springing towards each other after the gauge has been removed. Do not breathe on the vessel when doing this to avoid moisture contamination, or lean on its rim or other parts to avoid mechanical distortion.

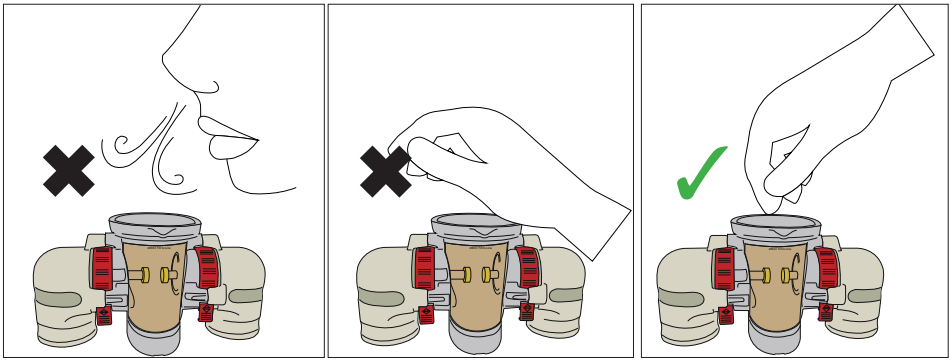


Fig 5: *Do not breathe on the vessel or lean on its rim or other parts*

Note: If the OTS is moved for one location to another please ensure the electrode gap is re-checked as described above as a precaution.

3. **Rinsing and then immediately filling the test vessel with the insulating fluid sample**

Prior to filling the test vessel it is important to rinse the vessel with clean dry oil or with some of the sample oil about to be tested. Rinsing should always be performed before each test, even if performing repetitive testing in an oil test laboratory.

Remember that when rinsing the vessel, equal attention should be given to any magnetic bead, impeller, baffle plate, lid and to the electrodes, not just the vessel walls. Rinsing should be applied to any surfaces that will come in contact with the oil sample during testing.

After rinsing the test vessel with the sample oil it is most important to ensure it is immediately filled with the oil sample to be tested. Any significant delay, (even a few minutes), may result in the oil film on the vessel's walls absorbing water from the air; since the walls have a large surface area, this is likely to contaminate the oil sample and reduce the breakdown voltage once it has been mixed with the sample. Just 30 parts per million, (ppm), of water is sufficient to halve the breakdown values.

In fact, ASTM D1816 specifies that the test vessel must be filled with the oil sample within just 30 seconds of the rinsing taking place.

When filling, pour the oil sample into the vessel swiftly but with minimum turbulence so as not to entrap air.

Place the lid on the oil vessel, this will prevent contamination, then allow the sample to stand for a few minutes before testing. Leaving the oil to stand will allow any air bubbles to clear from the oil.

However it is important not to leave the sample to stand for longer than absolutely necessary as it may absorb water from the air in the headspace above it, again reducing the breakdown voltage. The baffle/lid must be fitted to prevent air contact whilst the oil is left to stand to allow any bubbles to clear.

- Excluding air from circulating oil when using an impeller to stir the insulating fluid sample

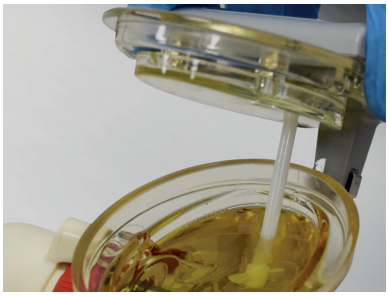


Fig 6: *Baffle plate must come in contact with the oil*

If you are using an impeller stirrer that utilises a baffle plate to exclude air from the oil sample, ensure that oil does not pass over the upper surface of the baffle plate.

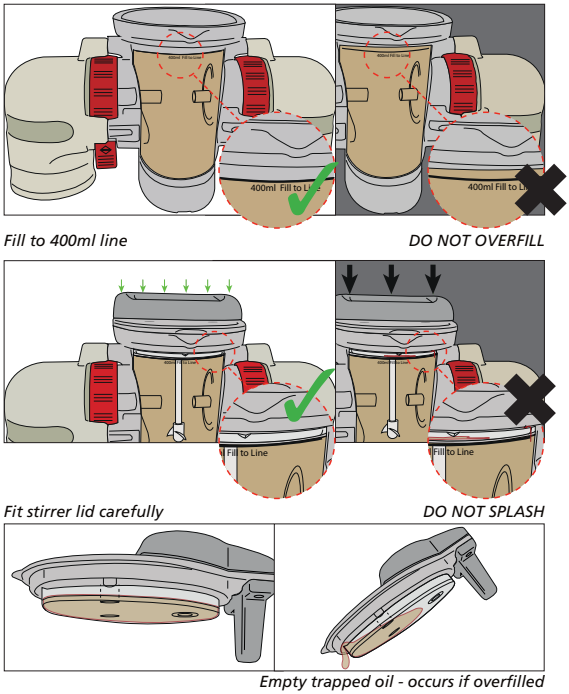
It is also important that the oil sample is in full contact with the underside of the baffle plate.

This will prevent moisture being absorbed from the contact of circulating oil with air as intended by the test standard.

- Fill the test vessel running the oil down the side wall so as not to cause splashing that will introduce unwanted air bubbles into the test sample
- Fill the test vessel to the 400 ml fill line, DO NOT OVERFILL (see figure 7)
- Gently place the stirrer lid onto the test vessel so that the baffle plate contacts the oil slowly, again so as not to cause splashing that will introduce unwanted air bubbles into the test sample
- Periodically remove baffle plate from the stirrer lid and clean thoroughly.

NOTE: If the oil is poured too fast, turbulence may generate bubbles which should be avoided.

NOTE: If the oil is poured too slowly the large surface area of the oil exposed to the air will absorb moisture. This should be avoided.



Fill to 400ml line *DO NOT OVERFILL*

Fit stirrer lid carefully *DO NOT SPLASH*

Empty trapped oil - occurs if overfilled

Fig 7: *Filling the test vessel*

4. **Selecting the optimum stirring option for the insulating oil sample to minimise air/moisture contamination**

When testing to IEC 60156:

IEC 60156 allows the optional use of a stirring impeller, the use of a magnetic bead stirrer or even no stirring at all. The standard states that differences between tests with or without stirring have not been found to be statistically significant. The use of a magnetic stirrer is only permitted when there is no risk of removing magnetic particles from the oil sample under test. When oil is used as a coolant as well as an insulator it may be useful to stir the sample during testing. For example oil from a transformer is normally circulated in use to help cool the transformer, but in doing so might also pick up contaminants and debris with it; so to achieve the most realistic breakdown results an oil sample taken from such a device would normally be stirred during test to ensure the best chance of detecting any detrimental effects of particle contamination. Oil from a circuit breaker is normally static in use, so particles would naturally fall to the bottom where they are unlikely to cause a problem. So in static use applications, an oil sample would not usually be stirred during testing.

The use of a magnetic bead for IEC60156 is recommended where possible as oil will circulate in the lower portion of the test vessel, whereas the impeller will circulate all of the oil in the test vessel. The magnetic bead therefore has the advantage that any moisture absorbed by oil in contact with air is not stirred into the sample, avoiding unwanted contamination. If the impeller is used it is vital that air is prevented from coming into contact with the surface of the oil by fitting the baffle plate and ensuring that the oil level is sufficient to make contact with the bottom surface of the plate without flowing over its top surface.

When testing to ASTM D1816:

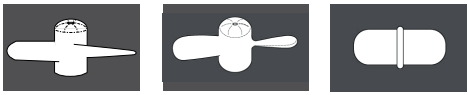
ASTM D1816 specifies that the oil is stirred throughout the test sequence, and a two bladed motor-driven impeller is specified. The standard prescribes the impeller dimensions and pitch as well as the operating speed, which must be between 200 rpm and 300 rpm. But remember, with this stirring requirement it is vital that air is prevented from coming into contact with the oil as described above.

When testing to ASTM D877:

ASTM D877 does not specify oil sample stirring

STIRRER OPTIONS

Megger supplies a range of impellers to optimise the stirring set-up.



IEC60156 ASTMD1816 Magnetic bead

Fig 8: *Impeller and bead*

Megger supplies as standard with the stirrer lid assembly two impellers.

The Impeller on the left is compliant to IEC 60156, whilst the one on the right is compliant to ASTM D1816.

Vigorous circulation can exacerbate the inclusion of any moisture captured on the surface film of oil left behind after rinsing at the vessel preparation stage, making the need for rapid filling even more critical, so as not to detrimentally affect breakdown results.

Ordering Information

For ordering information please refer to OTS60PB--OTS80PB--OTS60AF--OTS80AF--OTS100AF Datasheet.

Oil dielectric breakdown voltage testing can provide a quick, first line evaluation of the condition of insulating oils.

However, cleanliness, and good preparation is key to obtaining accurate and meaningful test results. Information on the Megger range of test instruments can be found on the Megger website www.megger.com. Further information can be found on the Megger booklet “The Megger guide to insulating oil dielectric breakdown testing”, part number 2003-149.

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