IsoTec
Reliable. Safe. Sustainable.

IsoTec NE 350

Moisture Tolerance and Asset Life Extension

Moisture Tolerance

IsoTec NE 350 exhibits exceptionally high moisture tolerance, allowing it to absorb significantly more water than mineral oil or silicone fluid without affecting its dielectric performance. Additionally, it can bind water, which may help slow the aging of cellulose insulation. In contrast, mineral oil carries the risk of releasing absorbed water as condensation.

Why Moisture Tolerance is Important in Transformers:

- Dielectric strength - decreases as moisture content increases Rate of
- paper ageing - accelerates with higher moisture content Condensation during
- cool down - risk of free water being released from mineral oil

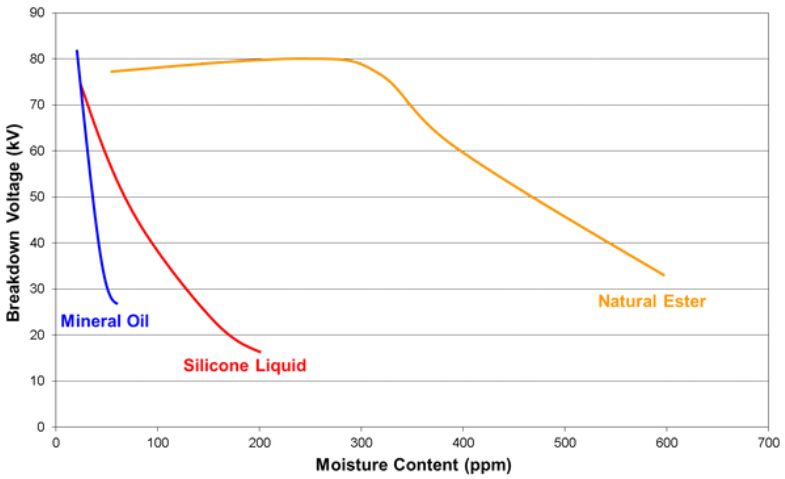
Dielectric Strength

Figure 1 presents the breakdown voltage at ambient temperature for IsoTec NE 350, mineral oil, and silicone fluid as moisture levels increase. The data clearly show that even small amounts of water in mineral oil or silicone fluid lead to a rapid decline in breakdown voltage. In contrast, IsoTec NE 350 retains a high breakdown voltage of over 75 kV, even when moisture levels exceed 300 ppm.

Rate of Paper Ageing

The rate at which paper insulation ages is closely linked to its water content. Studies have demonstrated that for each additional 1% of water in the cellulose, its lifespan can decrease by up to a factor of ten. As the cellulose deteriorates, it releases more water, further accelerating the aging process. Consequently, keeping the cellulose as dry as possible is essential.

Figure 1 – **Breakdown voltage vs. moisture content at 20°C (IEC 60156 2.5mm)**



One study conducted by the well-known paper manufacturer Weidmann Electrical Technology demonstrated that in sealed systems, IsoTec NE 350 is able to maintain cellulose at a much lower moisture content than mineral oil, significantly slowing its aging. For example, at 150 °C, pressboard immersed in mineral oil lost over 65% of its original tensile strength after four months, effectively reaching the end of its service life. Under the same conditions, pressboard in IsoTec NE 350 retained 57% of its original strength and remained suitable for continued use.

Condensation During Cool Down

In mineral oil, water can be released as a transformer cools from operating temperature to ambient, because its low moisture saturation limit decreases further with falling temperature. IsoTec NE 350, however, has a much higher saturation limit, making it far less likely to reach saturation and release water.
For example, in a transformer filled with mineral oil and paper insulation containing 1.5% water, operating at 90 °C, the water content of the mineral oil would be around 65 ppm. Upon shutdown, much of this water remains in the oil. At 20 °C, however, the saturation limit of mineral oil drops to 55 ppm, meaning the oil is 118% saturated and free water will be released into the transformer. This also significantly lowers the breakdown voltage of the mineral oil, increasing the risk of failure upon restarting.

Using the same scenario for IsoTec NE 350, at 90 °C the water content would be approximately 300 ppm. At 20 °C, IsoTec NE 350 has a saturation limit of 1100 ppm, so even if all the water remains in the fluid, it would only be 27% saturated. This ensures that no free water is present and the fluid retains an excellent breakdown voltage.

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Moisture Content Testing

The standards for moisture content in new fluids are summarized in Table 1. New IsoTec NE 350 is produced to very high quality standards, with a typical moisture content of around 50 ppm, highlighting IsoTec NE 350's superior moisture tolerance.

This has practical implications when interpreting moisture level measurements for IsoTec NE 350 compared to mineral oil. Additionally, if a transformer is equipped with moisture-monitoring devices, their tolerance settings should be adjusted to account for the higher moisture-holding capacity of IsoTec NE 350.

Moisture Removal

If the moisture content exceeds the recommended in-service limit, the same techniques and equipment used to remove water from mineral oil—such as molecular sieves and vacuum filtration units—can also be applied to IsoTec NE 350.

For further advice please contact the IsoTec technical team: info@isotec.bio

Table 1 **– Standards for Moisture Content**

Standard	Moisture Content
IEEE C57.147 - New Natural Ester	max. 200ppm*
IEC 60296 - New Mineral Oil	max. 30ppm

*sample from bulk tank