

Moisture Tolerance

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Moisture Tolerance

MIDEL 7131 has a very high moisture tolerance. This means it can absorb far greater amounts of water than mineral oil and silicone liquid without compromising its dielectric properties. MIDEL 7131 can also trap more water which may slow down cellulose ageing. In the case of mineral oil, there is a danger that this water will be released as condensation.

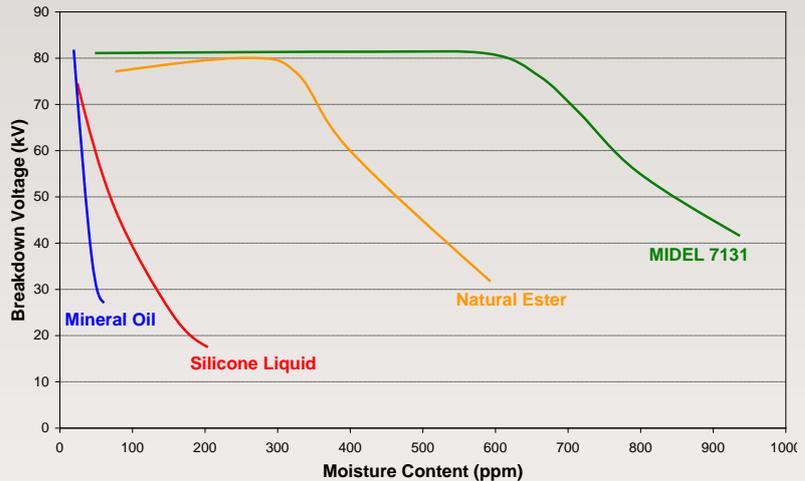
Why Moisture Tolerance Is Important in Transformers:

- ▶ Dielectric strength - reduces as moisture content increase
- ▶ Rate of paper ageing - increases with higher moisture content
- ▶ Bubble formation during overloads - bubbles form at a lower temperature when there is a high moisture content in the paper
- ▶ Condensation during cool down - risk of release of free water from mineral oil

Dielectric Strength

Figure 1 shows the breakdown voltage at ambient temperature of MIDEL 7131, natural ester, mineral oil and silicone liquid with increasing moisture levels. It clearly illustrates that even a small amount of water in mineral oil and silicone liquid cause a rapid deterioration in breakdown voltage. In contrast, MIDEL 7131 maintains a high breakdown voltage of >75kV even when moisture levels exceed 600ppm.

Figure 1 - Breakdown Voltage vs. Moisture Content at 20°C (IEC 60156 2.5mm)



Rate of Paper Ageing

The rate of paper ageing is directly related to the water content. Various studies have shown that the lifetime of the paper reduces by as much as a factor of ten for each extra 1% of water content in the cellulose. As the cellulose ages it releases water, thus accelerating the ageing process. Therefore it is vital that cellulose is kept as dry as possible.

MIDEL 7131 has the ability to trap more moisture than mineral oil, which can reduce the amount of water in the paper and hence reduce the ageing rate.

Using moisture equilibrium curves it is possible to show that for MIDEL 7131 at 60°C, water content in fluid of 200ppm would equate to water content in the cellulose of 1.1%. At the same temperature, mineral oil with a water content of 20ppm would lead to water content in the cellulose of 2.6%. The extra 1.5% of moisture would equate to at least a tenfold decrease in the life of the cellulose.

Bubble Evolution During Overloads

Bubbles in dielectric fluids are undesirable since they are electrically weak. According to IEC 60076-14, bubble evolution temperature is directly related to the moisture content of cellulose. During overload conditions the temperature of paper wrapped conductors will rise, increasing the risk of reaching critical temperatures for bubble evolution. For example, with a paper water content of 2.6% the temperature at which bubbles form will be 130°C. With a water content of 1.1% the bubble evolution temperature is 165°C. Since MIDEL 7131 has the ability to keep paper drier it gives a greater margin of safety during overloads.

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Condensation During Cool Down

With mineral oil there is a potential for water to be released when a transformer cools from operating temperature to ambient. This is because mineral oil has a low moisture saturation limit which reduces as the temperature drops. MIDEL 7131 has a much higher saturation limit, which means that it is far more difficult to reach the saturation point.

For example if a transformer with mineral oil and a paper water content of 1.5% was running at 90°C the water content of the mineral oil would be 65ppm. If the transformer then shut down, the water would tend to stay in the mineral oil. At 20°C the saturation limit of mineral oil is 55ppm, so the mineral oil would be 118% saturated, releasing free water into the transformer. The breakdown voltage of the mineral oil will also be very low, increasing risk of failure when restarting.

Using the same example for MIDEL 7131 at 90°C the water content would be 700ppm. The saturation limit for MIDEL 7131 at 20°C is 2700ppm, so even if all the water stays in the MIDEL 7131 it will only be 26% saturated. This means there is no free water and still an excellent breakdown voltage.

Table 1 - Standards for Moisture Content

Standard	Moisture Content
IEC 61099 - New Esters	max. 200ppm
IEC 61203 - In-service Esters	max. 400ppm
IEC 60296 - New Mineral Oil	max. 30ppm
IEC 60422 - In-service Mineral Oil*	max. 30ppm

Note: The typical value for new MIDEL 7131 is 50ppm

*Equipment at >72.5kV and <170kV

Moisture Content Testing

The standards relating to moisture content for new and in-use fluids are shown in the Table 1. New MIDEL 7131, as delivered, is manufactured to very high standards with typical moisture content of 50ppm.

MIDEL 7131 will still be within specification up to 400ppm. In contrast, mineral oil will be out of specification above just 30ppm. This has practical implications for the interpretation of moisture level analysis. Also, if moisture-monitoring equipment is integrated within a transformer, its tolerance settings should be adjusted accordingly.

Moisture Removal

Should the moisture content rise above the maximum in-service limit, the same methods and equipment that are used for removing moisture from mineral oil can also be used to remove moisture from MIDEL 7131. For example molecular sieves and vacuum filtration units.

For further advice on the moisture tolerance and asset life extension benefits of MIDEL 7131 please contact the MIDEL technical team on mideltech@mimaterials.com.