Mineral Oil

Mineral oil is a hydrocarbon-based fluid that is distilled from naphthenic-based oils. It has been the go-to fluid for transformers for many years, which is why there is more performance data available on it than any other fluids on the market to date. Mineral oil has a low viscosity which makes it an effective fluid for cooling by natural convection.

Mineral oil's fire point is around 165 degrees C which does not qualify it as a suitable fluid for applications requiring a "less flammable fluid". Transformers filled with mineral oil will bear an ONAN cooling class designation (the "O" designating a fluid with a flashpoint below 300 degrees C) Most mineral oil options contain an inhibitor to improve oxidation stability and reduce the buildup of sludge inside the transformer tank. The presence of this inhibitor is for the most part standardized across the industry and denoted by the prefix "Type II".

Natural Esters (FR3® fluid)

Originally developed to provide a more environmentally friendly version for higher flashpoint fluids, natural esters are now the go-to for applications requiring a less flammable fluid-filled transformer. Transformers filled with natural esters bear a KNAN cooling class marking on their nameplate (the "K" designating a fluid with a flashpoint above 300 degrees C). Natural ester fluids are typically seed oil based rather than hydrocarbon-based–like mineral oil.

Several versions of natural ester type fluids have been introduced into the market over the years. The most significant and widely used option in the US currently is FR3® fluid. It is 100% vegetable oil based and fully biodegradable with a flashpoint around 330 degrees C or higher. The use of FR3® fluid in transformers can also enable an additional increase in transformer kVA capacity. Studies have shown that the use of FR3® fluid can also increase the lifespan of a transformer's insulation system. In a sense, FR3® fluid can *dry out* the paper insulation around the windings. Moisture near the coils is continually moved away from the windings–and through hydrolysis–converted into mild non-harmful fatty acids–eliminating the harmful effects of moisture build-up in and around the windings.

Learn more about the benefits of FR3® fluid.

Silicone

Silicone is a synthetic fluid that is less widely used in transformers today. Its high fire point makes it suitable for applications requiring a less flammable fluid, however, since it has no biodegradability, natural esters are usually favored where a high fire point is required. Between natural esters and mineral oil, silicone is typically the more costly of the three.

Transformer Oil Comparison

Fluid Comparison

	Flashpoint	Firepoint	Biodegradability	Toxicity		
Mineral Oil	~155°C	~165°C	Poor	Low to none	Low	Petroleum
Natural Esters (FR3)	~330°C	~360°C	100%	None	Higher	