COOPER Power Systems

Envirotemp FR3 Fluid in Cold Climate Applications

1. Does FR3 fluid meet IEEE's limit for normal operating temperatures down to –20°C?

A: Yes, FR3 fluid's pour point is typically –21 °C per test method ASTM D-97.

2. What happens to FR3 fluid when it's cold?

A: Like all dielectric fluids, FR3 fluid's viscosity increases as temperature decreases, and as it approaches its pour point, it thickens.

The pour point of FR3 fluid is typically –21 °C (-6 °F) vs. the standard limit of –40 °C (-40 °F) for mineral insulating oil. Pour point is the lowest temperature at which fluid will flow. Unlike water, FR3 fluid does not have a well-defined liquid/solid transition temperature. However, we know that volume, temperature, and time at temperature all have influence over how much viscosity increases at cold temperatures. As little as 15 gallons exposed to –25 °C (-13 °F) ambient for 11 days remains fluid, while a quart may solidify within 48 hours. For detailed information, see the PPT 'How Cold is Cold'.

3. It gets cold for long periods of time here. Can I use FR3 fluid in my transformers?

A: Yes, even where people perceive their climate is colder than our pour point temperature.

In distribution transformers, CPS has cold tested FR3 fluid in conjunction with all of our components down to temperatures of –25 °C (-13 °F) for 3 days. CPS Load-break switches, de-energized switches, and Bay-O-Net fuses meet the ratings published in the test reports, which allow installation and operation of distribution transformers, even in very cold conditions for up to a week. Re-energizing CPS transformers (whether they contain these components or not) even when the fluid is solid is typically acceptable. If by chance the transformer is faulted, bayonets and isolation links will still operate as designed.

In power transformers, CPS has conducted many tests to understand how these transformers operate with FR3 fluid as the dielectric fluid. FR3 fluid works effectively as an electrical insulator even when solid. Transformers containing FR3 fluid below its pour point temperature may lose convective cooling (heat transfer via flowing fluid) and rely on conductive cooling (dielectric absorbs heat) to get the heat out of the coils. As the fluid warms, convective cooling is restored. Gelling in the main tank can only occur in a transformer that is de-energized for an extended time in very cold conditions. We have data indicating that this is very unlikely in the contiguous US.

For further information, see the PPT 'How Cold is Cold'.

4. Can I energize a distribution transformer where FR3 fluid is gelled?

A: Typically, Yes.

The exception may include applications where devices require mechanical movement to complete their function (ie: switches and circuit breakers). FR3 fluid can inhibit physical movement of the device at very high viscosities. In these instances, the transformer should be warmed to at least -10 °C.

5. Will transformers operate normally in cold weather?

A: Yes.

As long as the transformer is energized, the fluid will stay in liquid form, even in cold weather.

The energy losses in an unloaded transformer are enough to keep it from solidifying in the main tank. Field experience includes 230 kV power transformers that have endured ambient temperatures as low as -40 °C and operated normally.

6. What happens if FR3 fluid gels in the radiators?

A: CPS tests show that the gelled fluid in the radiators headers warms, restoring flow.

This occurred before the top oil temperatures exceeded IEEE's limits outlined in the Transformer Loading Guide. These test results are summarized in the PPT 'How Cold is Cold'.

7. What if the power is lost for a long time during cold weather?

A: When transformers experience a prolonged outage due to upstream loss of power, the fluid slowly cools to ambient temperature.

The time required to reach ambient is dependent on many variables, including volume of fluid, ambient temperature, and rate of cooling. If the ambient is below FR3 fluid's pour point, tests show as little as 15 gallons in the tank does not solidify when exposed to temperatures of –25 °C (-13 °F) for as long as 11 days. For details, see the PPT 'How Cold is Cold'.

8. Can I use CPS Bay-o-Net, tap changer or load break switches in cold weather?

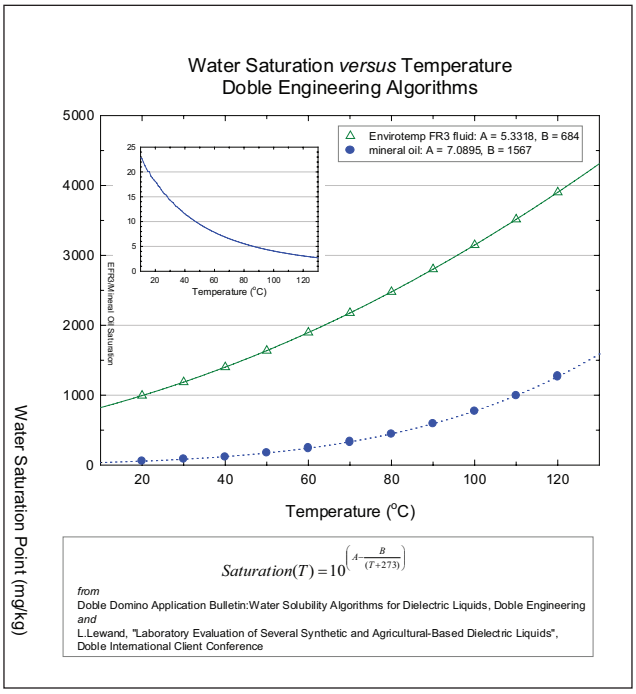
A: Typically Yes.

Certified test reports of Cooper Power Systems switches and fuses confirm that equipment operated at –20 °C meets all CPS performance ratings for distribution transformers.

9. Will cold FR3 fluid form 'free water', as can happen with cold mineral oil?

A: Typically, FR3 fluid will not contain enough moisture to precipitate out free water during the cooling process due to its more favorable saturation vs. temperature curve. (See Water Saturation Curve)

Water Saturation Curve



10. Can I use FR3 fluid in LTC applications in colder environments?

A: The customer should consult their transformer or LTC OEM to validate performance of LTC in FR3 fluid in their environment.

CPS does offer voltage regulators filled with FR3 fluid that prevent operation at temperatures below –10 °C. Both Reinhausen and Waukesha Electric Systems will conditionally offer FR3 fluid in LTCs, provided that they are of sealed design (non-free breathing).

11. Does FR3 fluid meet the Canadian standard CSA 50?

A: No

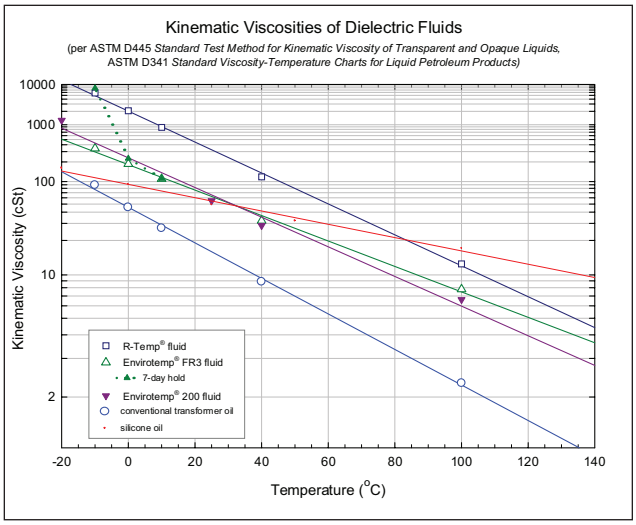
The Canadian Standard CAN/CSA-C50 'Insulating Oil, Electrical for Transformers and Switches' is specifically for mineral oil, and does not apply to other fluid types such as natural esters like FR3 fluid.

12. Can FR3 fluid be transferred by pump when it's cold?

A: The customer should provide to his pump manufacturer our FR3 fluid viscosity versus temperature curve so that the pump OEM can verify the pump will work properly at low temperatures.

The pump manufacturer can best address operation at cold fluid temperatures. Care should be exercised when energizing pumps when the fluid temperature is near its gel point. See CPS Storage and Handling guide for additional details. (See Viscosity Curve)

Viscosity Curve



13. I tried to take a sample from my transformer, and the FR3 fluid would not flow. Why?

A: The FR3 fluid gelled, due to prolonged exposure of a small volume of fluid in the drain valve to cold temperatures.

In colder climates, it is not unusual for the small volume of FR3 fluid in the drainpipe and valve to be at ambient temperature, even though the unit may have been in service during or just prior to sampling. Because the sampling valve (typically located at the lowest point of the transformer temperature gradient) contains a small volume of stagnant fluid, and the valve metal "transmits" the cold, the probability of gelling is a magnitude higher than other areas of the transformer. In these cases, the service pipe and drain valve should be heated until the fluid flows. In these instances, CPS recommends you flush a small volume of fluid through the pipe and valve before taking your sample.

14. Are you aware of any field failures of an installed transformer due to cold FR3 fluid?

A: No

We are not aware of any FR3 fluid related failures with approximately 150,000 installed transformers, including many with cold temperature exposure. Installations include US, Canada, Norway, and mountainous regions. Additionally, we possess over 30 years of experience with R-Temp (same D97 pour point as FR3 fluid filled transformers with no cold temperature related field failures, including installations near the Arctic Circle.

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