Dielectric Fluids

COOPER Power Systems

Service Information

Cold Start Recommendations for Envirotemp FR3 Fluid Distribution Class Transformers

R900-20-22

INTRODUCTION

Envirotemp FR3 fluid behaves differently at low temperatures than does mineral oil. This becomes important during prolonged outages at temperatures below the normal ANSI/IEEE usual service conditions (lower limit of –20 °C (-6 °F)). It is important to recognize that for distribution transformers in service, the temperature of fluid is significantly higher than ambient. Even no load losses are typically enough to keep the fluid temperature above concern. In the event of prolonged outages or extended periods of time where equipment is exposed to temperatures that are continuously lower than –20 °C, the viscosity of the fluid could increase, hampering fluid flow. However, CPS full scale tests confirm that transformer losses quickly warm the fluid such that normal flow and cooling result, without undue aging of the insulation system.

WHAT HAPPENS TO FR3 FLUID WHEN IT'S COLD?

Physical

The pour point of FR3 fluid is about –20 °C, the same as the pour point of R-Temp fluid. This is the lowest temperature at which it will easily flow. The pour point of transformer mineral oil is typically ≤ -40°C (≤-40°F).

Unlike water, FR3 fluid does not have a well-defined solid/liquid phase transition temperature. During extended exposure to very cold temperatures, FR3 fluid does not change immediately from liquid to solid, but instead begins to thicken, and with time, can gel. Its viscosity near the pour point depends not only on the temperature, but also time at temperature (see Figure 1).

Electrical

FR3 fluid maintains its dielectric strength down to at least –50 °C (-58 °F). Unlike mineral oil, FR3 fluid is not likely to saturate and allow formation of free water, greatly reducing risk of dielectric failure at low temperatures.

WHAT DOES THIS MEAN IN PRACTICAL TERMS?

FR3 Fluid in Distribution Class Transformers

Distribution class transformers containing FR3 fluid can be energized at any fluid temperature so long as no moving components are actuated immediately before or soon after energization.

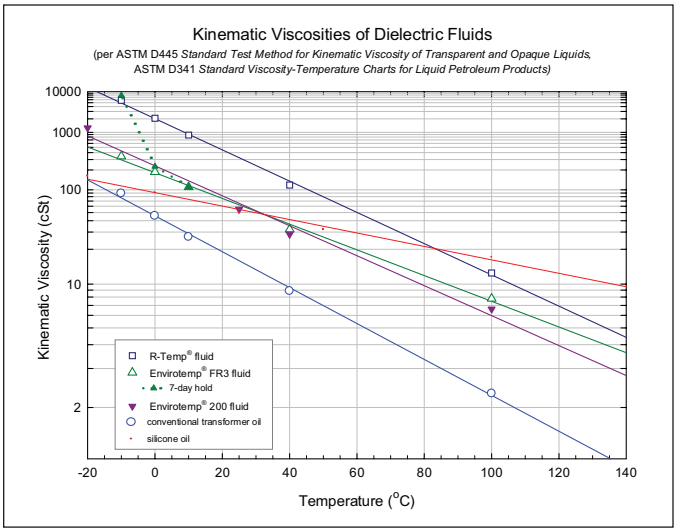

Figure 1.
Kinematic Viscosities of Dielectric Fluids

Movable liquid immersed components

Although FR3 fluid maintains acceptable electrical strength at temperatures below its pour point, the more viscous fluid may hamper mechanical movement, and extinguish arcs more slowly. 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. Consult your transformer or component equipment suppliers to confirm their test results and to obtain their recommended procedures for cold starting transformers when fluid temperatures are below –20 °C.

COLD START RECOMMENDATIONS FOR DISTRIBUTION CLASS TRANSFORMERS

1. Recommendation for energizing FR3 fluid filled transformers having no moveable components immersed in fluid: Units should be energized using normal start up procedures, regardless of ambient or fluid temperature.

2. Recommendation for energizing FR3 fluid filled transformers containing liquid immersed movable components: If the transformer has been exposed to temperatures continuously below –20 °C for longer than seven days, or the fluid temperature is below –25 °C, warm the unit until the fluid temperature reaches –10 °C, then energize using

normal start up procedures. For less severe temperature conditions, energize using normal start up procedures.

Fans

During cold start, the fluid in the radiators will warm up considerably slower than the fluid in the main tank. For this reason, the fans should not come on immediately, but should turn on when the additional cooling is required.

Switches

Follow the manufacturer's recommended practice. For CPS transformers, follow recommendation 2.

Bay-O-Net Fusing

Follow the manufacturer's recommended practice. For CPS transformers, follow recommendation 2.

COLD START TEST

Distribution class transformers instrumented to measure core, coil, and oil temperatures were tested by CPS. They were energized at full rated load at -30 °C (-22 °F) without incident or unusual temperature excursions [1].

References

[1] K.J. Rapp, G.A. Gauger, J. Luksich, "Behavior of Ester Dielectric Fluids Near the Pour Point", IEEE Conference on Electrical Insulation and Dielectric Phenomena, October 17-20, 1999, Austin, TX

R900-20-22 • New Issue • Replaces S900-20-3

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