BIOTEMP®
Cold Start Procedure for Distribution Transformers

Introduction

BIOTEMP™ is a biodegradable, high fire point, natural ester (vegetable based) dielectric coolant. It was developed to deliver an environmentally safe fluid with a high margin of fire safety. It is miscible with conventional transformer oils (mineral based oils) and compatible with standard transformer materials. BIOTEMP can be used in many applications where its unique environmental, safety and performance properties are an advantage.

Natural ester fluids have certain characteristics that need to be taken into consideration during operation and maintenance of the transformer.

One such characteristic of a liquid is its pour point being the lowest temperature at which it will pour or flow under prescribed conditions. BIOTEMP will begin to gel at temperatures below its pour point. Gelling is a function of time, volume and temperature as it is a slow process occurring during prolonged exposure to temperatures below -5°C.

IEC and IEEE/ANSI standards recognize ambient operating temperature below -20°C as extreme conditions. Pour point and minimum operating temperature need to be considered when a transformer is in storage or during a prolonged outage taking load off the transformer.

BIOTEMP behavior under cold temperatures

BIOTEMP when exposed to temperatures below 0°C will harden into a gel-like solid that will not expand or contract maintaining its insulating integrity and cooling capacity down to the most extreme temperatures. Unlike mineral oil, water dissolved in BIOTEMP does not separate or fracture into layers due to high water solubility even when below its pour point.

BIOTEMP characteristics are as follows:

−−Pour point is -15°C[1]

−−Begins to gel between -5°C and -15°C

−−Returns to its liquid state when reaching +5°C

Typical operating conditions of a distribution transformer

Accessory operation may be the limiting factor when operating a distribution transformer with BIOTEMP as it depends if the fluid is a liquid or gel-like solid.

Distribution transformers are loaded on average 20 to 50% of nameplate dependant on type of load be it residential, commercial, industrial or other.

Fluid temperature in a transformer is usually higher than the ambient temperature outside the transformer. Transformer loads can be the highest during times of system peaks which can happen in extreme temperature conditions well above and below zero Celsius.

Table 1 shows how top fluid temperature varies with transformer load and ambient temperature. In case of a transformer installed outdoor in an ambient of - 20°C and minimum 50% load, there should be sufficient heating to keep the top oil temperature near 3°C. Note transformer accessories are typically located in the oil just below the top oil level.

[1] Note: Pour point measurements as per ASTM D97; mineral oil is typically <-40°C

Transformer Load (% Nominal)	Fluid top temp rise (°C)	Fluid avg temp rise (°C)	Top fluid temperature, absolute @ ambient (°C)												
			40	30	20	10	0	-5	-10	-15	-20	-25	-30	-35	-40
0%	10	7	50	40	30	20	10	5	0	-5	-10	-15	-20	-25	-30
10%	10	7	50	40	30	20	10	5	0	-5	-10	-15	-20	-25	-30
20%	12	9	52	42	32	22	12	7	2	-3	-8	-13	-18	-23	-28
30%	14	11	54	44	34	24	14	9	4	-1	-6	-11	-16	-21	-26
40%	18	14	58	48	38	28	18	13	8	3	-2	-7	-12	-17	-22
50%	23	17	63	53	43	33	23	18	13	8	3	-2	-7	-12	-17
60%	29	22	69	59	49	39	29	24	19	14	9	4	-1	-6	-11
70%	35	27	75	65	55	45	35	30	25	20	15	10	5	0	-5
80%	43	32	83	73	63	53	43	38	33	28	23	18	13	8	3
90%	51	38	91	81	71	61	51	46	41	36	31	26	21	16	11
100%	60	45	100	90	80	70	60	55	50	45	40	35	30	25	20

Table 1: Top fluid temperature as a function of load and ambient temperature.
(Calculations based on IEC 60076-2)

Transformers installed indoor or in a Compact Substation (CSS) usually have an ambient temperature that is about 10°C higher than outside ambient temperatures.

Operability of accessories installed under oil

Another characteristic of a liquid is its viscosity being measure of resistance or internal friction of a fluid. Viscosity of a dielectric fluid increases as temperature decreases. This temperature dependency is even greater for natural esters fluids such as BIOTEMP. As viscosity increases for the dielectric fluid, the operating capacity of devices in the fluid such as fuses, fuse disconnects and switches may change. ABB works with its device suppliers to ensure ratings are appropriate for their application.

Fuse interrupting ratings apply to usual service conditions which as stated by ANSI/IEEE C57.12.00 Transformer Standards Committee would be top oil temperatures at and above -20°C for mineral oil. For BIOTEMP, this would be top oil temperatures at and above -5°C.

Mechanically operated devices such as load break switches and de-energized tap changers are designed to function under oil when the fluid is a liquid. Do not operate these devices when BIOTEMP temperature is less than +5 °C as this may cause the device to malfunction causing it not to operate correctly and/or damage the device.

If the transformer did not come equipped with an oil temperature indicator, one can estimate the top oil temperature by using Table 1. For example, a transformer loaded to 30% nominal rating for 16 hours in an ambient of -10°C should be sufficient time for BIOTEMP to be in a liquid state allowing operation of the under-oil mechanical devices.

One can also get an indication of top oil temperature by a measuring the temperature of the top cover. There exists various methods one being the use of a pyrometric thermometers that give an indication of temperature upon contact with a device.

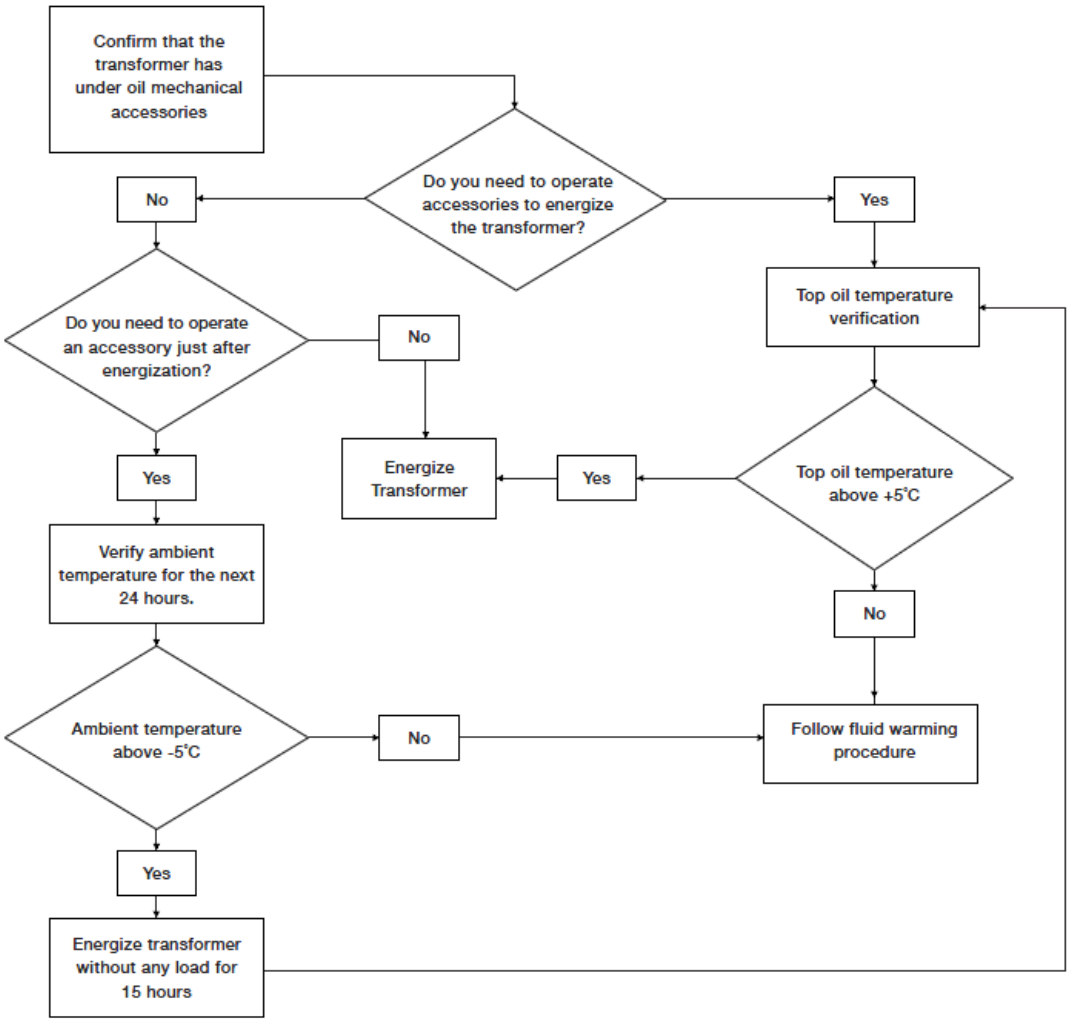
If a transformer has been in storage or in a prolonged outage (no load) while ambient temperatures are less than 0°C, care must be taken not to operate the under oil accessories should the top fluid temperature be less than 5°C. For instructions for operating under loaded conditions, reference operability of accessories installed under oil.

The flow chart follows steps through the process for energizing a transformer equipped with BIOTEMP fluid.

Should the fluid temperatures not meet the temperature stipulations then follow the fluid warming procedure.

Note: BIOTEMP filled units using radiators are not recommended in applications where ambient temperatures are less than 0°C as oil in the piping between main tank and radiators may gel or become a solid impeding the cooling capacity of the radiators. Accommodations must be made to ensure the piping between the main tank and radiators are at a temperature ensuring that BIOTEMP remains a fluid.

Cold start procedure



Fluid warming procedure

This procedure is to be followed if one needs to increase the temperature of the fluid in the transformer or cannot confirm the fluid temperature.

Method 1: To increase the temperature of the fluid, transport the transformer to a warmer ambient until the temperature of the BIOTEMP increases above +5°C by reading the top oil temperature indicator located on the transformer tank. If there is no top oil temperature indicator, it is recommended to keep the transformer above +5°C for at least 12 but a recommended 16 hours.

Note: Before operating the under oil mechanical devices, see operability of accessories installed under oil.

Method 2: If moving the transformer is not an option, then heat the transformer on-side with an external heating source. You will need as equipment - thermometer or thermocouple, tent or tarp and forced air heater. Before starting, de-energize the transformer and any other part of the transformer requiring electricity. Cover the tank with a

tent or tarp and introduce heated air into the tent or tarp until such time the top oil temperature indicator records +5°C.

If there is no oil temperature indicator, it is recommended to circulate heated air around the transformer for a minimum of 24 hours. Heated air should be no less than 15°C. If a tank hand-hole is available, open the hand-hole cover to observe if the fluid is in a liquid state.

Note: Replacement of the nitrogen blanket will be required before sealing back the handhole cover.

Once the fluid is in a liquid state, the transformer can be energized and under oil mechanical devices can be operated in accordance with normal operating procedures.

For more information please contact:

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