BecFluid® 9902

Dielectric Cooling and Insulating Fluid

Enhancing of transformer life

The influence of moisture on the insulation of old transformers is an important critical issue identified in investigations into transformer breakdown. A report on Insurance against Equipment Failure issued by the US Association, Hartford Steam Boiler Inspection and Insurance Co. (HSB), reached the conclusion "*Damage to the insulation in the last 10 years represents the second most important cause of failure. The average age of transformers which fail because of insulation damage is 17.8 years, which is therefore much less than the expected life of 35 to 40 years*."[1]

The weak point of transformer insulation is the solid insulation material which is usually based on cellulose. When this ages the polymer structure degrades and slowly releases water into the insulating oil. If the transformer fluid cannot absorb the water it remains in the windings. The water can then cause further decomposition by hydrolysis.

The water in the transformer arises from the cellulose itself (water content 1% in a dry condition), from ageing processes (oxidation of insulation materials) and from the surrounding air. In „free exchange" transformers, air can be taken up from the atmosphere; under rapid cooling the water is not completely removed by the desiccant cartridge. Even a sealed transformer is not completely isolated from the environment over its full working life. Through ageing and decomposition of the transformer cellulose both the electrical and mechanical integrity are reduced. In general the more the loss of mechanical integrity, the greater is the water content.

Mineral oil contains only a very small quantity of water, but cellulose has a large capacity to absorb moisture. The major part of the water found is in the windings reducing thereby the insulation resistance of the transformer.
This also undermines the stability of the transformer resistance under those mechanical and electrical loads which occur in normal service. Therefore a high humidity level can accelerate the cellulose decomposition as well as compromising the intrinsic stability of the mineral oil to voltage breakdown. With time, this leads to the failure and/or emergency reduction of load of the transformer and can ultimately produce complete breakdown.

BecFluid® 9902 has a more polar molecular structure than mineral oil and has a much higher capacity to absorb water without loss of insulation properties (Figure 1). The use of BecFluid® 9902 as insulating and cooling fluid provides a completely different equilibrium of water with the cellulose compared to that of mineral oil. Much more water can be taken from the cellulose by the ester fluid. By reducing the water in the cellulose its hydrolysis and thereby the ageing of the insulation system is slowed and the working life of the transformer extended.

Borsi et al[2] proved that the high affinity of esters for water is a key property for this process. Furthermore, they showed that the addition of only 20% ester to a mineral oil-filled operating transformer can improve the performance, by improving the hygroscopic properties of the original oil.

Summary

Damage of the insulation is the second most important cause of transformer failure. Reduction of the water content of the cellulose insulation is critical for the protection of the transformer. Even if the solid insulation is damaged in one place this can short circuit the coil and eventually lead to the destruction of the whole coil. Drying of the cellulose enables the life of the transformer to be extended.
BecFluid® 9902 has the ability to absorb relatively large amounts of water without loss of dielectric strength and allows effective recovery of a saturated transformer. Application of BecFluid® 9902 is an effective method to extract water from the cellulose and to restore and extend the operating performance of the transformer.

1 "An Analysis of Transformer Failures, 1988 through 1997, William H. Bartley, P.E. © 1997 Hartford Steam Boiler Inspection and Insurance Co.
2 "Drying of liquid immersed solid insulations using a hygroscopic insulating liquid" V. Wasserberg, H.Borsi, E. Gockenbach, I.Fofana, Schering Institute.

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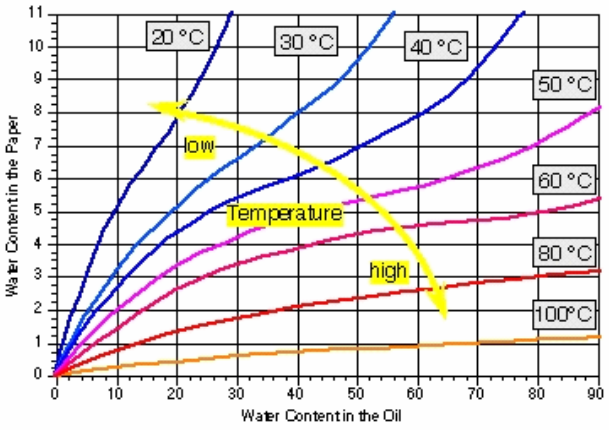
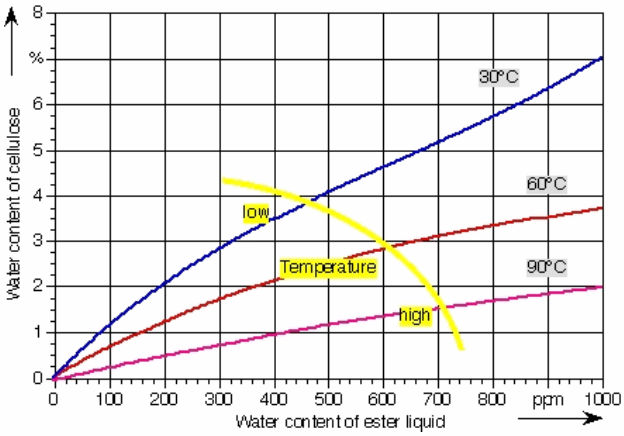
Diagram 1: Moisture equilibrium between cellulose and insulating fluid



Mineral Oil



Ester