

The Corrosion of Copper by Transformer Oil

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Abstract.

The transformers used in the electrical power distribution networks are normally insulated by a combination of electrical grade paper and 'transformer oil'. The large transformers of the national grid system will typically contain many tonnes of each of these components and in recent papers [1-3] we have drawn attention to a mode of degradation in which copper ions from the transformer windings diffuse into and through the tightly wound paper insulation. The paper is permeated with oil and this acts as the medium through which oxygen from dissolved air can reach the copper and initiate the corrosion process that generates the copper ions. It has been shown in laboratory tests that dissolved air is a necessary pre-requisite for corrosion but, in making these tests, it became clear that different batches of oil gave differing degrees of attack.

Transformer oils are supplied to a well-controlled specification with regard to their electrical properties, especially their dielectric behaviour under high potential fields, but their composition can vary to some extent according to source. Samples of copper exposed to five different batches of oil for up to 50 days grew tarnish layers having very different intensity and hue of colour. The tarnish films were analysed by X-ray photoelectron spectroscopy, showing that they were basically oxide but contained a significant amount of sulphide.

Having identified a batch of oil that caused only a minimal level of tarnishing, trials were set up to explore the possible role of organo-sulphur compounds in giving the batch-to-batch variation in the extent of corrosion. These trials draw on the known propensity of sulphur compounds, acting synergistically with oxygen, to cause corrosion of copper. Samples of electrical-grade copper were exposed at 95°C to the non-tarnishing oil that had been contaminated with different concentrations of thiols. The paper will report and discuss the results of these trials, and the extent to which protection is offered by benzotriazole under these conditions..

References

- 1 T.B.Whitfield, J.E.Castle and M.Ali The Corrosion of Copper in Electrically Insulating Oils. p123, Eurocorr2000, pub. IOM Communications ISBN 1-86125-127-0 plus associated CD ROM London
- 2 T.B.Whitfield, J.E.Castle, C Saracco and M.Ali , 'XPS Observations Of The Diffusion Of Copper Through The Paper Layers Used To Insulate Transformers' Surf Interface Anal. **34** pp 176-179 (2002)
- 3 J.E.Castle, T.B.Whitfield, and M.Ali ' The Transport of Copper through Oil Impregnated Paper Insulation in Electrical Current Transformers and Bushings' IEEE Insulation magazine to be published (2003)