Transformer Oil Passivation and Impact of Corrosive Sulphur

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In recent years a significant volume of research has been undertaken in order to understand the recent failures in oil insulated power apparatus due to deposition of copper sulphide on the conductors and in the insulation paper. Dibenzyl Disulfide (DBDS) has been found to be the leading corrosive sulphur compound in the insulation oil [1]. The process of copper sulphide formation and the deposition in the paper is still being investigated, but a recently proposed method seems to be gaining some confidence [1]. This method suggests a two-step process; initially the DBDS and some oil soluble copper complexes are formed. Secondly the copper complexes are absorbed in the paper insulation, where they then decompose into copper sulphide [2]. The most commonly used mitigating technique for corrosive sulphur contaminated oil is passivation, normally using Irgamet 39 or 1, 2, 3-benzotriazole (BTA). The passivator is diluted into the oil to a concentration of around 100ppm, where it then reacts with the copper conductors to form a complex layer around the copper, preventing it from interacting with DBDS compounds and forming copper sulphide.

This research project will investigate the electrical properties of HV transformers which have tested positive for corrosive sulphur, and the evolution of those properties as the asset degrades due to sulphur corrosion. Parallel to this the long term properties of transformers with passivated insulation oil will be analysed in order to understand the passivator stability and whether it is necessary to keep adding the passivator to sustain its performance. Condition monitoring techniques under investigation will include dielectric spectroscopy, frequency response analysis, recovery voltage method (aka interfacial polarisation) amongst others. Partial discharge techniques will not be investigated, as the voltage between the coil plates is low and therefore it will not contribute significantly to the overall insulation breakdown, in corrosive oil related faults [3]. The goal of this research is to establish key electrical properties in both passivated and non-passivated power transformers that demonstrate detectable changes as the equipment degrades due to the insulation oil being corrosive.

Figure 1: Conductor and papers from the inspection of a failed unit [1].

[1] Dahlund M et al., “Copper sulphide in transformer insulation,” CIGRE WG A2-32, Final Report No378, 2009.

[2] S. Toyama, J. Tanimura, N. Yamada, E. Nagao, and T. Amimoto, “Highly sensitive detection method of dibenzyl disulfide and the elucidation of the mechanism,” *IEEE Transactions on Dielectrics and Electrical Insulation*, **16**(2), pp. 509-515, Apr. 2009.

[3] F. Scatiggio, V. Tumiatti, R. Maina, M. Tumiatti, M. Pompili, and R. Bartnikas, “Corrosive Sulfur Induced Failures in Oil-Filled Electrical Power Transformers and Shunt Reactors,” *IEEE Transactions on Power Delivery,* **24**(3), pp. 1240-1248, Jul. 2009.