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SULPHUR CORROSION PHENOMENA AND RELATED POWER TRANSFORMER FAILURES

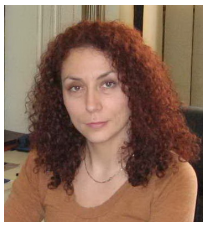
dr Jelena Lukić
Elektrotehnički institut "Nikola Tesla" u Beogradu, Univerzitet u Beogradu

Abstract: Risk assessment and mitigation of transformers with corrosive oils has been a technical challenge for scientific and engineering society in past decade. Over last 10 years two CIGRE working groups (WG A2.32 issued CIGRE TB 378 in 2008 and WG A2.40 issued CIGRE TB 625 in 2015) and IEC TC 10 and ASTM standardization (creation of IEC 62535, IEC 62697, ASTM D1275-15) had been working on this topic in order to define appropriate tests to detect corrosive sulfur species, understand the mechanism of copper sulfide formation in the paper insulation, define risk factors, provide Risk assessment and explore availability and long-term effects of mitigation techniques. Failures attributed to copper corrosion and deposition of copper sulfide in the paper insulation was one of main concerns of the industry and transformer community. In many cases failures occurred without prior warning through regular oil testing. Mechanism of metallic sulphides formation is elaborated in this paper, together with Risk Assessment based on postulated mechanism and service experiences.
Recently, problems and failures encountered with silver corrosion, i.e. formation and deposition of silver sulfide on silver plated contacts of OLTC's were dominant. The problem was encountered with low efficiency and inappropriate application /malfunction of mitigation techniques applied for copper corrosion mitigation. Inefficiency of metal passivator based on tolyil triazole amine derivative (Irgamet 39) and bounce-back corrosion after oil reclamation process were main drawbacks of sulver corrosion mitigation. Presence of elemental sulfur, a highly corrosive compound was found to be the root cause of number of failures, often occurring after oil reclamation with reactivating adsorbent.
Different oil treatment processes are used for removal of corrosive sulfur species from the oil to extend transformer life. Removal of DBDS and other disulfides can be achieved by conventional oil reclamation and by processes derived from PCB decontamination technologies which involve chemical conversion, while service experiences reveal that removal of elemental sulfur from the oil was found to be of limited efficiency and performance. INT technology was developed to selectively remove all types of corrosive sulphur compounds from the oil responsible for silver and copper corrosion. Reactive disulfides, including DBDS are successfully removed using oil desulfurization process, by the use of inorganic base dispersed in organic solvent, while elemental sulfur is

efficiently removed from the oil by oil reclamation process using specially activated adsorbent.
Guidelines for mitigation of sulfur corrosion are provided in this paper, taking into consideration differences in mitigation of copper and silver corrosion.

Key words: corrosive sulphur, copper sulphide, failure, transformer, PLTC, mitigation, oil reclamation, elemental sulphur.

Author's Biography



Jelena Lukic is Head of Laboratory for insulating oil and paper testing, department for Electrical Measurements of Electrical Engineering Institute Nikola Tesla. Jelena's field of expertise is power transformers diagnostics derived from oil analyses and know-how in transformer oil re-refining, removal of PCB and corrosive sulphur. Jelena Lukic earned Ph.D in Chemical Engineering at Faculty of Chemical Engineering, University of Belgrade, Serbia. She has published then 60 technical papers published, eight invited papers/lectures at international conferences and five peer review scientific papers. Jelena is delegate of Serbia NC in IEC TC 10, Serbia NC observer member in CIGRE SC A2 and co-liaison officer of CIGRE SC A2 to IEC TC 10. She is engaged in number of different IEC TC 10, CIGRE SC A2 and SC D1 WG's dealing with phenomenon of transformer oils and power transformers. Jelena Lukic was the convener of CIGRE WG A2.40: "Copper sulphide long-term Mitigation and Risk Assessment".