

Transformer Corrosive Sulfur Removal by Oil Reclaiming for Life Extension

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Introduction

- Many documented large transformer failures due to presence of corrosive Sulfur compounds in oil
- Related to corrosive reaction with metal surfaces and formation of copper sulphide and deposits in winding insulating paper
- Oil with corrosive Sulfur compounds and dibenzyl disulphide (DBDS) has much higher risk of failure depending on the winding design, loading and ambient temperature
- Six transformers at a generating station had high corrosive oil with Sulfur level 4b (ASTM D1275B) and DBDS up to 76ppm

ID	Rating [MVA]	HV [kV]	LV [kV]	Oil Quantity [L]	ASTM D1275B Tamish	DBDS [ppm]
1	300	420	20	114,000	4b	37
2	300	420	20	114,000	4b	33
3	300	420	20	97,500	4b	53
4	300	420	20	97,500	4b	55
5	350	420	20	132,200	4b	52
6	350	420	20	132,200	4b	76

- Decided to perform online reclamation process on 4 of the 6 units (to avoid production loss at the power plant).
- Other 2 units had offline process reclamation process performed

Method overview

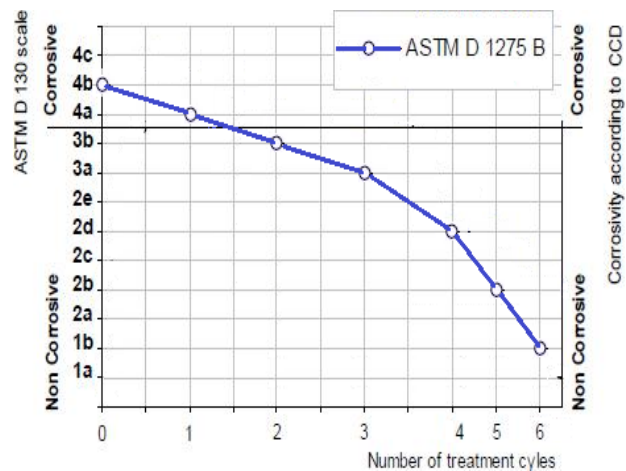
- Reclaiming is removal of contaminants in oil and degradation byproducts by physical or adsorbent means
- Performed by drawing oil through an oil heater, clay media (in columns), degassing chamber (to remove gasses and moisture) and returning to transformer or oil tank
- Clay media becomes saturated after 12 – 14 hours and must be reactivated (high temperature process to effectively burn off contaminants)
- ONLINE reclamation – performed while transformer is energized, no lost production
- OFFLINE reclamation – performed while transformer is de-energized
- Reclaiming to remove DBDS is a special type of reclamation process

Results and discussion

- All transformers had 6 passes (i.e. 6 times the oil volume)
- DBDS removed to below 5 ppm (from 37 – 76 ppm)
- All units became "non-corrosive" (formerly "corrosive") by ASTM D1275B
- Units 1 and 2 tested after 6 months and no change
- Unit 2 detailed results shown below (representative for all units)

Test	Before	3 rd Pass	6 th Pass	Final	6 Months
Interfacial Tension ASTM D971 [Dynes/cm]	33.45	44.42	42.94	44.9	43.6
Corrosive Sulfur ASTM D1275B & IEC 62535	Corrosive		Non Corrosive		
Tamish Level ASTM D130	4b	3a	1b	1b	1b
DBDS IEC 62697 [ppm]	33	2.9	1	1	3

Results and discussion (continued)



Conclusion

- Online reclamation to remove corrosive Sulfur & DBDS from the transformer oil was highly effective = "corrosive" to "non-corrosive level", DBDS reduced to < 5ppm, oil quality results such as acidity, interfacial tension and color close to new oil parameters
- Winding insulation very well cleaned of DBDS
- Transformers had no service interruption
- Results are long lasting as shown by the 6-month results
- While earlier damage to winding insulation from copper sulphide deposits is possible, there will be no future progression and the transformers can be utilized with a high level of confidence
- Oil reclamation process effectively extended the transformer useful life – significant environmental benefit compared to prematurely replacing the transformers, and for the re-use of the oil (versus replacing the oil)
- Oil reclamation for the removal of corrosive Sulfur and DBDS can be an important asset management action

References

- [1] CIGRE Technical Brochure 378, "Copper Sulphide in Transformer Insulation", Working Group A2.32, 2009
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- [3] CIGRE Technical Brochure 761, "Condition Assessment of Power Transformers", Working Group A2.49, 2019
- [4] IEEE Guide C57.637-2015, "IEEE Guide for the Reclamation of Mineral Insulating Oil and Criteria for Its Use"
- [5] CIGRE Technical Brochure 887, "Life extension of oil filled transformers and shunt reactors"