Space Charge Behaviour in Oil-Paper Insulation with Different Aging Condition

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Oil-paper insulation system is widely used in power transformers and cables. The dielectric properties of oil-paper insulation play an important role in the reliable operation of power equipment. Oil-paper insulation degrades under a combined stress of thermal (the most important factor), electrical, mechanical, and chemical stresses during routine operations, which has great effect on the dielectric properties of oil-paper insulation [1]. Space charge in oil-paper insulation has a close relation to its electrical performance [1]. In this paper, space charge behaviour of oil-paper insulation sample with three different ageing conditions (aged for 0, 35 and 77 days) was investigated using the pulsed electroacoustic (PEA) technique. The influence of aging on the space charge dynamics behaviour was analysed.

Results show that aging has great effect on the space charge dynamics of oil-paper insulation. The homocharge injection takes place under all three aging conditions above. Positive charges tend to accumulate in the sample, and increase with the oil-paper insulation sample deterioration. The time to achieve the maximum injection charge density is 30s, 2min and 10min for oil-paper insulation sample aged for 0, 35 and 77 days, respectively. The maximum charge density injected in the sample aged for 77 days is more than two times larger than the initial sample. In addition, the charge decay speed becomes much slower with the aging time increase. There is an exponential relationship between the total charge amount and the decay time. The decay time constant τ increases with the increasing deterioration condition of the oil-paper insulation sample. The τ value may be used to reflect the aging status of oil-paper insulation.

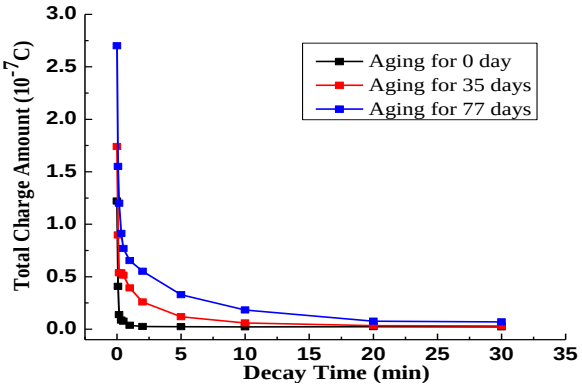

Figure 1: Relationship between total charge amount in the oil-paper insulation sample with different aging condition and decay time

Table 1: Fitting parameters of total charge amount (y) and decay time (x) according to $y = A + Be^{-\frac{x}{\tau}}$

sample	Constant		τ	R2
	A	B		
0 day	0.0367	1.1832	0.0715	0.9968
35 days	0.2054	1.4754	0.1350	0.8945
77 days	0.3386	2.1976	0.2044	0.9212

τ: decay time constant; R2: fitting coefficient

[1] Chao Tang, G. Chen, M. Fu, Rui-jin Liao, "Space charge behavior in multi-layer oil-paper insulation under different DC voltages and temperatures", *IEEE Transactions on Dielectrics and Electrical Insulation*, vol. 17, no. 3, pp. 778-788. 2010