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BEHAVIOR OF REMICA MATERIALS DURING ACCELERATED THERMAL STRESS

Abstract: This paper described behavior of ReMica material during accelerated thermal stress. Samples of 20 sets were stressed during their 25% of life time. Stressed temperature was 186°C. Polarization processes were observed due to direct voltage application. Absorption curves were measured and following isothermal relaxation current analysis was realized. Also capacitance and loss factor development was monitored.

1. Introduction

Present state of knowledge does not offer us one complex method that could determine the state of insulation systems itself. That is why the set of methods has to be applied. As equipments are different the set of methods has to be different too. Also, one kind of equipment can be made with several different kind of insulation system. Then it is necessary to utilize selected computing evaluation [1]. The knowledge of current condition and a possible lifetime calculation of expensive equipment (transformers, generators etc.) is important to make sure an operation furthermore especially by older equipments and higher strain of the electrical power networks.

In this occasion the condition orientated maintenance of insulation of equipment in electrical power supply includes a lot of possible diagnostic methods and technique to detect of typical failures, defects and dangerous ageing effects. According to [2] there are summarized typical diagnostic methods versus the application on different equipment.

2. The application of DC methods

The application is narrowly connected with bandwidth of observing spectrum. As ca be seen on Fig.1 the most information of the common insulation material is in interval from 10^{-4} to 10^{5}s.

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Direct methods are based on observing current or voltage time responses. The well known are polarization indices, absorptive or resorbtion current analysis, recovery voltage or self-discharge analysis e.t.c.

It was proved that the characteristic shape of the current curve changed during the ageing of the insulating material as the electro-physical quality is changed. It is possible to observe another changes of electrical quantities during service ageing.

The analysis of the polarization spectrum of the insulating material is based on the measurements of absorption and resorbtion currents now.

The total current consists of three components:

$$i_t(t) = i_c + i_v + i_a(t) \tag{1}$$

where $i_c(t)$ – geometrical capacity current, $i_a(t)$ – absorption current, i_v – steady current.

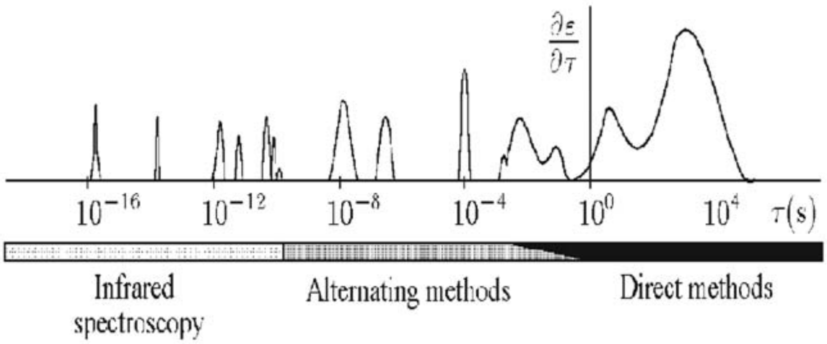

Fig.1.

Geometrical capacity current is too quick (about 10^{-12}s) and it is possible to neglect it. Then the total current can be described as:

$$i_t(t) = \frac{U_0}{R_0} + \sum_{i=1}^{n} I_{mi} \exp\left(\frac{-t}{\tau_i}\right) \tag{2}$$

The equivalent model of the insulating material is based on ***n*** independent Debye's polarization processes. Each process has its own time constant of stabilization τ_i and maximum of elementary current $\boldsymbol{I_{mi}}$ and by observing it's changes it is possible to get information about the state of insulation system.

Well known one and ten minute polarization indices are possible to calculate from observing current :

$$p_1 = \frac{I_{15}}{I_{60}} \qquad\qquad p_{10} = \frac{I_{60}}{I_{600}} \tag{3}$$

and if **n = 3** then the ageing constant ***A*** according to prof. Kranz from Wupertal [3] can be calculated:

$$A=\frac{1+\frac{I_{m2}\cdot\tau_2}{I_{m1}\cdot\tau_1}\cdot\left(1-e^{\frac{-\tau_3}{\tau_2}}\right)+\frac{I_{m3}\cdot\tau_3}{I_{m1}\cdot\tau_1}\cdot\left(1-\frac{1}{e}\right)}{1+\frac{I_{m2}\cdot\tau_2}{I_{m1}\cdot\tau_1}\cdot\left(1-\frac{1}{e}\right)+\frac{I_{m3}\cdot\tau_3}{I_{m1}\cdot\tau_1}\cdot\left(1-e^{\frac{-\tau_2}{\tau_3}}\right)} \qquad (4)$$

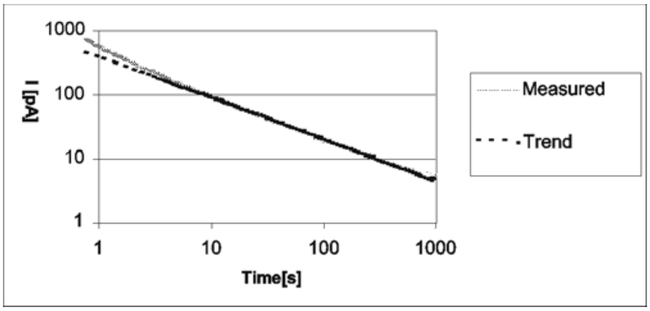

Fig. 2

In addition the slope in log-log scales is very similar to straight line (as Fig.2 shows) and that is why it can be scanned by simply equation

$$i_{\log}(t)=a\cdot\log(t)+b \qquad (5)$$

with parameters ***a*** and ***b*** and described behavior of total current.

3. Test and results

The laboratory tests were carried out. The samples were made from Re-Mica material Relanex. The samples were thermal stressed at 186° C during 1344 hours.

The accelerated ageing was reached. The cataloged data set was measured. There were 20 sets each with seven samples. Distances among the sets were the same in logarithmic time axis.

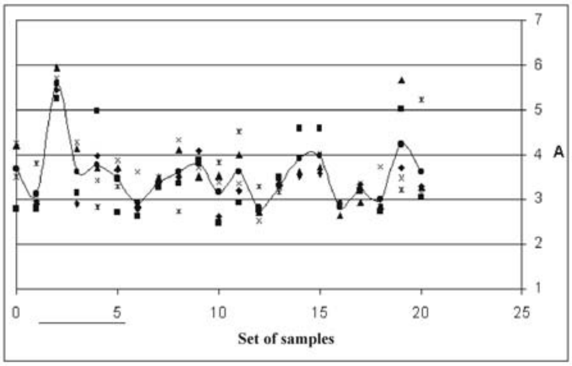

Fig. 3

Ageing constant ***A*** of prof Kranz in Fig.3 can't be described ageing process. Primarily it was design for XLPE material. ReMica material is more complex and 3 elements aren't enough.

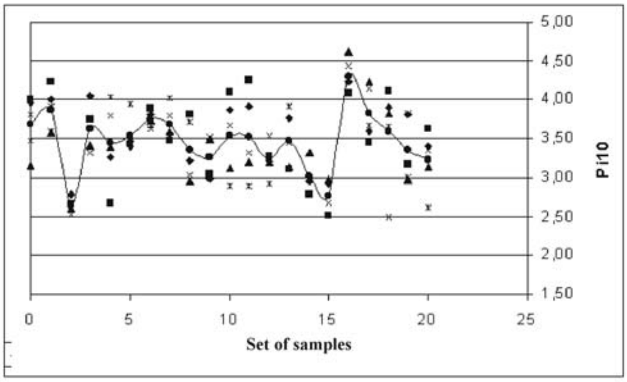

Fig.4.

The same results were obtained with one minute polarization index P_1, line parameters ***a*** and ***b,*** elementary currents amplitudes $I_{mi.}$ Better cases were reached in ten minute polarization index P_{10} in Fig.4 and time constants of stabilization of elementary polarization processes in Fig.5.

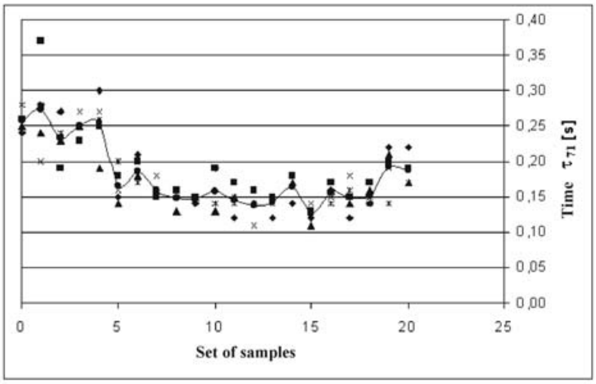

Fig.5.

From 15-th set the change of behavior can be observed. It is probably point of finishing of hardening of material and real ageing starts from this point.

The capacitance and dissipation factor were measured too, but also without reasonable results. Noticeable influences of voltage were observed only in dissipation factor measurements but without correlation of ageing.

Conclusion

The aim of test was to obtain characteristic behavior of nowaday used diagnostic parameters during initial ageing process. First 25% of life-time investigated. Reasonable results were achieved for ten minutes polarization index P_{10} and time constants of stabilization of elementary polarization processes.

The test will continued up to end of the life time of samples

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