



IONIC (GARTON) EFFECTS ON CAPACITOR INSULATION SYSTEMS

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The level of impurities (or foreign particles) within an oil-impregnated capacitor insulation system. The dissipation power factor or the dielectric loss angle, which is a loss component of power when measured in the range of 7-15% of rated voltage, has direct correlation to when compared with the value taken at rated voltage. In other words, the value of dissipation factor at low voltage measurement is a global indication of the quality of the manufacturing process for the capacitors. For the obsolete Kraft Paper Capacitor impregnated with mineral oil, such impurities within the system could lead to thermal instability when the ambient temperature was high since paper is essentially a dipolar material and generates approximately four times the heat as a mixed dielectric system utilizing polypropylene film and paper. Polypropylene is a non-polar material which does not respond to A.C. voltage excitation.

The unique characteristic of a good capacitor synthetic oil is related to its being a good solvent. This property allows for the rapid absorption of hydrogen gas generated during partial discharge. However, the oil tends to also dissolve virtually all surface foreign matter on the capacitor housing and hence this will show up as a mild garton effect. One would expect higher dissipation factor (D.F.) values when measured at lower voltages compared to mineral oil systems but be less concerned about if for the reason explained above. Areva's in-house quality requirements require to have a D.F. of less than 0.35% when measured at 10% rated voltage. The typical D.F. of Areva capacitors (synthetic oil/mixed dielectric) at rated voltage is 0.06%. The expression to calculate the dielectric loss W at voltage V for capacitor of value C is:

$$W = \omega * X * V^2 * 100 * \text{D.F. watts}$$

Where $\omega = 2\pi f_s$ f_s being the system frequency in herz.

E.G. $C = 5000 \text{ pF} = 5000 * 10^{-12}\text{F}$

$$V = 230.000 / \sqrt{3} \text{ V}$$

$$\text{D.F.} = .060\% \quad \text{at the operating temperature}$$

The dielectric loss

$$W = 2\pi * 60 * 5000 * 10^{-12} * \frac{230000^2}{3} * .06/100 = 19.9\text{W}$$

App. 20 W is generated from a capacitor rated for 230 kV system.

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