

Ageing of the Varistors Containing Oxide of Zinc

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Abstract: The varistors are materials which belong to the class of ceramics and which in the beginning was primarily made up of Silicon carbide (SiC), but for a few years one has advantageously used the varistors Containing Zinc Oxides (ZnO); these last are used more and more for the protection of the electric components against overpressures. The varistors used as element of lightning protector on the lines of distribution of energy are subjected in a permanent way to the various types of constraints. We thus propose a study of the ageing of the varistors under the thermal stresses and electric. However, we examined, during the operation of ageing revolution according to the time of three sizes characterizing a varistor: the leakage current, the tension of threshold and the coefficient of linearity.

Keys words: Varistor, ZnO, ageing, temperature, leakage current, threshold voltage

INTRODUCTION

During, the operation of the varistors, like elements of lightning protector on the lines of distribution of energy, they are really subjected to several constraints of fields electric, heat, etc.... Consequently the degradation of their performances according to the time of application of these pressures is inevitable.

We present, first of all the evolutions relating to the parameters (Rousseau, 1992; Chi-Yen Shen, 1993; Laurent and Magaux, 1990) of the varistor according to two tensions of threshold, respectively for three levels different from the temperature. Finally we will analyze the lifespan of the tested sample.

Ageing: During the operation of ageing, we followed the evolution according to the time of three principal sizes characterizing a varistor (Rousseau, 1992): the leakage current, the tension of threshold and the coefficient of nonlinearity under the effect of tensions of constraint in effective values equalize to 0.55 and 0.75 times the tension of threshold.

The results of the tests presented relate to a sample defined by following dimensions: Thickness $e = 8$ mm; $D = 5.4$ cm diameter; surface $S = 22.8$ cm²; surface $S_2 = 11.34$ m² electrodes and the masses before and after cooking are respectively $M_1 = 100$ g and $M_2 = 95$ g.

Variation of the leakage current: Figure 1 shows evolution of the leakage current for an alternative tension

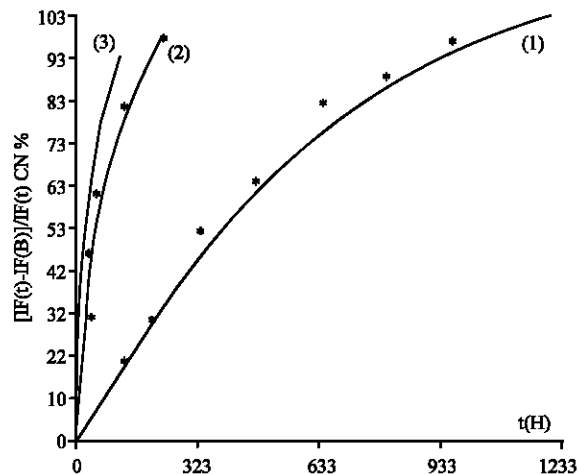


Fig. 1: Evolution of leakage current for $U = 0.55 \cdot U_{eff}$

of threshold of value $0.55 \cdot U_{eff}$ et of frequency 50 Hz at temperatures of 100, 120 and 150°C, respectively curved 1, 2 and 3.

Figure 2 shows the same type of Characteristics under the same constraints of temperatures, but this time, under a tension of threshold of $0.75 \cdot U_{eff}$

$$\Delta I / Y_{ew}$$

For a voltage of threshold given the slope Curves obtained are all the more large as the temperature is higher.

Table 1: The values of these slopes are calculated and consigned

T°C	U
	0.55 Ueff
100	0.16
120	0.144
150	0.06

Count 1.: Slope of the Yew = F (T)

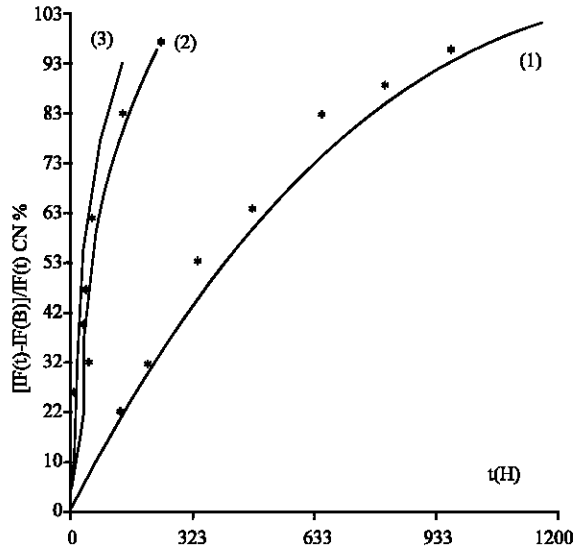


Fig. 2: Evolution of leakage current for: U = 0.75 * Ueff

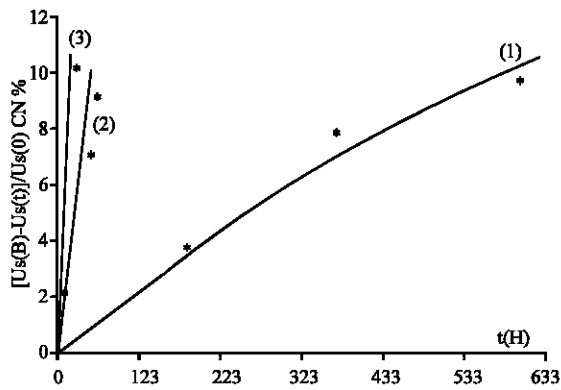


Fig. 3: Evolution of the voltage of threshold U = 0.65*Ueff

$$\Delta I_f / Yew = [Yew(T) - Yew(0)] / Yew(t) \quad (1)$$

Where If (T) represents the leakage current has the moment of measurement (T) and Yew (0) the current at the beginning of ageing show in Table 1.

Variation of the voltage of threshold: Throughout ageing, the voltage of threshold tends to drop. In order to illustrate these variations, we have trace

$$\Delta U_s / Custom = [Custom(0) - Custom(T)] / Custom(0) \quad (2)$$

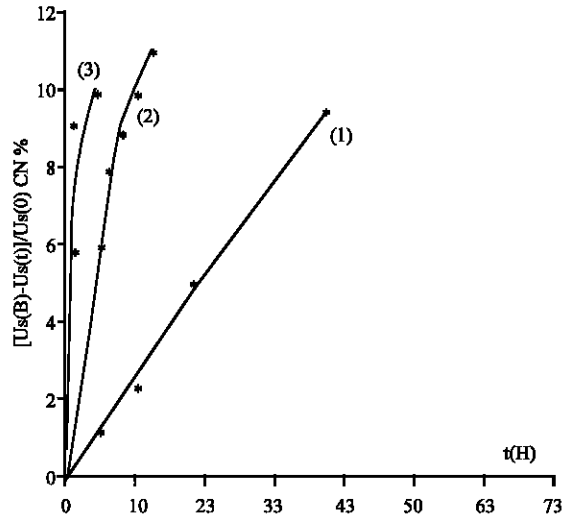


Fig. 4: Evolution of the voltage of threshold U = 0.75 * Ueff

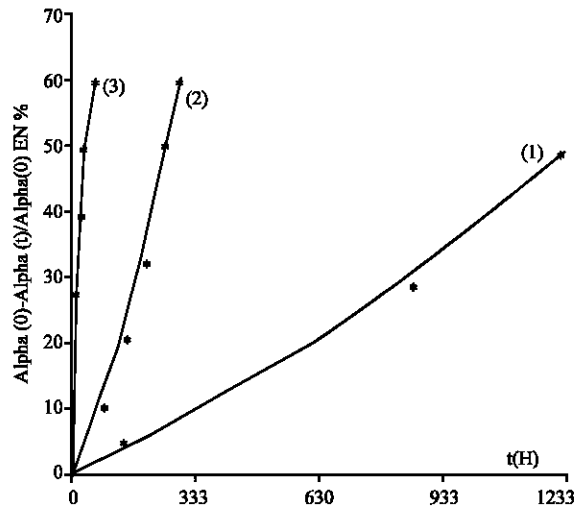


Fig. 5: Evolution of the coefficient of nonlinearity: U = 0.65 * Ueff

Or Custom (T) measurement has the moment (T) and Custom (0) at the initial moment Us (0) = 1800 volts.

One notices a reduction exaggerated in the tension of threshold a chopping of the tension of use and a thermal runaway.

Variation of the coefficient of nonlinearity: The results obtained are shown in (Fig. 3 and 4). The coefficient of nonlinearity defined by $\Delta \alpha (T) / \alpha$, decreases along ageing (Fig. 5 and 6). However, the reduction in A until approximately 70% of its initial value is not awkward in measurement or $\alpha (0)$ is rather important.

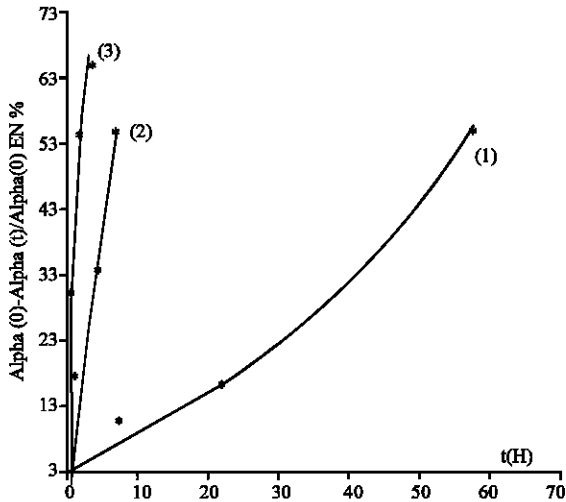


Fig. 6: Evolution of the coefficient of nonlinearity: $U = 0.75 * U_{eff}$

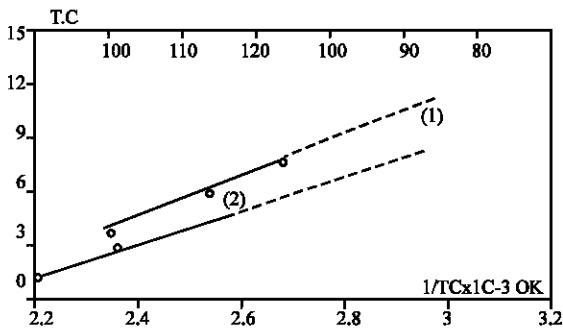


Fig. 7: Lifespan according to temperature

Lifespan: Lifespan of a varistor being time with the end of which the derivative of the tension of threshold defined previously exceeds 10% (Rousseau, 1992; Chi-Yen Shen, 1993). For the layout of its evolution, we use the static model of Arrhenius Dakin (Laurent and Magaurc, 1990). In theory, the lifespan is given by the following relation:

$$FD = A.E^{CT} \tag{3}$$

With

T : Temperature;

A : Constants;

C : Slope of log (FD) = F (1/T)

We present in Fig. 7 the relation Log (FD) according to the reverse of the temperature T [°K].

The both values of slopes 13200 and 9710, respectively for the tensions $0.55 * U_{eff}$ And $0.75 * U_{eff}$. Knowing that actually in practice industrial applications, the temperature of the varistor very seldom exceeds 40-45°C (Levinson and Herbert, 1986), then, if we suppose that the temperature is of 40°C and by using directly the lines of 7, we obtain the values of the lifespan.

Corresponding, are 67 years for a tension of $0.55 * U_{eff}$ and 37 years for a tension of $0.75 * U_{eff}$ these values are obtained by corresponding line prolongation. Up to the value $T = (40+273)°K$.

We read then log (FD) from which we deduced FD.

CONCLUSION

The layout of the evolution of the leakage current, the voltage of threshold and the coefficient of nonlinearity throughout ageing, enabled us to determine the maximum constraint of relative use, the sample studies for the value $0.55 * U_{eff}$, the leakage current remains stable in the course of time. The dissipated power is too weak and insufficient to cause a thermal runaway. Moreover, the derivative of α and U_{eff} remaining weak, this type of varistor preserves consequently all its effectiveness for Over potential protection It Would be appropriate, however, to contribute For Varistors Having other Compositions.

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