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APPLICATION OF THERMAL ANALYSIS TO STUDY THE CAUSES OF DISINTEGRATION IN INSULATING SYSTEMS

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In the procduction of high-voltage insulating systems, disintegration and non-homogeneity occur in some cases and these factors can lead to the deterioration and even the breakdown such systems. In research into the causes of these phenomena DTA and TG were applied to study the course of hardening of the systems and to quantify the leaking substances. The results demonstrate the great value of thermal analysis in this field.

Introduction

The research and verification of new materials necessitate the use of modern methods which provide as much information as possible. A Stanton Redcroft thermoanalytical system was applied for extensive studies on hardening of high-voltage insulating systems, with particular regard to the course of the hardening regime and the leakage of gas products during hardening.

Experimental

Thermal analyses were carried out on the Stanton Redcroft DTA 671 and TG 750 equipment.

The samples used had a diameter of 5 mm, the inner diameter of the analyser test vessel. The standard for DTA was Al_2O_3 annealed at 1000°C. The heating rate was chosen to be 4 deg·min^{-1} with regard to the maximum approach to the conditions in actual process of production of insulating systems.

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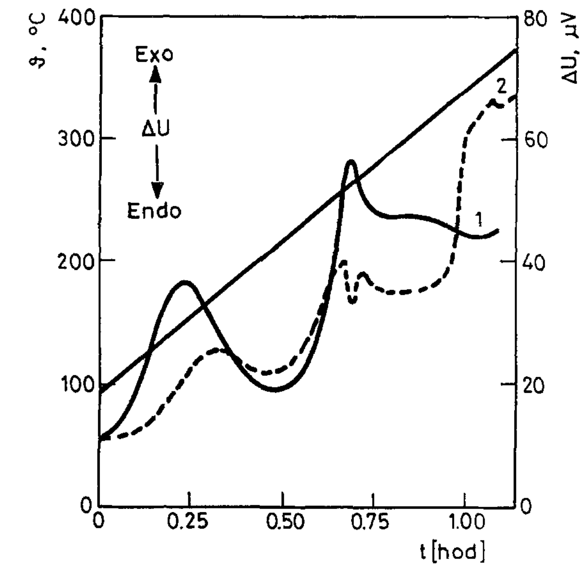

Fig. 1 DTA curves of Relanex [1] and Vulastik [2]

DTA was used to study the hardening processes (Fig. 1) of two chosen systems: Relanex [1] and Vulastik [2] (glass fibre and reconstructed mica bonded by modified epoxide resin; Vulastik has an additional component: polyethyleneterephthalic foil). In both cases it was simple to determine the thermal interval in which hardening occurs, and also the subsequent interval of the thermooxidizing reaction. The endothermic effect (260°C) relating to

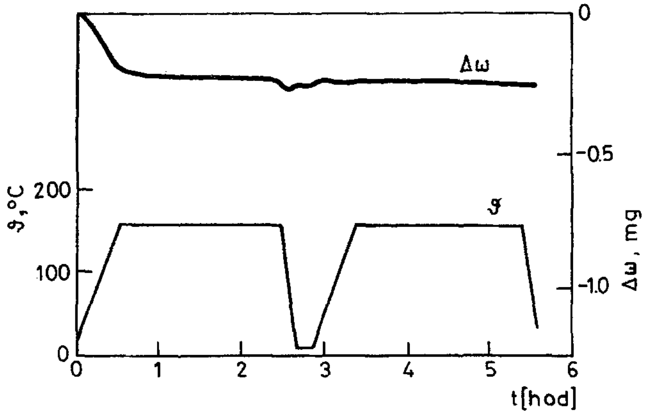

Fig. 2 TG curve of Relanex

thermal disintegration of the polyethyleneterephthalic foil is seen in the curve [2].

Quantification of volatile components

A thermogravimetric record for Relanex is given in Fig. 2. The test regime was chosen so that the sample was stressed in two cycles at 160°C, the length of temperature application to the sample in one cycle being 2 hours. The thermogram reveals that the material undergoes the highest loss in weight from the start up to the test temperature in the first cycle; the second thermal cycle proceeds without change in weight. The overall loss in weight was 0.33%.

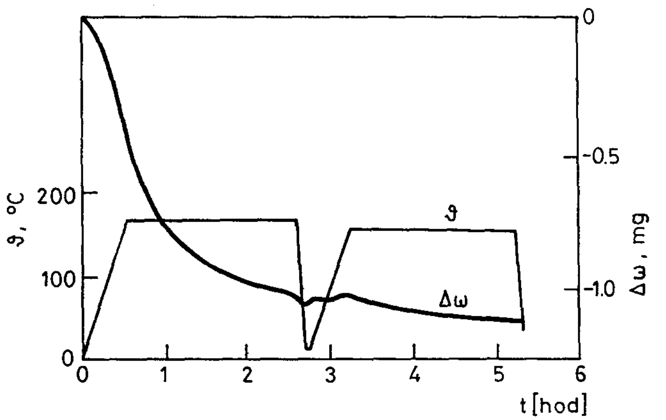

Fig. 3 TG curve of Vulastik

Figure 3 shows a thermogravimetric record for Sklotextit (glass fibre with dianon resin) in the test regime in two cycles at 170°C and 160°C, and in the same interval of temperature application for 2 hours. The thermogram reveals a perceptible loss in weight in both the first and second thermal cycles. The total loss in weight was 1.12%.

Results and discussion

The DTA records of Relanex and Vulastik clearly demonstrate that the hardening reaction starts at 100°C and is practically complete at 165°C for both materials. Since the most intensive loss of volatile components occurs in this interval, as revealed by TG, there is a real danger of their being trapped in the system, especially if the upper layer of the material is heated more quickly due to the technological arrangement.

The DTA records also show that, if the temperature of the system exceeds the starting temperature of the subsequent reactions, degradation occurs immediately. During the technological processing, therefore, this temperature must never be reached. For Relanex it is 24°C, and for Vulastik 220°C. It is also necessary to mention the temperature at which the decay of polyethyleneterephthalic foil in Vulastik occurs.

Conclusions

The volatile components are one of the possible causes of non-homogeneities and disintegration of high-voltage systems. The loss of volatiles during the hardening process lasts up to 165°C; the bonding attains stability up to the temperature of hardening; depending on the means of hardening of the systems, at 100°C there is a possibility that some of the gas products may be trapped in the insulation.

Knowledge gained from thermal analyses may be used in further research aimed at eliminating disintegration in the production of high-voltage systems. Such disintegration causes deterioration of the total insulating system, which must then be replaced. As the material is expensive, this means large economic losses.

It is therefore necessary to gain as much information as possible to prevent these losses. Thermal analysis contributes with valuable objective information and becomes an integral part of electrotechnological diagnostics.