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GB/Z 28820.2-2012

**Long-term radiation ageing in polymers -- Part 2: Procedures
for predicting ageing at low dose rates**

(English Translation)

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Foreword

GB/Z 28820 "polymer long-term radiation aging" consists of three parts.

- Part 1. Monitoring of diffusion-limited oxidation technology;
- Part 2. Prediction of aging programs at low dose rates;
- Part 3. Low voltage cable materials in service monitoring procedures.

This section GB/Z 28820 Part 2.

This section drafted in accordance with GB/T 1.1-2009 given rules.

This section uses the translation method identical with IEC/T S61244-2:1996 "polymer long-term radiation aging Part 2. Prediction of low-dose Rate the aging process. " this part is proposed by China Electrical Equipment Industry Association.

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Introduction

The behavior of polymers under radiation is strongly influenced by the radiation environment, especially in the presence of oxygen. When the polymer when irradiated in an oxygen-containing environment, it is generally observed that the dose of radiation required to achieve a certain degree of degradation varies with dose rate. Although many Years ago, people knew about the effects of this dose rate on radiation aging of polymeric materials, but only enough to influence the process until recent years Solution, and develop forecasting methods. The type of polymer dose rate effect is shown in Figure 1 [1], where DED (equivalent destruction dose) is defined as to the specific damage parameters (such as elongation at break, tensile strength, compression set, etc.) required dose.

Figure 1 shows the more common behavior of most (but not all) polymers. In an inert gas environment, represented by curve 1,

The degradation of the polymer is independent of dose rate beyond the high dose rate range. Curve 1 will connect when the dose rate is low until the effects of thermal aging are dominant Heat aging curves under near-inert conditions. In the double logarithmic graph of Figure 1, heat aging is expressed as a straight line with a slope equal to one.

In the presence of oxygen, the effect of dose rate can be manifested in several processes, such as diffusion-limited oxidation and time-dependent chemical reactions.

Under high dose rate conditions, diffusion-limited oxidation becomes more important (as shown in Figure 1); in this region the DED will increase with dose rate Increase. It should be noted that FIG. 1 is merely a schematic diagram that can only be used to illustrate the types of behavioral characteristics that may occur, especially the diffusion limited area Depending on the type and thickness of the polymer, the oxygen permeability and the sensitivity of the material to the surface properties, the field depends on many factors. Observed Degradation is greatly affected by the thickness of the oxide layer. When the dose rate is high enough, oxidation will take place on very shallow surfaces without affecting most poly the overall performance of the compound. The degradation observed in this case is similar to the degradation observed in inert environment and the DED will be nearly inert Aging line. The maximum allowable dose rate before heterogeneous oxidation can occur can be determined theoretically or using profiling techniques. These programs in this part of a detailed discussion. In the homogeneous oxidation zone, most polymer dose rates have little effect. When the dose rate is reduced, the slope of a DED-dose rate logarithmic curve is typically constant or approximately constant (as shown in curve II in Figure 1) until the dose rate is as low as hot Aging dominated so far. For class II behavioral traits, the slope of the DED-dose rate map is determined by the rate of reaction of the dominant chemical reaction. in case when the reaction rate is relatively high with respect to the initial reaction rate, the slope is small and may be close to 0; and when the reaction rate is low, the slope is larger but still less than one.

For several polymers irradiated in an oxygen-containing environment, more complex dose rate effects are observed in the homogeneous oxidation zone (eg, Curve 1 in Figure 1). A good example of a Class III behavior is PVC, which is generally believed to be due to the formation of intermediate peroxidation Hydrogen sulfide caused by cracking [2-4], see 5.5.

Long-term polymer radiation aging Part 2. Procedures for predicting aging at low dose rates

1 Scope

This part of GB/Z 28820 applies to predict the aging process at low dose rates.

This section presents three methods for extrapolating low dose rate data under normal conditions of use based on high dose rate test data. These parties the law assumes that homogeneous oxidation has been achieved under the experimental conditions. This section applies to all kinds of elastomers, thermoplastic materials and some thermosetting materials.

The methods themselves are constantly improving and perfecting. In order to be able to predict low dose rate conditions, a considerable amount of experimental data is required.

Exponential extrapolation is mainly used for isothermal data, and the superposition method can use the data obtained under a variety of different temperature conditions.

2 Normative references

The following documents for the application of this document is essential. For dated references, only the dated version applies to this article Pieces. For undated references, the latest edition (including all amendments) applies to this document.

GB/T 26168.1-2010 Electrical insulating materials to determine the effects of ionizing radiation - Part 1. Radiation Interactions and Dosimetry Set (IEC 60544-1:1994, IDT) GB/T 26168.2-2010 Electrical insulating materials to determine the impact of ionizing radiation Part 2. Irradiation and test procedures (IEC 60544-2:1991, IDT) GB/T 26168.3-2010 Electrical insulating materials to determine the effects of ionizing radiation - Part 3 Classification of radiation applications System (IEC 60544-4:2003, IDT) GB/Z 28820.1-2012 Long-term radiation aging of polymers - Part 1. Techniques for monitoring diffusion-limited oxidation (IEC/TS61244-1:1993, IDT)

3.1 Introduction

Exponential extrapolation is based on experimental data obtained at different doses of radiation in air or in the presence of oxygen and under isothermal conditions Extrapolation. The upper limit of dose rate is the condition for achieving homogeneous oxidation (see 3.4). The experimental data obtained under different dose rates are used to map Extrapolation of the shape to the end of the working dose rate, the end-point indicator is extrapolated to the working dose rate.

3.2 Test Procedure

According to the existing literature, you can also calculate the thickness of the oxide layer to estimate the maximum dose rate of the experimental material (refer to GB/Z 28820.1-2012). After determining the maximum dose rate, it is also necessary to select at least two (preferably 3) other dose rates, each of which should be at least the previous dose rate was an order of magnitude lower.

The sample type, radiation source, dosimetry and temperature control method should be selected according to the general principles of GB/T 26168.2-2010. Do Oxygen overpressure technique as described with reference to GB/Z 28820.1-2012 may pose a risk of transitional aging of the sample but all irradiation should when in the air or under constant pressure oxygen conditions. The thickness of the test specimen shall be checked using the profiling technique described in GB/Z 28820.1-2012 Oxidation uniformity in the direction. The test report should include details of radiation source, dose rate, atmosphere, temperature, specimen type and thickness.