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CHEMICAL INDUSTRY STANDARD
OF THE PEOPLE'S REPUBLIC OF CHINA

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Replacing HG/T 3087-1986(1997)

**Method of Accelerated Determination for Shelf-Life of
Rubber Static Sealing Parts**

静密封橡胶零件贮存期快速测定方法

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Method of Accelerated Determination for Shelf-Life of Rubber Static Sealing Parts

1 Scope

This Standard is applicable to the determination of rubber static sealing parts in the undeformed and deformed state (radial compression 12%~25%, axial compression 15%~40%), in air and various oil media, and under warehouse storage conditions to keep the storage period of working capacity.

This method is not applicable to easily hydrolysed rubber, such as parts made of silicone rubber, polyurethane, acrylate and epichlorohydrin rubber, which are in contact with air during storage.

The storage period of rubber parts measured according to this method can be used as one of the bases for formulating the storage period of products.

2 Normative References

The following standards contain provisions which, through reference in this Standard, constitute provisions of this Standard. At the time of publication, the editions indicated are valid. All standards are subject to revision. The parties who are using this Standard shall explore the possibility of using the latest version of the following standards.

GB/T 528-1998 Rubber, Vulcanized or Thermoplastic - Determination of Tensile Stress-Strain Properties (eqv ISO 37:1994)

GB/T 1685-1989 Rubber, Vulcanized or Thermoplastic - Determination of Stress Relaxation in Compression (neq ISO 3384:1979)

GB/T 3512-1989 Rubber Hot Air Aging Test Method (neq ISO 188:1985)

GB/T 7759-1996 Rubber, Vulcanized or Thermoplastic - Determination of Compression Set at Ambient Elevated or Low Temperatures (eqv ISO 851:1991)

3 Principle of Method

The main factors that cause performance changes of rubber sealing parts under warehouse storage conditions are heat, oxygen, mechanical stress and oil medium. Within a certain temperature range, the accelerated aging of the oven is the same as

the deterioration mechanism under the warehouse storage conditions. Use the accelerated aging test data of a high temperature oven to extrapolate and calculate the shelf-life under the warehouse temperature.

The aging characteristic index may be used for undeformed rubber parts with elongation at break, and for deformed rubber parts with accumulate compression permanent deformation or compressive stress relaxation.

4 Specimen

4.1 The specimen for determining the elongation at break shall meet the requirements for the specimen in GB/T 528.

4.2 The specimen for determining compression permanent deformation and compression stress relaxation shall meet the requirements for specimen in GB/T 7759 and GB/T 1685.

5 Test Apparatus

5.1 Oven

The oven shall comply with the provisions of GB/T 3512.

5.2 Tensile tester

The tensile tester shall comply with the provisions of GB/T 528.

5.3 Compression stress relaxation meter

The compression stress relaxation meter shall comply with the provisions of GB/T 1685.

6 Test

6.1 Test conditions

6.1.1 Test temperature

6.1.1.1 The number of aging test temperatures shall be five, at least no less than four; and the interval between adjacent temperatures shall be no less than 10K.

6.1.1.2 The upper limit of the test temperature varies with the raw rubber and vulcanization system. Generally, refer to the following data: 363K for natural and neoprene rubber; 383~363K for nitrile-butadiene, styrene-butadiene, butyl and

butadiene rubber; 403~383K for ethylene-propylene rubber.

6.1.1.3 In order to properly select the upper limit of the test temperature, necessary exploratory tests may be done.

6.1.2 Test time

6.1.2.1 The end time of the test varies with different temperatures. For the tests of three higher temperature out of the five temperatures, the performance change must reach the critical value before it can end. For the lowest temperature test, the compression permanent deformation must be no less than 50%; and the stress relaxation and elongation shall be no higher than 50% of the initial value.

6.1.2.2 The number of test data at each test temperature shall be no less than 10. The time interval of each test point may be determined according to the performance change. Generally, the early interval is short and the later interval is long.

6.1.2.3 For the first test point of each test temperature, its performance change shall be no higher than 20% for compression permanent deformation; shall be no lower than 80% of the initial value for stress relaxation; and shall be no lower than 90% of the initial value for elongation.

6.1.3 Test in oil medium

When the sealing parts are stored in oil medium, the specimen shall be subjected to aging test in oil medium. During the test, the aging fixture is placed in a closed container filled with test oil. The volume of this container is 150mm×100mm×80mm. The amount of test oil shall be such that the fixture is completely immersed in the oil; the container is placed in an oven for aging; and the fixture is taken out of the container after the specified time interval is reached. Absorb the oil on the surface of the specimen with filter paper and perform the relevant test. After the test, put it into the container for aging.

6.2 Test procedures

6.2.1 According to GB/T 3512, carry out accelerated aging test in an oven.

6.2.2 The determination of compression stress relaxation shall be carried out according to GB/T 1685. Only the initial stress before aging is, after the fixture is installed, the stress that is measured after being left in a standard laboratory environment for 3d. For the test in oil medium, the fixture is placed in an enclosed container filled with oil, it is the stress that is measured after being stood in a standard laboratory environment for 3d. The stress after aging is measured when the fixture is taken out of the aging box and placed in a standard laboratory environment for 3h. After each measurement, put the fixture into the aging box for the next cycle's aging.

6.2.3 The determination of compression permanent deformation shall be carried out according to GB/T 7759. Only the initial height of the specimen is, installed the fixture, the initial height that is measured by standing in the standard laboratory environment for 1d, then removing the load and standing for another 1d. For test in oil medium, place the fixture in an enclosed container filled with oil, it is the initial height that is measured by standing it in a standard laboratory environment for 1d, then taking out the fixture from the container and removing the load, and then standing for another 1d. The height of the specimen after aging is, after the fixture is taken out of the oven and removes the load, the height that is measured after standing in a standard laboratory environment for 1d. After each measurement, put the specimen back into the fixture and return it to the aging box for the next cycle of aging.

6.2.4 The determination of elongation at break shall be carried out in accordance with GB/T 528. The elongation at break before aging is the average of 10 measurements; and the elongation at break after aging is the average of 5 measurements.

7 Processing of Results

7.1 The relationship between the aging characteristic index y and the aging time τ may be described by the following empirical formula:

$$y = Be^{-K\tau^\alpha} \dots\dots\dots (1)$$

Where:

y - the stress relaxation is the ratio of the stress f at any aging time τ to the initial stress f_0 before aging; the elongation at break is the ratio of the elongation L at any aging time τ and the elongation L_0 before aging; and the compression permanent deformation is 1 minus the compression permanent deformation ε at any aging time τ ;

B – test constant;

K – speed constant, d^{-1} ;

τ – aging time, d;

α – empirical constant.

7.2 The relationship between the speed constant K and the aging temperature T obeys the Arrhenius formula:

$$K = Ae^{-E/KT} \dots\dots\dots (2)$$

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