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**Heat Accumulation Storage Test Method for
Dangerous Goods**

危险品热积累储存试验方法

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Heat Accumulation Storage Test Method for Dangerous Goods

WARNING: this test has a potential explosion hazard, and it shall be ensured that the test equipment has sufficient protection for the test personnel to avoid the catastrophic consequences brought by the explosion.

1 Scope

This Standard specifies the test principles, safety measures, test equipment, test procedures, result evaluation and test report of the heat accumulation storage test for dangerous goods.

This Standard is applicable to the heat accumulation storage test for dangerous goods.

2 Terms and Definitions

The following terms and definitions are applicable to this document.

2.1 Self-accelerating Decomposition Temperature; SADT

Self-accelerating decomposition temperature refers to the lowest ambient temperature, at which, the substance might undergo self-accelerating decomposition in the container used for transportation.

[GB/T 21178-2009, 3.3]

3 Test Principles

In accordance with the Semenov Theory of thermal explosion, the main resistance of heat flow transmission in the thermal runaway system is concentrated on the container wall. Hence, a Dewar flask with a small volume but an extremely large thermal resistance on the container wall is used to simulate the thermal environment, in which, a relatively large volume of dangerous goods undergoes self-accumulating decomposition. It is used to determine the minimum constant ambient temperature, namely, the self-accelerating decomposition temperature, at which, the dangerous goods undergoes self-acceleration decomposition in containers, including medium-sized bulk containers and small tanks below 2 m³. The validity of the test depends on whether the heat loss rate per unit mass of the selected Dewar flask is similar to the heat loss rate per unit mass of the packaging used for the dangerous goods.

materials. For solids, a cork or rubber stopper may be used. Please refer to Appendix A for the Dewar flasks and sealing devices used for low-volatility or medium-volatility liquids and semi-solids. Samples with a high volatility at the test temperature shall be tested in a pressure-resistant metal container equipped with a pressure relief valve. During the test, place the pressure-resistant metal container in the Dewar flask and consider the influence of its thermal capacity.

5.6 Before the test, the heat loss rate per unit mass of the Dewar flask and its sealing device being used shall be determined, as it is shown in Appendix B. The sealing device has a significant influence on the heat loss rate per unit mass of the Dewar flask. To a certain extent, the heat loss rate per unit mass of the Dewar flask may be adjusted by changing the sealing device. In order to obtain the required level of sensitivity, the capacity of the Dewar flask shall not be lower than 0.5 L.

5.7 A Dewar flask with 0.4 L of sample and a heat loss rate per unit mass of 80 mW / (kg • K) ~ 100 mW / (kg • K) can usually represent the heat loss rate per unit mass of 50 kg package. For larger packaging, medium-sized bulk containers or small tanks, a Dewar flask with a larger capacity and a relatively small heat loss rate per unit mass shall be used to represent the heat loss rate per unit mass. For example, a 1 L spherical Dewar flask with a heat loss rate per unit mass of 16 mW / (kg • K) ~ 34 mW / (kg • K) may be used to represent medium-sized bulk containers and small tanks. Please refer to Appendix C for examples of the heat loss rate per unit mass of packaging, medium-sized bulk containers and tanks.

6 Test Procedures

6.1 Set the temperature of the incubator to a pre-determined temperature. Load the sample into the Dewar flask to 80% of its capacity; record the mass of the sample. Solid sample shall be appropriately compacted, so that its density is close to the density of the actual transportation or storage state. Insert the temperature sensor into the center of the sample. Put on the cover of the Dewar flask, then, place it into the incubator. Connect it with the temperature recording system and close the door of the incubator.

6.2 Heat up the sample; continuously measure the temperature of the sample and the incubator. Record the time point when the temperature of the sample reaches 2 °C lower than the temperature of the incubator. Then, continue the test for 7 d. Within 7 d, when the sample temperature rises to at least 6 °C higher than the temperature of the incubator, put an early termination to the test. Record the time for the temperature of the sample to rise from 2 °C lower than the temperature of the incubator to its maximum temperature.

6.3 After the test is completed, if there is a sample residue in the Dewar flask, after it cools down, take it out. Record the percentage of mass loss and determine whether the composition has changed.

Appendix B

(normative)

Test and Calculation of Heat Loss Rate Per Unit Mass of Dewar Flask

By measuring the temperature difference between the contents of the Dewar flask and the surrounding environment that varies with the time, determine the heat loss rate per unit mass of the Dewar flask. For example, for liquids, the container may be filled with dibutyl titanate or dimethyl titanate, then, heated up to about 80 °C. Water shall not be used as the contents. Within a certain temperature range, measure the temperature drop in the center of the contents. This temperature range shall include the predicted self-accelerating decomposition temperature. Continuously measure the temperature of the contents and the surrounding environment. The logarithm of the difference between the temperature of the contents and the ambient temperature, namely, $\ln(T - T_a)$ against the time t , is linearly regressed in accordance with Formula (B.1) to obtain the slope c in Formula (B.1). Then, in accordance with Formula (B.2), obtain the heat loss rate L per unit mass of the Dewar flask:

$$\ln(T - T_a) = c_o + c \times t \quad \dots\dots\dots (B.1)$$

$$L = c \times C_p \quad \dots\dots\dots (B.2)$$

Where,

T ---the temperature of the contents, expressed in (°C);

T_a ---the ambient temperature, expressed in (°C);

c_o ---the natural logarithm of the difference between the initial temperature of the contents and the initial ambient temperature;

c ---the slope of the straight line obtained through linear regression;

t ---time, expressed in (s);

L ---the heat loss rate per unit mass of the Dewar flask, expressed in [W / (kg • K)];

C_p ---the specific heat capacity of the contents, expressed in [J / (kg • K)].

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