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Determination of the Luminous Transmittance and Haze of Transparent Plastics

透明塑料透光率和雾度的测定

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Determination of the Luminous Transmittance and Haze of Transparent Plastics

1 Scope

This Standard stipulates two methods for the determination of luminous transmittance and haze of transparent plastics. Method A is haze meter method. Method B is spectrophotometry.

This Standard is applicable to the determination of luminous transmittance and haze of transparent plastics in plate, sheet and thin-film state.

2 Normative References

Through the reference in this Standard, clauses of the following documents become clauses of this Standard. In terms of references with a specific date, all the subsequent modification sheets (excluding the corrected content) or the revised editions are not applicable to this Standard. However, all parties that reach an agreement in accordance with this Standard are encouraged to explore the possibility of adopting the latest version of these documents. In terms of references without a specific date, the latest version is applicable to this Standard.

GB/T 2918-1998 *Plastics - Standard Atmospheres for Conditioning and Testing* (idt ISO 291:1997)

3 Terms and Definitions

The following terms and definitions are applicable to this Standard.

3.1 Haze

Haze refers to the ratio of scattered light flux (which deviates from the direction of incident light through transmittance on the sample) to transmitted light flux. It shall be expressed in percentage (in terms of this method, scattered light flux which deviates from the direction of incident light by over 2.5° shall merely be used in the calculation of haze).

3.2 Luminous Transmittance

Luminous transmittance refers to the ratio of light flux, which is transmitted on the sample, to light flux, which is cast onto the sample, expressed in percentage.

4 Samples

4.1 Requirements

Samples cannot have defects that would affect material performance or defects that would cause deviations in research.

4.2 Shapes and Dimensions

Sample dimensions shall be sufficiently large to cover the entrance window of integrating sphere. It is recommended that sample shall be circular pieces with the diameter of 50 mm, or, 50 mm × 50 mm square pieces.

4.3 Sample Inspection

Both sides of surface shall be flat and parallel. There shall be no dust, oil stain, foreign matters or scratches; or visible internal defects and granules. except when it is requested to test the influence of these defects on haze.

4.4 Sample Quantity

When there are no special requirements, there shall be 3 samples in each group.

5 State Conditioning

Under the temperature of $23\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ and the relative humidity of $50\% \pm 10\%$, in accordance with GB/T 2918-1989, conduct state conditioning for not less than 40 h, then, proceed with the test. Under special circumstances, in accordance with material instructions, or conditions negotiated and determined by the demand-side and the supply-side, conduct state conditioning.

6 Test Environment

Test shall be conducted in the same environment as sample state conditioning.

7 Test Methods

7.1 Method A: Haze Meter Method

7.1.1 Instrument

The geometric performance and optical performance of the instrument shall comply with the requirements in this Part. The principle of the instrument is shown in Figure 1.

Beams illuminated on sample shall basically be unidirectional parallel light. Any ray of light cannot be over 3° deviated from the optical axis. In any window area of the sphere, beams cannot generate halo.

When sample is placed in the entrance window of the integrating sphere, the angle between the vertical line of the sample, and the line of centers of the entrance window and the exit window shall not be more than 8° .

When a beam is not blocked by sample, it is approximate to a circle with distinct boundaries on the cross section of the exit window; the center of the beam and the center of the exit window are consistent. The angle corresponding with the center of the entrance window and the exit window constitute a $1.3^\circ \pm 0.1^\circ$ belt to the center of the entrance window.

Inspect whether the diameter of the unblocked beam and the central position of the exit window maintain constant, especially after there are changes in the aperture and focal length of the light source.

NOTE 1: in terms of haze degree, 0.1° belt deviation is equivalent to $\pm 0.6\%$ of uncertainty. This is related with the evaluation of accuracy and deviation of this method.

d) Reflective surface

The internal surface, baffle and standard reflector of the integrating sphere shall have basically identical reflectivity and unsmooth surfaces. In the whole visible light wavelength zone, they shall have a high reflectivity.

e) Light trap

When sample does not exist, light trap shall be able to completely absorb the light, otherwise, the design of light trap is unnecessary to the instrument.

f) Instrument calibration

Use standard haze plate to calibrate the instrument.

7.1.2 Test procedures

7.1.2.1 Sample dimensions

Measure the thickness of the sample. When thickness is less than 0.1 mm, the measurement shall at least be accurate to 0.001 mm. When thickness is more than 0.1 mm, the measurement shall at least be accurate to 0.01 mm.

7.1.2.2 Read data

Adjust the zero rotary knob of the haze meter, so that when the integrating sphere is

Figure 2 -- Sketch Map of Spectrophotometer Scattering

The spectral characteristics of the light source of the instrument shall comply with the tristimulus values of the color specification system released by International Commission on Illumination (CIE) in 1931; color coordinates of light source C or light source A in CIE standard.

This instrument uses integrating sphere as a measurement system. The sample stays close to the window of the integrating sphere. The internal surface, baffle and standard reflector of the integrating sphere shall have unsmooth internal surfaces and basically identical reflectivity. Within the whole visible light wavelength range, they shall have a high reflectivity.

Two geometric conditions may be adopted: non-vertical illumination with diffused reception and diffused illumination with non-vertical reception. Instrument which adopts diffused illumination with non-vertical reception shall comply with the following requirements:

a) Integrating sphere

Use integrating sphere to illuminate the diffusing sample. As long as the total area of the window does not exceed 4.0% of reflected surface area in the integrating sphere, any diameter of sphere is applicable. The center of the light trap window of the sample and the sphere shall be on the same maximum circumference of the sphere; the angle constituted by their center and the center of the sphere shall be not less than 170° . The angle constituted by the light trap window and the center of the sample window along the beam direction shall be within 8° . When light trap is in the work location and there is no sample, the axis of the incident beam shall pass through the sample and the center of the light trap window.

b) Condenser lens

Along the axis of the unidirectional beam, observe the sample. Any ray of light cannot be over 3° deviated from the optical axis. In any window area of the sphere, beams cannot generate halo.

When sample is in place, the angle between the normal of the sample, and the central connection of the sample and the light trap window shall not exceed 8° .

When sample is not in place, in the exit window area, the beam zone shall be approximate to a circle with distinct boundaries; the center of the beam and the center of the light trap window shall be consistent. The angle corresponding with the center of the sample window and the light trap window constitute a $1.3^\circ \pm 0.1^\circ$ belt to the center of the sample window.

c) Light trap

Appendix A

(informative)

Derivation of Haze Calculation Formula

A.1 Haze formula shall be derived through the following two steps.

A.1.1 Luminous transmittance

Luminous transmittance, which is expressed in percentage, shall be calculated in accordance with Formula (A.1):

$$T_t = \frac{T_2}{T_1} \times 100 \quad \text{.....(A.1)}$$

Where,

T_t ---luminous transmittance;

T_2 ---total transmitted light flux through the sample;

T_1 ---incident light flux.

A.1.2 When T_3 ---scattered light flux of the instrument is zero, scattered luminous transmittance, which is expressed in percentage, shall be calculated in accordance with Formula (A.2):

$$T_d = \frac{T_4}{T_1} \times 100 \quad \text{.....(A.2)}$$

Where,

T_d ---scattered luminous transmittance;

T_4 ---scattered light flux of the instrument and the sample;

T_1 ---incident light flux.

A.1.3 When T_3 ---scattered light flux of the instrument is larger than zero, the total scattered light flux T_4 is larger than the scattered light flux of the sample. This part of scattered light flux of the instrument is proportional to T_3 and equals to T_3 times of T_2/T_1 . Therefore, the modified scattered light flux of the sample--- T'_4 shall be calculated in accordance with Formula (A.3):

$$T'_4 = T_4 - T_3 \frac{T_2}{T_1} \quad \text{.....(A.3)}$$

Where,

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