Australian Standard®

Combustion characteristics of plastics

Method 1: Determination of flame propagation—Surface ignition of vertically oriented specimens of cellular plastics

PREFACE

This Standard was prepared by the Standards Australia Committee on Fire Tests for Plastics under the authority of the Multitechnics Standards Policy Board, to revise AS 2122.1—1978, *Combustion propagation characteristics of plastics,* Part 1: *Determination of flame propagation following surface ignition of vertically oriented specimens of cellular plastics*. In this revision, the Standard has been reformatted, the test specimen size has been changed, tolerances on the gas and air line pressures are added, a maximum airflow of 0.2 m/s through the test hood is specified and the burner arrangement (Figure 2) has been redrawn. Other Standards in the AS 2122 series dealing with combustion characteristics of plastics are:

AS
2122 Combustion characteristics of plastics
2122.2 Method 2: Determination of minimum oxygen concentration for flame propagation following top surface ignition of vertically oriented specimens
2122.3 Method 3: Determination of smoke-release—Cellular polyurethanes and polyisocyanurates

The terms ‘normative’ and ‘informative’ have been used in this Standard to define the application of the appendix to which they apply. A ‘normative’ appendix is an integral part of a Standard, whereas an ‘informative’ appendix is only for information and guidance.

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APPENDICES

FOREWORD

In the preparation of this Australian Standard, ISO 1210—1992, *Plastics—Determination of the burning behaviour of horizontal and vertical specimens in contact with a small-flame ignition source*, and ISO 3582—1978, *Cellular plastic and rubber material—Laboratory method of test to assess horizontal burning characteristics when subjected to a small flame*, were considered, and other tests which use horizontal specimen orientation were investigated. Experience has shown that test methods using horizontal specimen orientation are not acceptable because—

(a) the low heat return to the specimen of horizontal orientation leads to benign conditions;

(b) materials which melt often retreat from the ignition source;

(c) the tests tend to be 'go' or 'no go' tests, with little or no ability to discriminate between the performance of retarded grades.

This test, which uses vertically oriented specimens, has been found useful in the quality control of materials, particularly in relation to the proof of the incorporation of flame retardants in the materials. It has also been found useful in the research and development area. Guidance on the manner in which the results of this test method may be applied is given in Appendix A.

The combustion propagation characteristics of a material are complex and a series of tests would be required to specify all combustion characteristics of a material (e.g. ignitability, flame propagation, heat release, smoke release, toxicity, and dripping behaviour). This test may be used to compare aspects of this particular combustion propagation characteristic in a series of plastics materials.

It must be stressed that this combustion characteristics test will not indicate the fire hazard of a material in actual use. It is the manner in which the material is installed and the modification and fabrication which it undergoes in the production of the final product which determine the fire hazard of the material. This test may be used to specify a combustion propagation characteristic of a raw material in a product Standard.

METHOD

1 SCOPE This Standard describes the method of test for determining flame duration and material consumed for small, vertically oriented specimens of cellular plastics of density less than 100 kg/m^3, when exposed to a small flame.

NOTE: Guidance on the manner in which the results of this method may be applied is given in Appendix A.

2 REFERENCED DOCUMENTS The following documents are referred to in this Standard:

AS	
1327	Standard environments for conditioning and testing plastics materials
1886	Glossary of terms relating to plastics
2484	Fire—Glossary of terms
2484.1	Part 1: Fire tests
2744	Fire test standards—Preparation, application and format
ASTM	
D3014	Flame height time of burning, and loss of weight of rigid thermoset cellular plastics in a vertical position
ISO	
845	Cellular plastics and rubbers—Determination of apparent (bulk) density

3 DEFINITIONS For the purposes of this Standard the definitions of AS 1886 and AS 2484.1 apply.

4 PRINCIPLE The test specimen is positioned in a vertical orientation in a test chimney and ignited by a burner operating for a set time interval. The mass or volume of the residue and the time elapsed until flaming combustion ceases is recorded for the particular material being tested.

5 APPLICATION TO FIRE HAZARD ASSESSMENT

5.1 General On their own, these test results do not indicate the fire hazard of the material or product under actual fire conditions and consequently should not be applied to the assessment of fire hazard without taking into account additional supportive information.

5.2 Application of test results This test may be used to determine the flame propagation characteristics of various cellular materials. However, it must be stressed that this test will not indicate the fire hazard of a material in actual use. It is the manner in which the material is used and modified during fabrication which determines the fire hazard of the final product. This test may be used to specify the flame propagation in a raw material in a product standard.

5.3 References This method is based on the 'Butler Chimney Test' as the result of work carried out by CSIRO, Division of Building, Construction and Engineering. It has some features, such as chimney and one holder, in common with ASTM D3014 which is also based upon the Butler Test. Information on the development of this method may be found in CSIRO, Division of Building Research Special Report 1977, by G C Ramsay and N A McArthur, *Combustion Characteristics Tests for Cellular Plastics*, Part 2. See also AS 2744 for background information on fire test.

6 APPARATUS AND REAGENTS

6.1 Apparatus*—consisting of the following significant items:

(a) *Test chimney*—conforming to the dimensions in Figure 1, fabricated from galvanized steel of 1 mm thickness.

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* Information on the availability of apparatus described above, working drawings and a suitable manufacturer able to construct such apparatus may be obtained from CSIRO, Division of Building, Construction and Engineering, Graham Road, Highett, Victoria 3190.

(b) *Bunsen burner*—approximately 100 mm barrel length and 9 mm barrel ID modified as in Figure 2.

NOTE: Analite No. T203 is a suitable burner.

(c) *Ignition controller*—consisting of—

(i) a remotely-triggered spark igniter;

(ii) a timer capable of actuating a solenoid valve after intervals of 2 ±0.1 s, 5 ±0.1 s and 10 ±0.2 s (a photographic exposure timer has been found to be adequate);

(iii) a gas flow control unit capable of supplying air and gas at specified pressures to the burner for intervals controlled by the timer. Such a unit may include regulators, manometers and solenoid valves. The solenoid valves are mounted sufficiently close to the burner so that the flame is extinguished immediately the valves are closed.

NOTES:

1 The ignition controller should be so arranged that actuation of the air and gas solenoid valves triggers the igniter, and so that upon ignition of the gas/air mixture manual disengagement of the igniter initiates the timer. The solenoid valves should be closed by the timer after the set time. Provision should be made to allow operation of the timer and solenoid valves with the igniter circuit switched off.

2 If measuring devices other than open arm manometers are used to measure gas and air inlet pressures, such devices should be calibrated at appropriate intervals.

(d) *Specimen holders*—as detailed in Figure 3.

(e) *Aluminium foil*—approximately 0.02 mm thick.

(f) *Stopwatch*—capable of measuring to an accuracy of 0.1 s.

(g) *Balance*—capable of weighing to an accuracy of 0.01 g.

(h) *Test chamber*—comprising a draught-free laboratory hood of capacity sufficient to contain products of combustion of an individual test. The airflow in the hood should be no greater than 0.2 m/s during the test.

NOTE: Some hoods will require damping of their vents during the actual test.

(i) *Displacement cylinder*—a 250 mL measuring cylinder with a side arm attached about 50 mm below the top.

6.2 Reagents—propane gas (at least 95 percent purity) and compressed air supply for burner.

7 TEST SPECIMENS Test specimens shall be 255 × 20 × 20 ±1 mm, cut from a sample of material of uniform density. The specimens shall be cleaned of all dust and the cut edge shall be smooth.

For thermoplastics, at least 20 specimens are required; for thermosets, at least 10 specimens are required.

Unless otherwise specified, all test specimens shall be conditioned in accordance with AS 1327 at 23 ±2°C and 50 ±5 percent relative humidity for a minimum period of 24 h and shall only be moved to the testing location immediately prior to testing.

8 TEST PROCEDURE AND CALCULATIONS

8.1 Thermoplastics (Method A)

8.1.1 *Procedure* For Method A the procedure shall be as follows:

(a) Determine the density of each specimen by the method in Appendix B. If the density of any specimen varies by more than 5 percent from the average density for all specimens, discard that specimen and replace it by a specimen conforming to the density requirement. Record the volume of the retained specimens as V mL.

(b) Line the back and sides of the chimney with aluminium foil, with the more highly reflective surface facing the specimen. Replace the lining after every use.

(c) Locate the burner in position 1 (see Figure 4), 25 mm from the back of the test chimney and at an angle of 20 degrees from the vertical.

(d) Let the air/gas mixture run through the burner without ignition for a period of time sufficient to adjust the gas pressures to 1225 ±30 Pa (125 ±3 mm H_2O) and the air line pressure to 1910 ±50 Pa (195 ±5 mm H_2O). Check the pressures for compliance with these requirements before testing specimens of a new sample.

(e) Set a 5 s interval on the ignition controller.

(f) Determine the volume V_h mL of holder A by immersion in the displacement cylinder and then dry the holder.

(g) Cover the front surface of holder A with thin aluminium foil, with the more highly reflective surface facing outwards. Use new foil for each test. Provided that the foil is in intimate contact with the holder, the contribution of the foil to the volume measurements may be neglected.

(h) Impale a specimen on holder A in such a way that the bottom of the specimen is in line with the bottom of the holder and there is no gap between the specimen and the holder.

(i) Attach the loaded specimen holder to the back of the chimney, and position it centrally, ensuring that the specimen is 25 mm above the level of the burner barrel (see Figure 4).

(j) Ensure that the airflow through the hood is no greater than 0.2 m/s.

(k) Ignite the burner and simultaneously start the stopwatch.

(l) Stop the stopwatch when flaming combustion ceases, and record the elapsed time t_e to the nearest 0.1 s. The formation of any flaming drops should also be recorded.

(m) On completion of the test, immediately turn on the exhaust fan to remove products of combustion, which in some cases may be toxic.

(n) Allow the apparatus to cool to ambient temperature. Clean holder A and repeat the procedure from Step (g) on a further nine specimens.

(o) Set the ignition controller to 2 s and then repeat Steps (g) to (n), omitting the determination of the elapsed time t_e, on the remaining ten specimens. After each test determine and record the volume of the holder and residue V_t mL.

8.1.2 *Calculations*

(a) The data for elapsed times shall be treated in the following manner:

(i) Calculate flame duration to the nearest 0.1 s as follows:

$$t_d = (t_e - 5) \quad \ldots 8.1.2(1)$$

where

t_d = flame duration, in seconds

t_e = elapsed time, in seconds.

If flaming combustion ceased before the interval set on the ignition controller elapsed the flame duration shall be taken as 0 s.