

Australian Standard[®]

AS 1774.11—2005

Refractories and refractory materials—Physical test methods

Method 11: Determination of thermal expansion

PREFACE

This Standard was prepared by the Standards Australia Committee MN-007, Refractories and Refractory Materials, to supersede AS 1774.11—1996.

This Standard incorporates Amendment No. 1 (August 2007). The changes required by the Amendment are indicated in the text by a marginal bar and amendment number against the clause, note, table, figure or part thereof affected.

The content of this Standard arises from an examination of the commercially available apparatus most commonly used in the industry or of apparatus derived from this. Sample sizes, in particular, are considered to be of an order amenable to this test in terms of minimizing test times and optimizing the rate of heat distribution and stabilization throughout the specimen.

The previous edition has been editorially updated and confirms the method for determining the linear change of a refractory caused by temperature change.

This test determines the total thermal expansion for a test specimen as well as the reversible thermal expansion, as appropriate.

The objective of this Standard is to provide those responsible for the testing of refractories with standardized procedures for measuring the linear change with temperature.

The term ‘normative’ has been used in this Standard to define the application of the appendix to which it applies. A ‘normative’ appendix is an integral part of a Standard.

METHOD

1 SCOPE

This Standard sets out a method for the determination of the linear change of a refractory caused by a change in temperature.

This method is intended to determine the expansion characteristics of refractories up to specified temperatures, and to ascertain the reversibility of these characteristics. It may also be used to determine the expansion/contraction characteristics of raw materials and refractories that do not exhibit reversible linear changes with increasing temperature.

NOTE: The maximum temperature at which the test may be conducted is governed by the materials of manufacture of the test apparatus. For example, when fused silica tubes/rods are used, the maximum temperature should not exceed 1000°C.

2 REFERENCED DOCUMENTS

The following documents are referred to in this Standard:

AS

1774	Refractories and refractory materials—Physical test methods
1774.4.1	Method 4.1: Preparation of test pieces—By casting
1774.4.4	Method 4.4: Preparation of test pieces—Mouldable refractories
1774.4.5	Method 4.5: Preparation of test pieces—Gunning refractories
1774.30	Method 30: Drying and firing schedules
2243	Safety in laboratories (series)
2780	Refractories and refractory materials—Glossary of terms

3 DEFINITIONS

For the purpose of this Standard, the definitions given in AS 2780 and those below apply.

3.1 Reversible thermal expansion

The change in linear dimensions that occurs during the cooling of a specimen.

3.2 Test zone

The zone within the furnace where the test specimen is located during the test and whose temperature is controllable over the range specified for this test.

4 PRINCIPLE

A test specimen of predetermined length is heated to a specified schedule while the linear change is recorded continuously or at regular short intervals. The thermal expansion is then calculated.

5 SAFETY

For information on laboratory safety, reference should be made to the relevant parts of AS 2243.

6 APPARATUS

6.1 Main apparatus

6.1.1 General description (refer to Figures 1 and 2)

The main apparatus shall consist essentially of a furnace, a support for the test specimen, a differential measuring assembly, and thermocouple(s) to measure and control the temperature of the specimen.

The furnace, sample support and differential measuring assembly shall be arranged so that the test specimen is located in the test zone. This is generally achieved by mounting the furnace and the specimen support (with the associated differential measuring assembly) on guiderails or sliding rods fixed to the baseplate.

NOTE: Attention is drawn to the fact that all aspects of the apparatus described in this Standard and illustrated in Figures 1 and 2 are not mandatory. Any apparatus may be used, provided that its essential details comply with those specified in this Standard.

6.1.2 Furnace

The furnace shall be of the vertical type (see Figure 1) or of the horizontal type (see Figure 2) and shall essentially consist of a tube heated externally and capable of raising the temperature of the test specimen at the specified rate. The test zone shall be of a length at least 25 mm longer than the test specimen and the temperature within the test zone shall be uniform throughout to $\pm 5^{\circ}\text{C}$ of that indicated by the thermocouple/recorder system specified in Clauses 6.1.4 and 6.1.5.

6.1.3 Differential measuring assembly

The measuring assembly shall consist of the following:

- (a) *Outer tube* A tube made of any material whose expansion characteristics are well established up to the specified temperatures and for which certified reference material as described in Paragraph A2 is available, e.g. fused silica or recrystallized alumina. The tube is located inside the furnace tube (see Figure 1) and is of a diameter appropriate to the size of the furnace tube and the specimen. It shall be closed at the furnace end but a section shall be cut out to accommodate the specimen as illustrated in Figures 1 and 2.
- (b) *Inner tube* A tube or rod of the same material as used for the outer tube and whose external diameter is close to the internal diameter of the outer tube but allows free movement of one relative to the other.
- (c) *Parting discs (if necessary)* Where reaction is considered likely to occur between the test specimen and the inner or outer tube, inert parting discs of a suitable refractory material or platinum-rhodium foil of approximately 0.03 mm thickness, shall be inserted between the specimen and the tubes.
- (d) *Measuring device* An appropriate measuring device which shall be attached to the outer tube to measure the differential movement between inner and outer tubes during the test. The instrument shall be capable of measuring a linear change to ± 0.002 mm.

6.1.4 Recording thermocouple(s)

The thermocouple(s) shall be calibrated and shall be $\pm 5^{\circ}\text{C}$ over the required temperature range.

The recording thermocouple(s) shall be so placed that the hot junction is as near as practical to the specimen midway between the end faces whilst the specimen is in the test zone of the furnace. Figures 1 and 2 show suitable positions for the recording thermocouple(s).

NOTES:

- 1 Precautions should be taken to prevent the introduction of errors into the thermocouple(s) by stray emfs.
- 2 It is recommended that the thermocouple junction be suitably protected to prevent 'poisoning'.

6.1.5 Recorder

An instrument capable of recording to $\pm 5^{\circ}\text{C}$ the temperatures sensed by the thermocouple(s) either continuously or at regular short intervals.

6.2 Ancillary apparatus

6.2.1 Drying oven

A fan forced ventilated oven capable of maintaining a temperature of $110 \pm 5^{\circ}\text{C}$.

6.2.2 Linear measuring equipment

Any convenient instrument capable of measuring to an accuracy of 0.05 mm the initial and final dimensions of a test specimen.

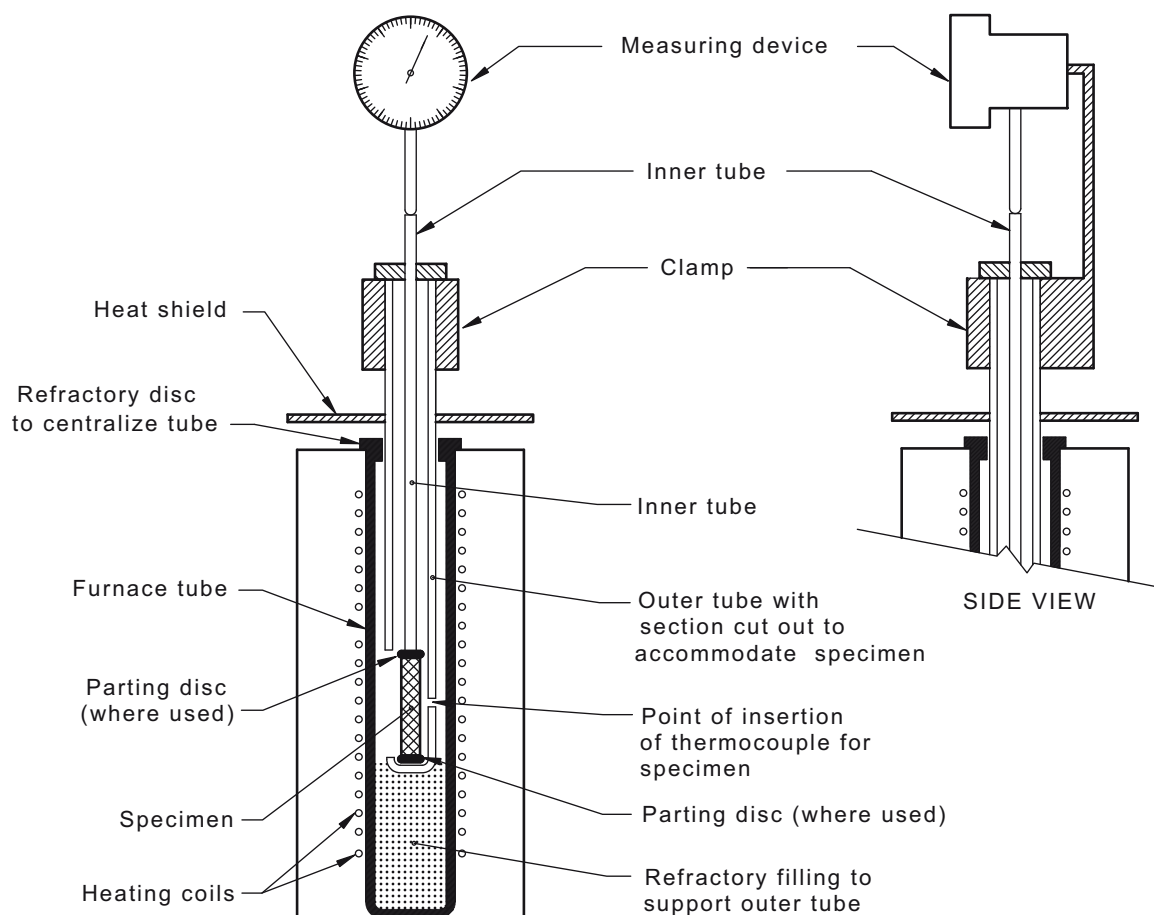


FIGURE 1 SECTIONAL VIEW OF A SUITABLE ARRANGEMENT FOR MEASURING THERMAL EXPANSION USING A VERTICAL FURNACE

7 SAMPLE PREPARATION

Where castables, mouldables, ramming materials or other unshaped refractories are to be tested, samples shall be prepared in accordance with AS 1774.4.1, AS 1774.4.4 or AS 1774.4.5.

NOTE: Unless otherwise specified, the test temperature should not exceed the firing temperature.

8 TEST SPECIMEN

The test specimen shall be prepared as follows:

- Record the relationship of the long/principal axis to the direction of forming of the refractory shape, if known. Cut the test specimen from the sample (e.g. brick or shape) to either a cylinder or right rectangular prism that can be accommodated by the available apparatus.

NOTE: It is recommended that with materials containing coarse particles, the diameter of the specimen be not less than twice the diameter of the largest particle.

- The end-faces of the test specimen shall be flat and parallel to each other.
- All surfaces shall be free from visible defects that may affect the results.