Australian Standard®

Refractories and refractory materials—Physical test methods

Method 14: Thermal conductivity

PREFACE

This Standard was prepared by the Standards Australia Committee on Refractories and Refractory Materials, to supersede AS R31.14—1966, *Methods for the physical testing of refractories and refractory materials*, Method 14: *The determination of thermal conductivity of insulating firebricks.*

In addition to the water-calorimeter method of AS R31.14, the Standard now contains a hot-wire method which is technically equivalent to the method given in ISO 8894-2, *Refractory materials—Determination of thermal conductivity*, Part 2: *Hot-wire method (parallel)*.

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METHOD

1 SCOPE This Standard describes a water-calorimeter method and a parallel hot wire method for determining the thermal conductivity of refractories.

The hot-wire method is applicable at temperatures up to and including 1600°C and to materials having a thermal conductivity lower than 25 W/(m.K) and a thermal diffusivity lower than 10^{-6} m^2/s. Electrically conducting materials are excluded.

The water-calorimeter method is designed for refractories having a conductivity of not more than 30 W/(m.K).

The parallel hot-wire method is a dynamic measuring procedure based on the measurement of the temperature increase at a certain location at a specified distance from a linear heat source embedded in a test piece.

This Standard is not applicable to refractories consisting predominantly of fibres.

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

AS
1618 Preferred sizes for refractory bricks

2497 Sampling procedures for acceptance testing of shaped refractory products

2780 Refractories and refractory materials—Glossary of terms

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

3.1 Thermal diffusivity, α—thermal conductivity divided by heat capacity per unit volume.

4 WATER-CALORIMETER METHOD

4.1 Principle A test panel of six standard bricks is heated at a continuous rate on one side and simultaneously cooled on the opposite side. Two thermocouples measure the temperature on the hot and cold sides of the test panel. A water calorimeter is used to measure the flux.

4.2 Apparatus The apparatus is shown diagrammatically in Figure 1 and shall consist of the following:

(a) *Heating chamber*—an electrically-heated chamber capable of operating over a temperature range of 205 ± 2°C to 1550 ± 2°C or ± 0.5 percent of the furnace temperature, whichever is the greater. A silicon carbide slab, measuring 345 mm × 230 mm × 25 mm with the 345 mm × 230 mm faces plane and parallel, shall be capable of being placed above the test specimen to provide uniform heat distribution. A layer of high-temperature insulation, 25 mm thick, shall be placed below the calorimeter and guard plates. The atmosphere shall be either neutral or oxidizing.

(b) *Calorimeter assembly*—a copper calorimeter assembly, of the design shown in Figure 2, for measuring the quantity of heat flowing through the test specimen. The water circulation is such that adjacent passages contain incoming and outgoing streams of water.

The calorimeter shall be 75 mm square and shall have one inlet and one outlet water connection. The inner guard surrounding the calorimeter shall be 345 mm × 230 mm and shall have two inlet and two outlet water connections. The outer guard shall extend 50 mm laterally from the inner guard and shall extend vertically to the member comprising the bottom of the heating chamber (see Figure 3). The separation between the calorimeter and the inner guard shall be 0.8 mm.

(c) *Water-circulating system*—a water-circulating system for supplying the calorimeter assembly with water at a constant inlet pressure equivalent to at least 30 kPa of hydrostatic pressure and at a temperature that is not changing at a rate greater than 0.5°C/h. The inlet water temperature shall at all times be within +2°C or – 1 °C of the room temperature. The regulating valves for controlling the rate of water flow through the calorimeter shall maintain a constant rate of flow ± 1 percent during the test period.

(d) *Instruments for measuring specimen temperature*—calibrated thermocouples embedded in the test specimen, for measuring the temperature. Chromel-alumel thermocouples shall be used for temperatures below 760°C, and platinum v. platinum-rhodium thermocouples for higher temperatures. 28 S.W.G wire shall be used in making the thermocouples. The e.m.f. for the temperature readings shall be taken with a potentiometer having an instrument error of not more than 0.05 mV. The cold junctions of the thermocouples shall be immersed in a mixture of ice and water.

(e) *Instrument for measuring temperature rise in calorimeter water*—a multiple-differential thermocouple for measuring within an accuracy of not less than 1 percent the temperature of the water flowing through the calorimeter. The thermocouple shall be immersed at least 90 mm in the inlet and outlet connections and the junctions shall not be more than 6 mm from the bottom of the calorimeter. A calibrated differential 10 × copper-constantan thermocouple shall be used and the millivolt readings taken with a potentiometer having an instrument error of not more than ± 0.01 mV in the range of 0 mV to 2 mV.