



Standard Test Method of Measuring the Thermal Expansion and Creep of Refractories Under Load¹

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1. Scope

1.1 This test method covers the procedure for measuring the linear change of refractory specimens that are subjected to compressive stress while being heated and while being held at elevated temperatures.

1.2 This test method does not apply to materials whose strength depends on pitch or carbonaceous bonds unless appropriate atmospheric control is used (see 7.3).

1.3 The values stated in inch-pound units are to be regarded as the standard. The values in parentheses are provided for information only.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 ASTM Standards:

E 691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method²

3. Terminology

3.1 Definitions of Terms Specific to This Standard:

3.1.1 *maximum dilation*—the percent expansion where the thermal-expansion rate equals the creep-deformation rate. It can be used in estimating thermal-expansion relief when used in conjunction with the temperature at maximum dilation.

3.1.2 *temperature at maximum dilation*—in addition to estimating thermal-expansion relief, it can be used to rank products in terms of relative refractoriness. In general, the higher the temperature at maximum dilation, the more refractory the product and the better it is able to resist deformation at elevated temperatures.

3.1.3 *20 to 50 h creep*—the percent deformation between the 20 and 50 h can be used to rank products in terms of relative load bearing capacity at a particular temperature. Relative rankings of various products may differ at different temperatures.

4. Summary of Test Method

4.1 Test specimens sawed from samples of refractory brick or from prefabricated samples of monolithic refractories are placed in a furnace and subjected to a prescribed compressive stress. Sensors are positioned for continuously measuring the linear change of the specimens parallel to the direction of the compressive stress. The temperature and linear change of the specimens are continuously recorded while heating the furnace at a controlled rate for thermal expansion under load testing. The time and linear change of the specimens are also continuously recorded while at soak temperature for 20 to 50 h of creep testing.

4.2 The user should be aware that other mechanisms, besides those related to creep, may be activated. This is especially true as temperatures approach 1650°C. When other material responses are activated, such as corrosion, oxidation, sintering, etc., strong caution should be exercised when interpreting and identifying creep mechanisms.

4.3 Since materials tend to exhibit faster creep rates during the initial stage of deformation, the user should be cautioned when extrapolating measured creep rates beyond the normal 50 hour test time. The material must be in the secondary creep stage in order to extrapolate to longer times.

5. Significance and Use

5.1 The thermal expansion under load and the 20 to 50 h creep properties of a refractory are useful in characterizing the load bearing capacity of a refractory that is uniformly heated. Directly applicable examples are blast furnace stoves and glass furnace checkers.

6. Interferences

6.1 *Chemical Interactions with Test Environment*—The test environment (vacuum, inert gas, ambient air, etc.), including moisture content (percent relative humidity), may have a strong influence on both creep strain rate and creep rupture life. In particular, refractories susceptible to slow crack growth or oxidation will be strongly influenced by the test environment. Testing should be conducted in environments that are either representative of service conditions or inert to the refractories being tested depending on the performance being evaluated.

6.2 *Specimen Surface Preparation*—Surface preparation of specimens can introduce machining flaws that may affect the creep strain rate and creep rupture life. Machining damage

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² *Annual Book of ASTM Standards*, Vol 14.02.