Designation: C774 – 88 (Reapproved 2011)ε1

Standard Test Method for Yield Strength of Enameling Steels After Straining and Firing[1]

This standard is issued under the fixed designation C774; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

ε[1] NOTE—Test Method was corrected editorially in 2011

INTRODUCTION

The strength after strain and fire of a steel is a significant factor in the strength of the final enameled ware. This test provides a method to quantify the yield strength of enamel steels after straining and firing by straining duplicate test plates to five different strain levels, exposing to a simulated enamel fire, and measuring the yield stress with a standardized tensile pull test.

1. Scope

1.1 This test method covers determination of the yield strength of steel specimens after simulated forming and enamel firing operations.

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

1.3 *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:*[2]

A370 Test Methods and Definitions for Mechanical Testing of Steel Products

E8 Test Methods for Tension Testing of Metallic Materials

3. Definition

3.1 *quarter lines*—imaginary lines parallel to the direction of rolling, positioned at a distance from the sheet mill edge equal to one quarter of the sheet width.

4. Summary of Test Method

4.1 Representative sheet-steel specimens are selected, strained in tension to simulate forming, heat treated to simulate enamel firing, and tension tested for determination of yield strength.

5. Significance and Use

5.1 In the manufacture of porcelain enameled ware, sheet steel is subjected to forming operations and subsequently to firing of the enamel at temperatures, typically, of 1400 to 1550°F (760 to 844°C). Some steels used for porcelain enameling are subject to grain growth in critically strained areas resulting in loss of strength.

5.2 This may lead to easy deformation of the steel and damage to the porcelain enamel coating.

5.3 This test method may be correlated with transit or use tests to evaluate the suitability of steel for porcelain enameled ware.

6. Apparatus

6.1 *Shear* for cutting blanks.

6.2 *Equipment* for cutting or machining tension specimens.

6.3 *Gage,* 2-in. (50.8-mm), for marking tension specimens.

6.4 *Tension-Testing Equipment,* as described in Test Methods and Definitions A370.

6.5 *Specimen-Supporting Rack,* slotted to support specimens on edge spaced 1 in. (25.4 mm) apart.

6.6 *Furnace,* capable of heating the test specimens and their supporting rack to the firing temperature in 2 min.

7. Reagents and Materials

[1] This test method is under the jurisdiction of ASTM Committee B08 on Metallic and Inorganic Coatingsand is the direct responsibility of Subcommittee B08.12 on Materials for Porcelain Enamel and Ceramic-Metal Systems.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

7.1 *Sheet Steel,* sufficient in size to provide the test specimen, described in Section 8.

7.2 *Solvent,* such as acetone or isopropyl alcohol.

7.3 *Hydrochloric Acid (1+1)*—Dilute 1 volume of concentrated hydrochloric acid (HCl, sp gr 1.19) with 1 volume of water.

8. Sampling

8.1 Obtain ten test samples, each approximately 1 by 9 in. (25 by 229 mm), from within the quarter lines of the sheet sample, the long dimension being in the direction of rolling.

9. Procedure

9.1 Remove burrs from the cut edges of the test samples.

9.2 Mark 2-in. (50.8-mm) gage lengths in the middle of the test samples and strain in tension. Maintain a minimum of 1 in. (25.4 mm) of length between the grips of the tension-testing machine and the gage marks.

9.3 Elongate duplicate test samples to nominal strain levels of 0, 8, 12, 16, and 20 %. Measure the elongation with extensometers, dividers, or other means.

9.4 Remove the test samples from the tension machine and measure actual strain to the nearest 0.01 in. (0.25 mm).

9.5 Clean the strained test samples with the solvent and fire in air atmosphere at 1450 ± 10°F (788 ± 5°C) for 4 min. Test samples may be hung from hooks or supported on edge spaced 1 in. (25.4 mm) apart (if the latter, be sure to support in a manner to prevent sagging during firing). The test samples should reach the firing temperature within 2.0 ± 0.5 min.

9.6 Remove the samples from the furnace and air cool.

9.7 Descale the fired samples in a HCl (1+1) solution containing a few drops of an inhibitor, such as formaldehyde, at a temperature of 70 to 100°F (21 to 38°C). Promptly rinse the test samples and dry.

9.8 Machine the descaled test samples to make standard rectangular tension tests specimens in accordance with Test Methods and Definitions A370. The specimens shall have a minimum length of 8 in. (204 mm) and the sides of the reduced section shall be parallel.

9.9 Measure the thickness and width of each specimen, and test for yield strength as described in Test Methods E8 at a crosshead speed of 0.10 in. (2.5 mm)/min. Determine the yield strength at the lower point or by the 0.5 % extension under load.

10. Report

10.1 Report the yield strengths determined for the duplicate specimens at each of the five strain levels.

10.2 Report the actual strain imparted to each specimen.

11. Precision and Bias

11.1 The precision and bias of yield strength and strain in this test method would be identical to the precision and bias of Test Methods E8. Refer to this standard for up-to-date precision and bias.