



Standard Test Method for Reboiling Tendency of Sheet Steel for Porcelain Enameling¹

This standard is issued under the fixed designation C 632; 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.

1. Scope

1.1 This test method covers the determination of whether a sheet steel for porcelain enameling will reboil under a given set of worse case conditions.

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:

C 286 Terminology Relating to Porcelain Enamel and Ceramic-Metal Systems²

3. Terminology

3.1 Definitions:

3.1.1 *ground coat*—a porcelain enamel applied directly to the base metal to function as an intermediate layer between the metal and the cover coat (see Terminology C 286).

3.1.2 *reboiling*—gas evolution occurring and recurring during repeated firing of the ground coat, sometimes a defect (see Terminology C 286).

3.1.3 *slip (slurry)*—a suspension of finely divided material in liquid (see Terminology C 286).

3.2 Description of a Term Specific to This Standard:

3.2.1 *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 Both surfaces of sheet steel sample plates are subjected to a cleaning treatment and are then porcelain enameled with a sheet-steel, ground-coat type finish. Subsequent reheating at various times is performed to reveal whether or not the steel

will cause reboiling. The presence or absence of reboiling is determined by visual inspection.

5. Significance and Use

5.1 The results of this test indicate whether or not a sheet steel will cause reboiling under one given set of enameling conditions and enable the enamel processor to establish a possible source of imperfections in the finished coating.

5.2 This test method is normally used to test samples from lots, coils, or lifts of sheet steel which for some reason, production problems, defects evident on enameled parts, or production experience are suspected of causing defects in enameled ware which have the appearance of reboiling. It is often used to establish whether a problem exists with the bare steel or other factors such as the porcelain enamel, processing contamination, and so forth.

6. Apparatus

6.1 This test can be conducted in any laboratory equipped for general porcelain enameling. It does not require facilities for metal surface preparation.

7. Reagents and Materials

7.1 *Steel Sheet*, sufficient in size to provide samples as described in 8.1 and 8.1.1.

7.2 *Porcelain-Enamel, Ground-Coat Slip*, obtained from production milling or prepared in laboratory facilities.

7.3 *Acetone or Isopropyl Alcohol*, reagent grade.

8. Sampling

8.1 Shear sufficient material from within the quarter lines of a selected steel sheet sample from a sheet, coil, or lift to be tested to provide a minimum of five panels, each at least 2 in. (50 mm) square but not greater than 4 by 6 in. (100 by 150 mm).

8.1.1 Choose panels from rust-free areas that do not contain the mill identification stamp.

8.1.2 Identify each panel by a method that enables identity to be monitored after repeated enamel firings. Steel die stamping is the most commonly used technique.

8.1.3 Material sheared from the sheet or coil may be within the range of sizes given in 8.1 or may be sheared into specimens of these sizes after application and firing of the ground-coat enamel.

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² *Annual Book of ASTM Standards*, Vol 02.05.

9. Procedure

9.1 Swab the cut-to-size steel panels with cheesecloth soaked with a solvent such as acetone or isopropyl alcohol.

9.1.1 Scrub the panels by hand with a portion of the ground-coat enamel. Remove the excess enamel from the panels by flushing with water if the panels are to be coated by spraying. Dry the panels thoroughly.

9.1.2 Avoid contact with soils of any nature and store the panels in a desiccator until they are ready for enameling.

9.2 Apply 24 g/ft² (2.6 g/dm²) of enamel slip to each surface (Note 1). Either dipping or spraying may be used, depending upon the method for which the slip is designed. Dry the surfaces adequately. Fire them at a temperature and for sufficient time to fuse the ground-coat enamel to the base metal. This time and temperature should be that recommended by the porcelain enamel manufacturers for optimum adherence (maturing temperature).

NOTE 1—Thin fired coatings of 2½ to 3 mils (0.06 to 0.08 mm) are desirable so that reboil bubbles can be readily observed.

9.3 Store the fired panels at room temperature for at least 16 h, but not more than 48 h, prior to conducting the reboiling test.

9.4 For determining reboiling, reheat the first panel for a time which is the median firing time expected in part production or that recommended by the frit supplier for optimum enamel properties. If no reboiling occurs, increase firing time for subsequent panels 5 s longer than the previous panel. Firing time should be increased to the point that reboiling occurs or the maximum time expected under worse case production conditions is met. Of course, one may determine maximum time for reboil by decreasing firing time sequentially. A minimum of five panels or a time spread of 25 s is to be used.

9.4.1 The reboiling furnace should be operated at about 50 ± 10°F (27 ± 5°C) below the maturing temperature of the ground-coat enamel.

9.4.2 At the end of the reheat time allotted for each panel, remove the panel from the furnace and air cool it to room temperature.

10. Inspection

10.1 Visually examine the series of panels for evidence of reboiling. The presence of reboiling on any of the steel panels is considered a failure.

10.2 Reboiling is characterized by the emergence of bubbles on the enamel surface. These bubbles rise and subside rapidly and may persist as areas of blistering if arrested in a state of development by removal of the sample from the furnace and cooling to room temperature. The typical appearance of reboiling is shown in Fig. 1.

11. Precision and Bias

11.1 No statement is made about either the precision or bias of this test method for measuring reboiling of sheet steel for porcelain enameling since the result merely states whether there is conformance to the criteria for success specified in the procedure.



FIG. 1 Reboiling of Porcelain Enamel on Steel

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