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Standard Test Methods for Evaluating the Corrosion Resistance of Stainless Steel Powder Metallurgy (PM) Parts/Specimens by Immersion in a Sodium Chloride Solution[1]

This standard is issued under the fixed designation B895; 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—Editorial changes were made throughout in October 2020.

1. Scope*

1.1 These test methods cover a procedure for evaluating the ability of sintered PM stainless steel parts/specimens to resist corrosion when immersed in a sodium chloride (NaCl) solution.

1.2 Corrosion resistance is evaluated by one of two methods. In Method 1, the stainless steel parts/specimens are examined periodically and the time to the first appearance of staining or rust is used to indicate the end point. In Method 2, continued exposure to the sodium chloride solution is used to monitor the extent of corrosion as a function of time.

1.3 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

A380 Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems

B243 Terminology of Powder Metallurgy

B528 Test Method for Transverse Rupture Strength of Powder Metallurgy (PM) Specimens

D610 Practice for Evaluating Degree of Rusting on Painted Steel Surfaces

D1193 Specification for Reagent Water

G1 Practice for Preparing, Cleaning, and Evaluating Corrosion Test Specimens

G48 Test Methods for Pitting and Crevice Corrosion Resistance of Stainless Steels and Related Alloys by Use of Ferric Chloride Solution

3. Terminology

3.1 *Definitions*—Useful definitions of terms for metal powders and powder metallurgy are found in Terminology B243.

4. Summary of Test Method

4.1 Method 1 is recommended for evaluating the corrosion resistance of stainless steel powder metallurgy parts/specimens and to verify that proper materials and processing conditions were used.

4.1.1 In this method, parts/specimens are immersed in 5 % (by mass) NaCl solution and examined periodically until the first appearance of staining or rust. A part or specimen is considered to have reached the end point when the first sign of corrosion occurs.

4.2 Method 2 is recommended for evaluating the processing variables used in producing parts/specimens.

4.2.1 In this method, parts/specimens are exposed further to the NaCL solution and periodically rated as either A, B, C, or D (A-no corrosion; D-high or extreme corrosion) by comparison with Fig. 1, a photograph of corroded specimens which serves as a standard. Additional examples of quantitative ratings may be found in Practice D610. Method 2 has been found useful in alloy screening and process optimization studies.

[1] These test methods are under the jurisdiction of ASTM Committee B09 on Metal Powders and Metal Powder Products and are the direct responsibility of Subcommittee B09.05 on Structural Parts.

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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.

*A Summary of Changes section appears at the end of this standard

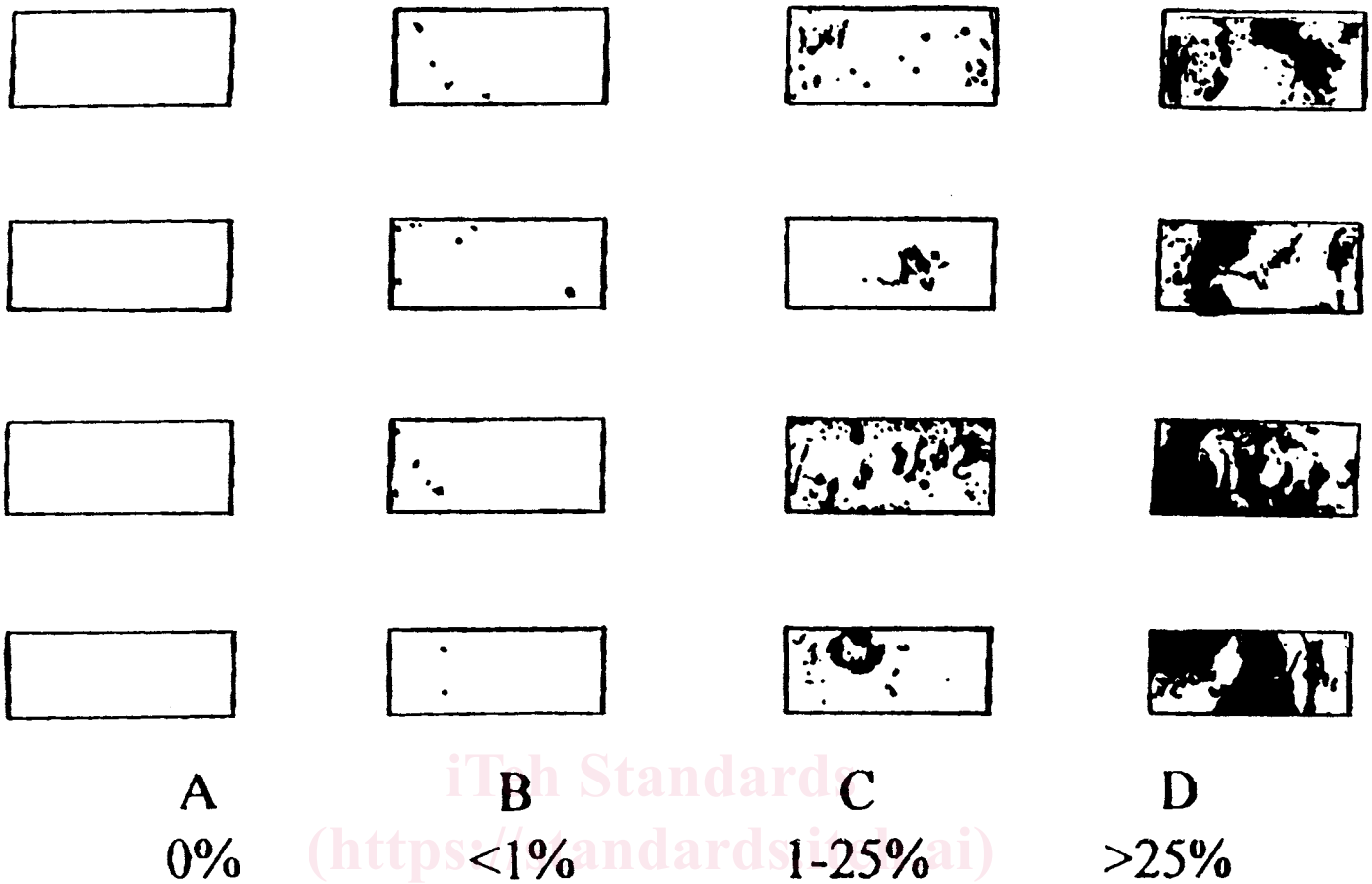

FIG. 1 Examples of Ratings for Various Amounts of Rust or Stain (Immersion in Aqueous Solution of 5 % NaCl)

5. Significance and Use

5.1 The ability of sintered powder metallurgy stainless steel parts/specimens to resist corrosion when immersed in sodium chloride solution is important to their end use. Causes of unacceptable corrosion may be incorrect alloy, contamination of the parts by iron or some other corrosion-promoting material or improper sintering of the parts (for example, undesirable carbide and nitride formations caused by poor lubricant burnoff or improper sintering atmosphere).

5.2 This standard may be part of a purchase agreement between the PM parts producer and the purchaser of the parts (Method 1). It may also be used to optimize part or specimen production parameters (Method 2).

6. Apparatus

6.1 *Sealable Glass or Plastic Jars,* of suitable capacity for specimens to be completely covered by the NaCl solution.

6.2 *Glass Beads* (4 mm is recommended).

6.3 *Glass Stirring Rods.*

6.4 *Tongs* (Stainless steel or plastic, nonmetallic plated).

7. Reagents

7.1 A sodium chloride solution consisting of 5 ± 0.1 % (by mass) NaCl shall be prepared using distilled or deionized water conforming to Specification D1193 (Type 4) and ACS reagent grade NaCl solution. The 5 % NaCl solution shall be prepared no less than 16 h before beginning the corrosion testing.

7.2 Concentrated HCl.

7.3 Distilled or deionized water.

8. Test Specimen

8.1 Usually test parts are sintered parts, but they may also be standard transverse rupture bars as defined in Test Method B528. A minimum of ten parts/specimens shall be used for each test except for routine testing of production parts, where the use of five parts is acceptable.

8.1.1 The density of the parts or specimens, as well as any post sintering treatments (that is, coining, repressing, machining, etc.), shall be stated. Parts or specimens shall be free of oil, dirt, grease and fingerprints. If they have been cleaned, the cleaning method shall be stated. Refer to Practices A380 and G1 for recommended cleaning practices.

8.1.2 The use of tongs or gloves, or both, to prevent contamination in handling is suggested.

NOTE 1—Iron or low-alloy steel particles present on the surface of the sintered stainless steel parts/speciments can be revealed by placing the parts/specimens in a concentrated solution of copper sulfate, $CuSO_4$. The dissolved copper plates out on the iron/low-alloy particles within minutes and can be seen by using a low-magnification microscope.

9. Preparation of Apparatus

9.1 Soak previously used jars and glass beads in concentrated HCl for at least 12 h to remove rust stains; rinse with distilled or deionized water, then rinse again and allow to dry.

9.1.1 Place the glass beads in the bottom of the beaker. Use a sufficient number of beads to keep the test specimen off the bottom of the jar.

10. Procedure

10.1 *Method 1:*

10.1.1 Place one part or specimen per jar on top of the glass beads. Add the NaCl solution to each jar so that the volume of solution, in millilitres, is at least five times the mass of the specimen in grams. The distance from the surface of the part/specimen to the top of the solution should be at least 25 mm. The ratio of the volume of air to the volume of solution in a jar is recommended to be about 1:2 to 1:3. Remove air bubbles attached to the specimen surface and glass beads by swirling the solution or moving the specimen with a glass stirring rod. Close the jars. Record the date and the time of the start of the test. Store the immersed test specimens at a temperature of 21 to 24 °C.

10.1.2 Examine the parts/specimens after ½, 1, 2, 4, and 8 h and at 24 h intervals from the onset of the test. Thereafter, the interval may be lengthened as time progresses until the first appearance of rust or stain. The corrosion life of a part or specimen is the time of the previous examination, that is, the last examination taken before the observation of stain or rust. Do not include corrosion which appears at the interface between a part/specimen and the glass beads. This is considered to be crevice corrosion and may be evaluated by Test Methods G48.

10.2 *Method 2:*

10.2.1 Method 2 follows the procedure of Method 1 through 10.1.1. It continues with periodic examination as in 10.1.2, except that testing continues beyond the first appearance of stain or rust. In Method 2, for each examination, the parts/specimens are ranked for the degree of staining or corrosion according to the following:

A—The part/specimen is free from stain or rust.

B—The first sign of stain or rust appears or up to 1 % of surface is covered by stain or rust.

C—More than 1 and up to 25 % of surface is covered by stain or rust.

D—More than 25 % of surface is covered by stain or rust.

10.2.1.1 Examples of ratings exhibiting these conditions are shown in Fig. 1.

10.2.1.2 Do not include corrosion which appears at the interface between the test specimens and the glass beads. This is considered to be crevice corrosion and is not the subject of this test method. As a part/specimen shows increasing amounts of rust, it may become necessary to use a pair of tongs to remove it from the solution so as to distinguish between loose and adherent rust. Rinsing should not be used because loose rust may be washed off.

10.2.2 Record the results of the timed observation at the intervals used. Table 1 shows a typical example of a data collection table.

10.2.3 Plot the percent of parts/specimens having an A, B, or C class rating for suitable time intervals on a logarithmic time scale.

10.2.4 Draw curves to fit the data. A typical plot is shown in Fig. 2. When plotting the data for the "B" and "C" ratings, it is the percentage holding a "B or better" rating and a "C or better" rating that is plotted. For example, in Table 1, a "B or better" rating is held by 100 % of the specimens for up to 168 h. A "C or better" rating is held by 100 % of the specimens for up to 496 h.

11. Report

11.1 *Method 1:*

11.1.1 Report the individual corrosion lives in hours as determined in 10.1.2 and calculate the arithmetic average. Acceptance criteria shall be mutually agreed upon between purchaser and producer.

TABLE 1 Example of Corrosion Rating Chart for a Set of Ten Replicate Specimens of Sintered 316L Stainless Steel[A]

Specimen	Hours submersed in 5 % aq. NaCl																		
#	0.5	1	2	4	8	24	31	50	74	104	168	240	336	496	696	984	1368	1804	2282
1	A	A	A	A	A	A	A	A	B	B	B	B	C	C	C	C	D	D	D
2	A	A	A	A	A	A	A	A	A	A	B	B	B	B	C	C	C	D	D
3	A	A	A	A	A	A	A	B	B	B	B	C	C	C	D	D	D	D	D
4	A	A	A	A	A	A	A	A	A	B	B	B	B	C	C	C	C	C	D
5	A	A	A	A	A	A	A	A	A	B	B	B	B	C	C	C	C	C	C
6	A	A	A	A	A	A	A	A	A	B	B	B	B	C	C	C	C	C	D
7	A	A	A	A	A	A	B	B	B	B	B	B	C	C	C	C	C	D	D
8	A	A	A	A	A	A	A	B	B	B	B	B	C	C	C	D	D	D	D
9	A	A	A	A	A	A	A	A	B	B	B	B	B	C	C	C	C	D	D
10	A	A	A	A	A	A	A	A	A	B	B	B	B	C	C	C	C	C	D
% Holding 'A' Rating	100	100	100	100	100	100	90	70	50	10	0								
% Holding 'B' Rating											100	90	60	10	0				
% Holding 'C' Rating														100	90	80	70	40	10

[A] See Section 10.1.1 for definition of ratings.