



Designation: G 76 – 02

# Standard Test Method for Conducting Erosion Tests by Solid Particle Impingement Using Gas Jets<sup>1</sup>

This standard is issued under the fixed designation G 76; 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 material loss by gas-entrained solid particle impingement erosion with jetnozzle type erosion equipment. This test method may be used in the laboratory to measure the solid particle erosion of different materials and has been used as a screening test for ranking solid particle erosion rates of materials in simulated service environments (1, 2).<sup>2</sup> Actual erosion service involves particle sizes, velocities, attack angles, environments, etc., that will vary over a wide range (3-5). Hence, any single laboratory test may not be sufficient to evaluate expected service performance. This test method describes one well characterized procedure for solid particle impingement erosion measurement for which interlaboratory test results are available.

1.2 *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 122 Practice for Calculating Sample Size to Estimate, With a Specified Tolerable Error, the Average for a Characteristic of a Lot or Process<sup>3</sup>

G 40 Terminology Relating to Wear and Erosion<sup>4</sup>

### 2.2 American National Standard:

ANSI B74.10 Grading of Abrasive Microgrits<sup>5</sup>

## 3. Terminology

### 3.1 Definitions:

<sup>1</sup> This practice is under the jurisdiction of ASTM Committee G02 on Wear and Erosion and is the direct responsibility of Subcommittee G02.10 on Erosion by Solids and Liquids.

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<sup>2</sup> Boldface numbers in parentheses refer to references at the end of this test method.

<sup>3</sup> *Annual Book of ASTM Standards*, Vol 14.02.

<sup>4</sup> *Annual Book of ASTM Standards*, Vol 03.02.

<sup>5</sup> Available from American National Standards Institute, 11 West 42nd Street, 13th Floor, New York, NY 10036.

3.1.1 *erosion*—progressive loss of original material from a solid surface due to mechanical interaction between that surface and a fluid, a multicomponent fluid, or impinging liquid or solid particles.

3.1.2 *impingement*—a process resulting in a continuing succession of impacts between (liquid or solid) particles and a solid surface.

### 3.2 Definitions of Terms Specific to This Standard:

3.2.1 *erosion value*—the volume loss of specimen material divided by the total mass of abrasive particles that impacted the specimen ( $\text{mm}^3 \cdot \text{g}^{-1}$ ).

3.2.2 *Normalized Erosion Rate*—erosion value ( $\text{mm}^3 \cdot \text{g}^{-1}$ ) of specimen material divided by erosion value ( $\text{mm}^3 \cdot \text{g}^{-1}$ ) of reference material.

## 4. Summary of Practice

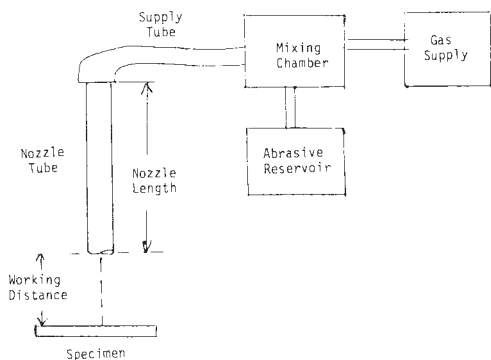
4.1 This test method utilizes a repeated impact erosion approach involving a small nozzle delivering a stream of gas containing abrasive particles which impacts the surface of a test specimen. A standard set of test conditions is described. However, deviations from some of the standard conditions are permitted if described thoroughly. This allows for laboratory scale erosion measurements under a range of conditions. Methods are described for preparing the specimens, conducting the erosion exposure, and reporting the results.

## 5. Significance and Use

5.1 The significance of this test method in any overall measurements program to assess the erosion behavior of materials will depend on many factors concerning the conditions of service applications. The users of this test method should determine the degree of correlation of the results obtained with those from field performance or results using other test systems and methods. This test method may be used to rank the erosion resistance of materials under the specified conditions of testing.

## 6. Apparatus

6.1 The apparatus is capable of eroding material from a test specimen under well controlled exposure conditions. A schematic drawing of the exit nozzle and the particle-gas supply system is shown in Fig. 1. Deviations from this design are



**FIG. 1 Schematic Drawing of Solid Particle Erosion Equipment**

**TABLE 1 Characteristics of Type 1020 Steel Reference Material**

Annealed 15 min at 760°C (1400°F), air cooled.

Hardness: HRB = 70 ± 2.

Chemical Composition:
C = 0.20 ± 0.01 wt %
Mn = 0.45 ± 0.10
S = 0.03 ± 0.01
Si = 0.1 ± 0.05
P = 0.01 ± 0.01

permitted; however, adequate system characterization and control of critical parameters are required. Deviations in nozzle design and dimensions must be documented. Nozzle length to diameter ratio should be 25:1 or greater in order to achieve an acceptable particle velocity distribution in the stream. The recommended nozzle<sup>6</sup> consists of a tube about 1.5 mm inner diameter, 50 mm long, manufactured from an erosion resistant material such as WC, Al<sub>2</sub>O<sub>3</sub>, etc. Erosion of the nozzle during service shall be monitored and shall not exceed 10 % increase in the initial diameter.

6.2 Necessary features of the apparatus shall include a means of controlling and adjusting the particle impact velocity, particle flux, and the specimen location and orientation relative to the impinging stream.

6.3 Various means can be provided for introducing particles into the gas stream, including a vibrator-controlled hopper or a screw-feed system. It is required that the system provide a uniform particle feed and that it be adjustable to accommodate desired particle flow values.

6.4 A method to measure the particle velocity shall be available for use with the erosion equipment. Examples of accepted methods are high-speed photography (6), rotating double-disk (7), and laser velocimeter (8). Particle velocity shall be measured at the location to be occupied by the specimen and under the conditions of the test.

## 7. Test Materials and Sampling

7.1 This test method can be used over a range of specimen sizes and configurations. One convenient specimen configuration is a rectangular strip approximately 10 by 30 by 2 mm

thick. Larger specimens and other shapes can be used where necessary, but must be documented.

7.2 The abrasive material to be used shall be uniform in essential characteristics such as particle size, moisture, chemical composition, etc.

7.3 Sampling of material for the purpose of obtaining representative test specimens shall be done in accordance with acceptable statistical practice. Practice E 122 shall be consulted.

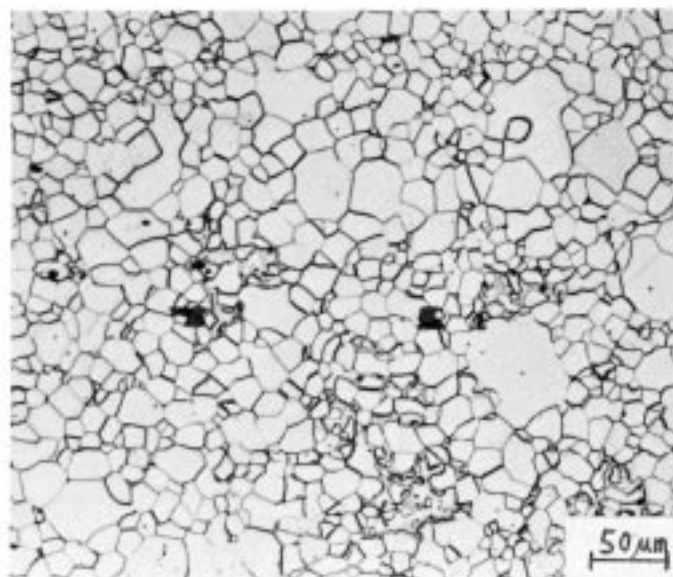
## 8. Calibration of Apparatus

8.1 Specimens fabricated from Type 1020 steel (see Table 1 and Fig. 2) equivalent to that used in the interlaboratory test series<sup>7</sup> shall be tested periodically using specified (see Section 9) 50 μm Al<sub>2</sub>O<sub>3</sub> particles to verify the satisfactory performance of the apparatus. It is recommended that performance be verified using this reference material every 50 tests during a measurement series, and also at the beginning of each new test series whenever the apparatus has been idle for some time. The recommended composition, heat treatment, and hardness range for this steel are listed in Table 1. The use of a steel of different composition may lead to different erosion results. A photomicrograph of the specified Al<sub>2</sub>O<sub>3</sub> particles is shown in Fig. 3. The range of erosion results to be expected for this steel under the standard test conditions specified in Section 9 is shown in Table 2 and is based on interlaboratory test results.<sup>7</sup>

8.2 Calibration at standard test conditions is recommended even if the apparatus is operated at other test conditions.

8.3 In any test program the particle velocity and particle feed rate shall be measured at frequent intervals, typically every ten tests, to ensure constancy of conditions.

<sup>7</sup> Supporting data are available from ASTM Headquarters. Request RR:G02-1003.



**FIG. 2 Microstructure of 1020 Steel Reference Material ASTM Grain Size 9**

<sup>6</sup> A source for the recommended nozzle (tungsten carbide) is Kennametal, Inc., Latrobe, PA.