



Standard Test Method for Determination of Slurry Abrasivity (Miller Number) and Slurry Abrasion Response of Materials (SAR Number)¹

This standard is issued under the fixed designation G75; 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 a single laboratory procedure that can be used to develop data from which either the relative abrasivity of any slurry (Miller Number) or the response of different materials to the abrasivity of different slurries (SAR Number), can be determined.

1.2 The test data obtained by this procedure is used to calculate either a number related to the rate of mass loss of duplicate standard-shaped 27 % chromium iron wear blocks when run for a period of time in the slurry of interest (Miller Number), or to calculate a number related to the rate of mass loss (converted to volume loss) of duplicate standard-shaped wear specimens of any material of interest when run for a period of time in any slurry of interest (SAR Number).

1.3 The requirement for a finished flat wearing surface on the test specimen for a SAR Number test may preclude application of the procedure where thin (0.051 to 0.127-mm), hard, wear-resistant coatings will not allow for surface finishing. The 6 hours total duration of the SAR Number Test may not allow establishment of a consistent rate-of-mass-loss of the unfinished surface.

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*:²
G40 Terminology Relating to Wear and Erosion

¹ This test method is under the jurisdiction of ASTM Committee G02 on Wear and Erosion and is the direct responsibility of Subcommittee G02.30 on Abrasive Wear.

Current edition approved Nov. 1, 2015. Published November 2015. Originally approved in 1982. Last previous edition approved in 2013 as G75–07 (2013). DOI: 10.1520/G0075-15.

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.

2.2 Military Standard:

MIL-R-6855C Rubber, Synthetic, Sheets, Strips, Molded or Extruded Shapes³

3. Terminology

3.1 Definitions:

3.1.1 Definitions used in this test method are in accordance with Terminology G40 as follows:

3.1.2 *abrasive wear*—wear due to hard particles or hard protuberances forced against and moving along a solid surface.

3.1.3 *corrosive wear*—wear in which chemical or electrochemical reaction with the environment is significant.

3.1.4 *abrasion-corrosion*—a synergistic process involving both abrasive wear and corrosion in which each of these processes is affected by the simultaneous action of the other and, in many cases is thereby accelerated.

3.1.5 *cumulative erosion-time curve*—a plot of cumulative erosion versus cumulative exposure duration, usually determined by periodic interruption of the test and weighing of the specimen. This is the primary record of an erosion test. Most other characteristics, such as the incubation period, maximum erosion rate, terminal erosion rate, and erosion rate-time curve, are derived from it.

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

3.1.7 *erosion-corrosion*—a conjoint action involving corrosion and erosion in the presence of a corrosive substance.

3.1.8 *instantaneous erosion rate*—the slope of a tangent to the cumulative erosion-time curve at a specified point on that curve.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *mass concentration*—the mass of solid particles per unit mass of mixture, expressed in percent.

³ Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.

3.2.2 *Miller Number*—a measure of slurry abrasivity as related to the instantaneous rate of mass loss of a standard metal wear block at a specific time on the cumulative abrasion-corrosion time curve.

3.2.3 *SAR Number*—a measure of the relative abrasion response of any material in any slurry, as related to the instantaneous rate of mass-loss of a specimen at a specific time on the cumulative abrasion-corrosion time curve, converted to volume or thickness loss rate.

3.2.4 *slurry*—a mixture of solid particles in liquid, of such a consistency as to be capable of being pumped like a liquid.

3.2.5 *slurry abrasivity*—the relative tendency of a particular moving slurry to produce abrasive and corrosive wear compared with other slurries.

4. Summary of Test Method

4.1 The relative effect of slurry abrasivity in both the Miller Number and the SAR Number is determined by using the measured mass loss of a standard-shaped 27 % chrome iron metal wear block (Miller Number); or a metal, ceramic, composite, plastic, or elastomer wear specimen (SAR Number), driven in a reciprocating motion by a rotating crank, riding in the bottom of a trough containing the slurry. A direct load is applied to the wear block or wear specimen. For each test, the bottom of the trough is equipped with a new piece of a sheet of Neoprene⁴ to act as a lap. The interior of the trough has a flat-bottomed or truncated “V” shape trough that confines the slurry particles to the path taken by the wear block or wear specimen. At one end of each stroke, the wear block wear specimen is lifted off the lap by a cam action for sufficient time to allow fresh slurry material to flow under the wear block or wear specimen. The wear block/wear specimen holder is made of plastic, as are the troughs, so that electrolysis inherent in certain slurries is minimized.

4.2 The test consists of measuring the mass loss of a part that is referred to either a wear block or wear specimen to be consistent with Section G34 of Form and Style for ASTM Standards. Standard wear blocks of 27 % chrome iron are used for the Miller Number test where the slurry is the specimen and the results are the relative abrasivity of the slurry. Wear specimens are used in the SAR Number test where the test results are the relative wear rate of different wear specimens in a given slurry.

4.3 This test method was originally developed as a 16-h test to be run in 4-h increments. However, experience has shown that the extended test length is unnecessary and it has been established that a 6-h test, run in 2-h increments, gives essentially equivalent results. The current revision is based on the shorter test procedure.

5. Significance and Use

5.1 The Miller Number⁵ is an index of the relative abrasivity of slurries. Its primary purpose is to rank the abrasivity of

⁴ Neoprene is a registered trademark of E. I. du Pont de Nemours and Co., Wilmington, DE 19898.

⁵ “The Miller Number—A New Slurry Rating Index,” *AIME Paper 73-B-300*, SME Meeting, Pittsburgh, PA, 1973.

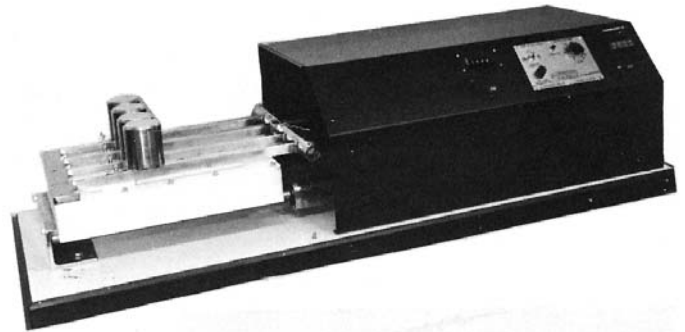


FIG. 1 Miller Number Machine

slurries in terms of the wear of a standard reference material. The wear damage on the standard wear block is worse as the Miller Number gets higher.

5.2 The SAR Number is an index of the relative abrasion response of materials as tested in any particular slurry of interest. The SAR Number is a generalized form of the Miller Number applicable to materials other than the reference material used for the Miller Number determination. A major purpose is to rank construction materials for use in a system for pumping and fluid handling equipment for a particular slurry. It can also be used to rank the abrasivity of various slurries against any selected construction material other than the reference material specified for a Miller Number determination. The slurry damage on the specimen of material being tested is worse as the SAR Number gets higher.

5.3 Experience has shown that slurries with a Miller Number or a SAR Number of approximately 50 or lower can be pumped with minor abrasive damage to the system. Above a number of 50, precautions must be observed and greater damage from abrasion is to be expected. Accordingly, the Miller Number and the SAR Number provide information about the slurry or the material that may be useful in the selection of pumps and other equipment and to predict the life expectancy of liquid-end parts of the pumps involved.

5.4 The SAR Number can be used to determine the most suitable materials for certain slurry systems.

6. Apparatus

6.1 Figs. 1 and 2 show the arrangement of a typical test machine.⁶

6.2 Description of Machine:

6.2.1 The drive mechanism provides a horizontal reciprocating harmonic motion to the wear block/wear specimen arm of 203.2-mm travel. The arm is freely pivoted to a crosshead at a point that results in the arm being parallel (level) to the

⁶ The sole source of supply of the machine and parts, including laps and wear blocks, known to the committee at this time is Falex Friction and Wear Test Machines, 1020 Airport Dr., Sugar Grove, IL 60554. If you are aware of alternate suppliers, please provide this information to ASTM Headquarters. Your comments will receive careful attention at a meeting of the responsible technical committee¹ which you may attend.

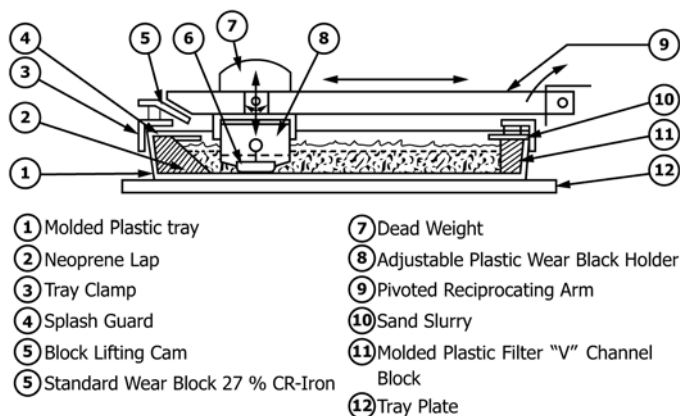


FIG. 2 Miller Number Machine Slurry Trough Cross-Section

crosshead ways in the operating position. The crosshead is connected to a crank, rotating at 48 r/min, by an appropriate connecting rod.

6.2.2 The apparatus includes two operating arms for an averaging effect and as a check on the accuracy of measurements. It is possible to combine four arms on one machine so that two simultaneous tests can be run.

6.2.3 Each arm is loaded with a mass so that the total downward force on the face of the wear block or wear specimen is 22.24 N (5 lb).

6.2.4 A cam is provided on the trough cover plate to momentarily lift each arm at the end of a stroke to a distance of 1 mm off the rubber lap.

6.2.5 Troughs about 50 mm wide by 381 mm long by 50 mm high are used. A separate trough is required for each arm.

6.2.6 Troughs as described above are machined into an elastomer material to form a slurry trough component that is used to hold the rubber lap in place between the bottom of the trough and the base plate and to provide a V-shaped open bottom trough for the length of the wear block or wear specimen travel. There is a slope of 45° at the cam end of one stroke to generate a surge or back flow of fresh slurry under the lifted wear block or wear specimen.

6.2.7 A wear block/wear specimen holder is machined from plastic to about 50 mm by 50 mm by 12.7 mm with a height-adjusting system and a slot to hold the wear block or wear specimen and a nonmetallic clamp-bolt to hold the wear block or wear specimen in alignment. See Fig. 3.

6.2.8 The wear block/wear specimen is mounted on the arm in such a manner as to allow adjustment of the wear block or wear specimen vertically and to establish parallelism with the flat rubber lap.

6.2.9 Except for the wear block or wear specimen and stroke length, dimensional tolerances of the machined parts are not critical and the tolerances can be in the order of 0.5 % total.

7. Reagents and Materials

7.1 The reference material⁷ for the Miller Number is a proprietary alloy⁸ of the type commonly used in pipeline pump applications. The nominal composition of this chromium-iron wear block reference material is: Carbon-2.5 %, Manganese-1.0 %, Silicone-0.6 %, Nickel-0.25 %, Chromium-28 %, Molybdenum-0.3 %, Vanadium-0.8 %, Iron-balance.

7.1.1 The material is obtainable in the form of a centrifugally cast cylinder, approximately 183-mm outside diameter by 152-mm inside diameter by 305 mm long.

7.1.2 In this case the following heat-treat procedure and specimen preparation procedure should be followed:

7.1.2.1 Anneal 24 h, turn and bore, approximately 179-mm outside diameter by 164-mm inside diameter.

7.1.2.2 Heat to 1010°C (1850°F), 60 min.

7.1.2.3 Air cool, hardness 59 to 60 HRC.

7.1.2.4 Grind to approximately 178-mm outside diameter by 165-mm inside diameter.

7.2 Using an abrasive wheel or wire EDM, cut 25.4-mm lengths or “rings” from the cylinder. Cut the rings into 15-mm wide segments. Grind the segments to the shape shown in Fig. 3.

7.3 As a final finish on the wearing surface, wet grind on 320-grit silicon carbide paper to a 0.8 micron surface finish. The wear specimens can be ground and resurfaced with 320-grit silicon carbide paper multiply times. Reconditioning is limited to homogeneous materials and minimum thickness that can be retained in wear specimen holder. It is important that a radius leading edge be maintained.

7.4 The lap is a 3.18-mm thick sheet, 57.2 mm by 362 mm long of molded neoprene rubber specified as a Modified MIL-R-6855C, Class 2, Grade 80. The Durometer specification of the Neoprene has been reduced from 80 ± 5 to 80 ± 3. The purpose of the tighter specification is to reduce variability observed in the initial interlaboratory test.

7.5 The SAR Number wear specimen of any selected candidate material is machined and ground to the shape shown in Fig. 3.

7.6 *Isopropyl Alcohol.*

8. Preparation of Apparatus

8.1 The following detailed description of the setup of the apparatus for the start of the test is appropriate for the commercially available unit. For other apparatus the procedure should be followed as closely as possible, particularly to ensure the alignment required.

⁷ Specimen available from Falex Friction and Wear Test Machines, 1020 Airport Dr., Sugar Grove, IL 60554. Falex is the sole source of supply known to the committee at this time. If you aware of alternative suppliers, please provide this information to ASTM Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee,¹ which you may attend.

⁸ Proprietary of Woolley Tool and Manufacturing Co., P.O. Box 3505, Odessa, TX 79760.