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Standard Test Method for Viscosity of Chemical Grouts by Brookfield Viscometer (Laboratory Method)[1]

This standard is issued under the fixed designation D 4016; 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 viscosity of catalysed chemical grouts with the Brookfield viscometer (laboratory method), over the range from 1.0 to 1000 cP (0.001 to 1 Pa·s).

1.2 *This standard does not purport to address all of the safety problems, 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.*

1.3 *This test method offers a set of instructions for performing one or more specific operations. This document cannot replace education or experience and should be used in conjunction with professional judgment. Not all aspects of this practice may be applicable in all circumstances. This ASTM standard is not intended to represent or replace the standard of care by which the adequacy of a given professional service must be judged, nor should this document be applied without consideration of a project's many unique aspects. The word "Standard" in the title of this document means only that the document has been approved through the ASTM consensus process.*

2. Referenced Documents

2.1 *ASTM Standards:* [2]

D 653 Terminology Relating to Soil, Rock, and Contained Fluids

D 3740~~Practice for Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction~~[2] Practice for Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction

D 6026 Practice for Using Significant Digits in Geotechnical Data

E 1 Specification for ASTM Liquid-in-Glass Thermometers

3. Terminology

3.1 For common definitions of terms used in this standard, refer to Terminology D 653.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *coefficient of viscosity*—the ratio between the applied shear stress and the rate of shear. This coefficient is a measure of the resistance to flow of the liquid. It is commonly called the viscosity of the liquid. The cgs unit of viscosity is 1 g/cm·s (1 dyn/s cm ^{2}) and is called a poise (P). Viscosities of thin liquids are normally given in hundredths of a poise or centipoises (cP). The SI unit of viscosity is 1 Pa·s (1 N·s/m^2) and is equal to 10 P, or 1000 cP.

3.2.2 *Newtonian liquid*—a liquid in which the shear stress is proportional to the rate of shearing strain. This constant ratio is the viscosity. Non-Newtonian behavior can be determined with the Brookfield instrument by taking measurements at different spindle speeds.

4. Summary of Test Method

4.1 A rotating spindle is immersed in a container of catalysed chemical grout. An index to the viscosity is read directly on the instrument scale.

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[1] This test method is under the jurisdiction of ASTM Committee D18 on Soil and Rock and is the direct responsibility of Subcommittee D18.15 on Stabilization With Admixtures.

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~~[2] Annual Book of ASTM Standards Vol 04.08.~~

[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.**

5. Significance and Use

5.1 This test is intended for materials that will penetrate soil voids and rock fissures. Viscosity alone is not necessarily an exact index of grout penetrability.

NOTE 1—The quality of the result produced by this test method is dependent on the competence of the personnel performing it and the suitability of the equipment and facilities used. Agencies that meet the criteria of Practice D 3740 are generally considered capable of competent and objective testing/sampling/inspection/etc. Users of this standard are cautioned that compliance with of Practice D 3740 does not in itself assure reliable results. Reliable results depend on mnay factors; of Practice D 3740 provides a means of evaluating some of those factors.

6. Apparatus

6.1 *Brookfield Viscometer*—Any model whose lower limit of effective measurement is less than the value of the sample. Models LVF and LVT should be used for measurements above 20 cP (20 mPa·s), and for measurements from 1 to 20 cP (1 to 20 mPa·s) with the addition of a Model UL adapter. Models RV, RT, HA, and HB may be used for measurements above 100 cP (100 mPa·s).

NOTE 2—The UL adapter may be used for better accuracy in the 20 to 100-cP (20 to 100-mPa·s) range also.

6.2 *Griffin Beaker*, 600-cm^3, low-form used as the container for the sample. Beaker material must not react with the grout. Glass beakers are not acceptable for silicates. Stainless steel beakers are acceptable for all materials.

6.3 *Calibrated Liquid-in-Glass Thermometers*, accurate to ±1.0°F (0.5°C), or any other thermometric device of equal accuracy.

NOTE 3—Glass thermometers should not be used with silicates.

6.4 *Temperature-Control Bath*, for work at other than ambient temperature, and large enough to hold the sample container. Any bath that will maintain its temperature within ±1.0°F (0.5°C) during the test period is adequate.

NOTE 4—Grout temperature must equal bath temperature at the start of the test. Temperature rise due to chemical reaction does not invalidate the test data.

7. ~~Sample Preparation~~

~~7.1The temperature of the grout components at time of testing shall be 68 ± 1°F (20 ± 0.5°C).~~ Sample Preparation

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NOTE 5—Alternatively, three or more tests at various temperatures may be taken to define a viscosity versus temperature relationship. It is desirable to have such tests span the anticipated ground temperature.

7.2 Viscosity data should be taken on catalysed grout solution that contains all of the components normally used for field application.

8. Procedure

8.1 Prepare the grout components separately and bring them to the required temperature.

8.2 When not using the UL adapter attach the No. 1 spindle to the lower shaft.

8.2.1 When using the UL adapter attach the locating channel to the viscometer. Assemble the spindle, extension link, and coupling nut. Thread the coupling nut onto the viscometer spindle coupling. Guide the tube over the spindle. Thread the lower mounting screw into the tube collar.

NOTE 6—For more detailed assembly instructions, refer to the manufacturer's operation manual.

8.3 Catalyse the grout in a 600-cm^3 beaker. For materials whose gel time range is between 10 and 30 min, gel time should be set at about 20 min. Instrument readings of viscosity (versus time) should be taken at approximately every two minutes.

8.3.1 For materials whose gel time range is less than 10 min, a gel time should be set between 50 and 100 % of gel time range, and readings taken at least every 2 min or, if possible, at 1-min intervals.

8.3.2 For materials whose gel time range is over 30 min, a gel time should be selected at least 25 % above minimum, and readings taken at approximately equal time intervals to permit at least five readings prior to gelation.

NOTE 7—For materials whose normal setting time is modified by prolonged agitation (this includes many silicate and acrylamide grouts) only one reading per sample should be taken, and multiple samples used to define the viscosity-time data.

8.4 Insert the spindle or UL adapter into the group up to the reference mark and level the viscometer.

8.5 Select the highest spindle speed that will give a viscometer reading between 20 % and 80 % of scale. The following table may be used as a selection guide.

With Model UL Adapter	
rpm	Range, cP or mPa·s
50 to 100	0 to 10
20 to 50	10 to 30
10 to 20	20 to 50