Designation: D 5890 – 02

Standard Test Method for Swell Index of Clay Mineral Component of Geosynthetic Clay Liners[1]

This standard is issued under the fixed designation D 5890; 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 an index method that enables the evaluation of swelling properties of a clay mineral in reagent water for estimation of its usefulness for permeability or hydraulic conductivity reduction in geosynthetic clay liners (GCL).

1.2 It is adapted from United States Pharmacopeia (USP) test method for bentonite.

1.3 Powdered clay mineral is tested after drying to constant weight at 105 ± 5°C; granular clay mineral should be ground to a 100 % passing a 100 mesh U.S. Standard Sieve with a minimum of 65 % passing a 200 mesh U.S. Standard Sieve. The bentonite passing the 100 mesh U.S. Standard Sieve is used for testing after drying to constant weight at 105 ± 5°C.

1.4 The values stated in SI units are to be regarded as the standard.

1.5 *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.* Specific precautionary statements are given in Section 7.

2. Referenced Documents

2.1 *ASTM Standards:*

D 1193 Specification for Reagent Water[2]

E 1 Specification for ASTM Thermometers[3]

E 11 Specification for Wire-Cloth and Sieves for Testing Purposes[4]

E 145 Specification for Gravity-Convection and Forced Ventilation Ovens[5]

E 691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method[4]

E 725 Test Method for Sampling Granular Carriers and Granular Pesticides[6]

2.2 *United States Pharmacopeia Standard:*

USP-NF-XVII Bentonite[7]

3. Terminology

3.1 *Definitions*—For definitions of terms used in this test method, refer to USP Standards and ASTM definitions for GCL products.

4. Significance and Use

4.1 Clay mineral is a major functional component of GCL systems that reduces the hydraulic conductivity of industrial, waste, or ground water through the liner.

4.2 Clay mineral quality can vary significantly and effect the hydraulic conductivity of the GCL composite. This test method evaluates a significant property of clay mineral that relates to performance.

5. Apparatus

5.1 *Mortar and Pestle or Laboratory Hammer Mill*, for grinding clay mineral to required particle sizing.

5.2 *U.S. Standard Sieve*, 100 mesh, 200 mesh, and automated sieve shaker.

5.3 *Drying Oven*, thermostatically controlled, preferably forced draft type, meeting requirements of Specification E 145 and capable of maintaining a uniform temperature of 105 ± 5°C throughout the drying chamber.

5.4 *Desiccator*, of suitable size containing indicator silica gel. It is preferable to use desiccant which changes color to indicate when it needs reconstitution.

5.5 *Laboratory Balance*, 100-g capacity, ±0.01-g accuracy and precision.

5.6 *Weighing Paper*, or small weighing dish.

5.7 *Glass Cylinder*, graduated TC (to contain), Class A volumetrically calibrated, with 1-mL subdivisions and ground glass stopper, high form with approximately 180-mm height from inside base to 100-mL mark.

5.8 *Wash Bottle*, for dispensing reagent water.

5.9 *Spatula*, flat-blade, to dispense clay mineral powder into cylinder; vibrating spatula should not be used since the

[1] This test method is under the jurisdiction of ASTM Committee D35 on Geosynthetics and is the direct responsibility of Subcommittee D35.04 on Geosynthetic Clay Liners.

Current edition approved June 10, 2002. Published September 2002. Originally published as D 5890 - 95. Last previous edition D 5890 - 01.

[2] *Annual Book of ASTM Standards*, Vol 11.01.

[3] *Annual Book of ASTM Standards*, Vol 14.03.

[4] *Annual Book of ASTM Standards*, Vol 14.02.

[5] *Annual Book of ASTM Standards*, Vol 14.04.

[6] *Annual Book of ASTM Standards*, Vol 11.05.

[7] Available from United States Pharmacopeial Convention, Inc., 12601 Twinbrook Parkway, Rockville, MD 20852.

delivery quantity may not be adequately controlled.

5.10 *Mechanical Ten-Minute Timer*.

5.11 *ASTM Calibration Immersion Thermometer*, 0 to 105 ± 0.5°C (Specification E1).

6. Reagents

6.1 *Purity of Reagents*—Unless otherwise indicated, references to water shall be understood to mean reagent water conforming to Specification D 1193, Type I, II, or III. Such water is best prepared by distillation or the passage of tap water through an ion exchange resin.

6.2 Specification D 1193 for reagent water, Type I, II, or III.

7. Hazards

7.1 *Safety Precautions*—No recognizable hazards.

8. Sampling and Selection

8.1 Carry out sampling in accordance with Test Method E 725.

9. Procedure

9.1 Grind the clay mineral sample to 100 % passing a 100 mesh U.S. Standard Sieve and a minimum of 65 % passing a 200 mesh U.S. Standard Sieve with a mortar and pestle or laboratory hammer mill as required.

9.2 Dry a portion of the whole composite ground sample to constant weight at 105 ± 5°C for swell index testing.

9.3 Weigh 2.00 ± 0.01 g of dried and finely ground clay mineral onto a weighing paper.

9.4 Add 90 mL reagent water to the clean 100-mL graduated cylinder.

9.5 Remove not more than a 0.1-g increment of clay mineral with a volumetric spoon from weighing dish or paper and carefully dust it over the entire surface of water in the the graduated cylinder over a period of approximately 30 s. Do not use a funnel that may concentrate the clay mineral in a poorly hydrated agglomerate. Allow the clay mineral to wet, hydrate, and settle to the bottom of the graduated cylinder for a minimum period of 10 min.

9.6 Add additional increments of the clay mineral powder, following the details in 9.5, until the entire 2.00-g sample has been added.

9.7 After the final increment has settled, carefully rinse any adhering particles from the sides of the cylinder into the water column, raising the water volume to the 100-mL mark. Carefully immerse the thermometer into the water, without disturbing the settled clay mineral and record the temperature of the slurry to ±0.5°C.

9.8 Place the glass stopper on the cylinder and allow it to stand undisturbed for a minimum of 16 h from the last incremental addition. After 2 h, inspect the hydrating clay mineral column for trapped air or water separation in the column. If present, gently tip the cylinder at a 45° angle and roll slowly to homogenize the settled clay mineral mass, allow the graduated cylinder with the hydrating clay mineral to remain undisturbed for a minimum of 16 h before recording the volume of the hydrated clay mass and its temperature.

9.9 After the minimum 16-h hydration period from the last increment addition, record the volume level in millilitres at the top of the settled clay mineral to the nearest 0.5 mL. Observe the distinct change in appearance at the upper surface of the settled clay mineral. Any low-density flocculated material (sometimes lighter in coloration to white) shall be ignored for this measurement. Record the observed volume of hydrated clay mineral.

9.10 Carefully immerse the thermometer and measure the temperature of the slurry. Record the temperature of the hydrated clay mineral to ±0.5°C.

10. Report

10.1 Report the following information:

10.1.1 Source of clay mineral, including sample identification or lot number,

10.1.2 Method of sampling used,

10.1.3 ASTM standard test method number used to perform the test,

10.1.4 Any modifications to the test method or unusual observations which may effect the test results,

10.1.5 Swell index as mL/2 g to the nearest 0.5 mL, and

10.1.6 Temperature of the slurry at the start and completion of the test to the nearest 0.5°C.

11. Precision and Bias

11.1 *Interlaboratory Test Program*—An interlaboratory study of the test method was run in 1999. The design of the experiment, similar to that of Practice E 691.Seven different clay mineral samples were distributed to ten laboratories. Three sets of test results were generated for each sample by each of the laboratories.

11.2 *Test Results*—The precision information is given in Table 1. The average swell index values ranged from 20 to 36 for the seven clay mineral samples tested. However, since the statistics were not related to the magnitude of the test result, the precision values have been presented in terms of coefficients of varaiation, CV %.

TABLE 1 Test Results

Statistic	ILS Range
Within laboratory repeatability limit, CV %^{r}	2 to 5 %
Between laboratory reproducibility limit, CV %^{R}	7 to 22 %
95 % confidence limit	6 to 14 %
Within laboratory repeatability, 2.8 CV %^{r}	
95 % confidence limit	20 to 61 %
Between laboratory reproducibility, 2.8 CV %^{R}	

11.3 *Bias*—The procedure in Test Method D 5890 for measuring the swell index of clay mineral component of geosynthetic clay liners has no bias because the values of swell index can be defined only in terms of this test method.