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Standard Practice for Laboratory Immersion Procedures for Evaluating the Chemical Resistance of Geosynthetics to Liquids[1]

This standard is issued under the fixed designation D 5322; 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 practice covers laboratory immersion procedures for the testing of geosynthetics for chemical resistance to liquid wastes, prepared chemical solutions, and leachates derived from solid wastes.

1.2 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

1.3 *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.* For specific hazards statements, see Section 7.

2. Referenced Documents

2.1 *ASTM Standards:*

D 123 Terminology Relating to Textiles[2]

D 471 Test Method for Rubber Property—Effect of Liquids[3]

D 543 Test Method for Resistance of Plastics to Chemical Reagents[4]

D 4439 Terminology for Geotextiles[5]

D 5747 Practice for Tests to Evaluate the Chemical Resistance of Geomembranes to Liquids[5]

2.2 *Other Document:*

SW 846, Method 9090 Compatibility Test for Wastes and Membrane Liners[6]

3. Terminology

3.1 Definitions—For definitions of many terms used in this practice, refer to Terminologies D 123 and D 4439.

3.2 *Descriptions of Terms Specific to This Standard:*

3.2.1 *chemical resistance*—the ability to resist chemical attack.

3.2.1.1 *Discussion*—The attack is dependent on the test method, and its severity is measured by determining the changes in physical properties. Time, temperature, stress, and reagent may all be factors affecting the chemical resistance of a material.

3.2.2 *geosynthetic, n*—a planar product manufactured from polymeric material used with soil, rock, earth, or other geotechnical engineering-related material as an integral part of a man-made project, structure, or system.

4. Significance and Use

4.1 This practice provides a standard immersion procedure for investigating the chemical resistance of a geosynthetic to a liquid waste, leachate, or chemical. The conditions specified in this practice are intended both to provide a basis of standardization and to serve as a guide for those wishing to compare or investigate the chemical resistance of a geosynthetic material(s).

4.2 This practice is not intended to establish, by itself, the behavior of geosynthetics when exposed to liquids. Such behavior, referred to as chemical resistance, can be defined only in terms of specific chemical solutions and methods of testing and evaluation criteria selected by the user.

4.3 Without regulatory approval, this practice does not supersede testing requirements, such as SW 846, Method 9090, stipulated by regulatory agencies.

5. Apparatus

5.1 *Exposure Tank,* for containment of the solution and test material. The tank must be chemically resistant and impermeable to the solution being used. Stainless steel or glass is recommended. Glass should not be used with strongly basic solutions.

5.1.1 The size of the exposure tank is not specified since the volume of liquid to be used with any given amount of immersed geosynthetic has not been standardized by ASTM or specified by the Environmental Protection Agency at the time of the writing of this practice. Sufficient liquid must be used to ensure the presence of any potentially detrimental chemicals

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[1] This practice is under the jurisdiction of ASTM Committee D35 on Geosynthetics and is the direct responsibility of Subcommittee D35.02 on Endurance Properties.

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[2] *Annual Book of ASTM Standards,* Vol 07.01.

[3] *Annual Book of ASTM Standards,* Vol 09.01.

[4] *Annual Book of ASTM Standards,* Vol 08.01.

[5] *Annual Book of ASTM Standards,* Vol 04.13.

[6] Available from US EPA, Office of Solid Waste and Emergency Response, Test Methods for Evaluating Solid Waste, Physical/Chemical Methods.

throughout the immersion. If sufficiently large exposure tanks are not possible, or if it is suspected that trace amounts of chemicals may be depleted from the liquid during the exposure, smaller tanks may be used if the immersion liquid is replaced with fresh solution after each test period.

5.2 *Exposure Tank Lid,* for sealing the tank. In order to prevent the loss of volatile components of interest, the tank must be capable of being sealed with a chemically resistant material.

5.2.1 Unless otherwise specified, agreed upon, or required, provisions must be made for maintaining ambient atmospheric pressure in the tank. Using a reflex condenser open to the air, a pressure relief valve or any method allowing the movement of gas to relieve pressure while minimizing changes in the chemical composition of the test solution is acceptable (see 9.7). The purpose of this feature of the equipment is to prevent pressure buildup in an exposure tank from the generation of gases by chemical reactions or biological activity.

5.2.2 Pressurized tanks that maintain a constant pressure may be used as an alternative to 5.2.1 when the maintenance of a pressure other than ambient atmospheric pressure is specified, agreed upon, or required.

5.3 *Temperature Control Equipment,* to maintain the immersion solution at the specified temperature. Options that have worked well are the following: (*1*) a hot water bath to contain the exposure tank; (*2*) a heating coil wrapped around the tank, or a hot plate used in conjunction with a thermostat and thermocouple; and (*3*) a room controlled at the exposure temperature for storing the tank. Placing a heating coil directly in the exposure solution is not recommended since corrosion may affect the coil, and chemical reactions that may not otherwise occur may occur on a hot coil.

5.4 *Stirrer,* if required (see 9.4), for mixing the solution. Magnetically moved stirring bars and mechanical stirrers entering the tank through the lid will both work, depending on the temperature control procedure.

6. Reagents and Materials

6.1 *Immersion Solution*—The solutions potentially used with this practice have large differences in origin. The user of this practice must determine the correct solution for use in the particular application. Liquid wastes, leachates collected from existing installations, leachates made from solid wastes, synthetic leachates made from laboratory chemicals, standard chemical solutions (Test Method D 543), and reference fuels and oils (Test Method D 471) are some of the possibilities.

7. Hazards

7.1 The solutions used in this practice may contain hazardous chemicals. Precautions must be taken when handling hazardous waste, chemicals, and immersion solutions. Protective equipment suitable for the chemicals being used must be worn by all personnel handling or exposed to the chemicals. Care should be taken when opening storage vessels at elevated temperatures, due to the increased volatility of organics and increased activity of acids and bases. Care must also be taken to prevent the spilling of hazardous materials, and provisions must be made to clean up any accidental spills that do occur.

8. Sampling

8.1 Samples of the geosynthetic(s) to be immersed should be taken in a manner appropriate for the particular material. It is essential that all of the material immersed, as well as the unexposed material to be tested, have physical properties that are as similar as possible. Refer to the section on sampling in the applicable standard for the chemical resistance of the specific geosynthetic to be tested.

9. Procedure

9.1 *Tank Preparation*—Clean the tank and lid thoroughly prior to introduction of the sample or liquid. Use distilled or deionized water for the final rinse of the cleaning procedure.

9.2 *Sample Exposure*—Hold the geosynthetic material to be immersed in place in the exposure container in such a way that contact with the container and other sheets of material is limited as much as possible.

9.2.1 Do not immerse different types of geosynthetic materials in the same immersion vessel.

9.2.2 Add the liquid to the tank with the test samples in place. The liquid must cover the samples completely.

9.2.3 If the liquid is placed in the tank at ambient temperature and heated subsequently to an elevated immersion temperature, the liquid will expand to a greater volume. This can result in the volume of the liquid exceeding the capacity of the tank and thus a spill of hazardous materials. Expansion of the liquid should be anticipated and procedures prepared for the containment of excess liquid.

9.3 *Sealing the Tanks*—Unless otherwise specified, agreed upon, or required, seal the exposure tanks with no air if the solution contains volatile organics or if the solution to be in contact with the geosynthetic will exist in the field under buried conditions. The pressure inside the tank must be the same as that outside the tank.

9.3.1 Do not seal the exposure tanks and leave an air space equal to 10 ± 2 % of the volume of the exposure tank if there are no volatile organics in the solution and the geosynthetic will be used under free air exchange conditions in the field. If the tank is not sealed, the solution must be monitored closely for volume changes due to evaporation or water absorption. Evaporation must be minimized as much as possible. Replace evaporated water with distilled or deionized water. Keep a record of the volume of water added and the date water was added. If the solution picks up moisture, store the tank in a low-humidity environment to eliminate the problem.

9.4 *Stirring the Solution*—Stirring the immersion liquid is required unless evidence can be offered that stirring is not necessary to maintain a homogeneous solution. By keeping the solution circulating slowly, fresh solution is constantly passing over the surface of the geosynthetic, thereby preventing a stagnant layer of reacted or used liquid from existing around the geosynthetic and thus stratification or settling of chemical constituents.

9.4.1 If the immersion liquid consists of two separate immiscible liquids, and if the volume of the lesser of the two liquids constitutes a significant portion of the solution (greater than 1 %), two separate immersions should be conducted with

the two liquids, if it is possible to collect enough of the lesser solution to perform the immersion.

9.5 *Immersion Temperatures*—Recommended standard temperatures are 23°C (73°F) and 50°C (122°F). Higher temperatures may affect the synthetic material adversely in a manner that would not occur at the lower temperatures. Immersion at temperatures above 50°C is not recommended unless the material is to be used at higher temperatures. Maintain the temperature of the exposure tanks within 2°C (4°F) of the selected immersion temperature.

NOTE 1—Caution must be used in interpreting the results from an elevated temperature immersion. The magnitude of changes seen at elevated temperatures, such as weight gain, may never occur at room temperature, regardless of the exposure period. Biological activity that may have an effect on the material may be terminated by the high temperatures. If possible biological attack on the material is expected, other tests for biological resistance should be conducted in addition to the chemical resistance test.

9.6 *Test Period Selection*—In addition to testing the unexposed geosynthetic material, conduct testing after four immersion periods. Immerse sufficient material for the planned immersion periods plus two additional periods. Testing after more than four periods may be necessary, if warranted by changes observed in the material, or if additional data are necessary due to erratic or inconclusive results.

9.6.1 In the absence of other specifications or user requirements, the standard immersion periods are 1, 2, 3, and 4 months.

NOTE 2—One month is intended to be approximately 30 days. Months are specified rather than a certain number of days in order to allow compensation for weekends and holidays during a test program.

NOTE 3—Testing after time periods longer than four months may be desirable to demonstrate long-term chemical resistance. Shorter test periods may be appropriate, if it is necessary to demonstrate only that a gross lack of chemical resistance does not exist, or if the geosynthetic is intended for use in contact with the liquid for only a short time period (less than the normal four-month immersion period) and is not intended for use after the short-term utilization.

9.7 *Maintaining Solution Chemistry*—If it is suspected that trace amounts of chemicals may be depleted from the liquid, or that the chemical nature of the liquid changes with time, it is recommended that the immersion liquid be replaced with fresh solution after each test period. If the liquid is to be replaced periodically, it is important that the fresh liquid be from the same source as the original liquid and that the fresh liquid be as similar to the original liquid as possible.

NOTE 4—The solution may need conditioning if it can be demonstrated that the solution chemistry will change under exposure conditions. If necessary, condition the liquid in a container separate from the tank holding the test samples. After 24 hours under exposure conditions, pour the conditioned liquid into the tank with the test samples in place.

9.8 *Test Procedures*—The actual physical testing of the geosynthetic materials before and after exposure is not covered in this practice. Practice D 5747 or SW 846, Method 9090 may be of interest for geomembrane testing.

NOTE 5—Additional test procedures for yielding test data are being provided in other guides presently being developed by ASTM Committee D-35.

10. Report

10.1 State that the procedures used were as directed in this practice.

10.2 Describe the material or product evaluated and the sampling method.

10.3 Include the following information in the report for the immersion procedure:

10.3.1 Description of the origin and chemical character of the immersion liquid.

10.3.2 Results of the centrifuging, if performed.

10.3.3 Composition of the tanks and lids.

10.3.4 Manner in which the tanks were sealed (tightly or not).

10.3.5 If the tanks were not sealed, a record of the level of the liquids and any water or chemical additions.

10.3.6 Whether the liquid was changed after each test period. If not, the basis of the decision.

10.3.7 If the liquids were stirred, approximate speed and size of the stirring device.

10.3.8 Immersion temperatures.

10.3.9 Whether an unacceptable deviation from the allowed temperature range occurred.

11. Keywords

11.1 chemical compatibility; chemical resistance; geosynthetics; immersion