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Standard Test Methods for Sorbent Performance of Absorbents¹

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1. Scope

1.1 These test methods cover the development of laboratory test data which describe the performance of absorbent materials used to remove oils and other compatible fluids from water.

1.2 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.3 *This standard should be used to measure and describe the properties of materials, products, or assemblies in response to heat and flame under controlled laboratory conditions and should not be used to describe or appraise the fire hazard or fire risk of materials, products, or assemblies under actual fire conditions. However, results of this test may be used as elements of a fire risk assessment which takes into account all of the factors which are pertinent to an assessment of the fire hazard of a particular end use.* (For a specific warning statement see 10.4.)

2. Referenced Documents

2.1 *ASTM Standards:*²

F726 Test Method for Sorbent Performance of Adsorbents

2.2 *Federal Standard:*

Fed. Std. No. 141a Paint, Varnish, Lacquer and Related Materials. Methods of Inspection, Sampling and Testing³

2.3 *Military Specification:*

MIL-I-631D Insulation, Electric, Synthetic Resin Composition, Nonrigid³

3. Terminology

3.1 *General Terminology:*

¹ These test methods are under the jurisdiction of ASTM Committee F20 on Hazardous Substances and Oil Spill Response and are the direct responsibility of Subcommittee F20.22 on Mitigation Actions.

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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.

³ Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5098, Attn: NPODS.

3.1.1 *gellant*—a material such as a colloidal network or other aggregate network that pervades and holds a liquid in a highly viscous fragile structure. Many gels may rapidly liquefy with added heat or ionic/polar addition. These materials are soluble/flowable in excess liquid.

3.1.2 *sorbent*—an insoluble material or mixture of materials used to recover liquids through the mechanisms of absorption or adsorption, or both.

3.1.3 *thickener*—a material (usually of higher molecular weight) that is soluble in excess liquid. These materials go from dry to gummy (viscoelastic) to flowable and then soluble. The final viscosity depends only on the liquid to solid ratio.

3.1.4 *universal sorbent*—an insoluble material or mixture of materials that will sorb both hydrophobic and hydrophilic liquid spills.

3.2 *Definitions:*

3.2.1 *absorbent*—a material that picks up and retains a liquid distributed throughout its molecular structure causing the solid to swell (50 % or more). The absorbent is at least 70 % insoluble in excess liquid.

3.2.2 *adsorbent*—an insoluble material that is coated by a liquid on its surface including pores and capillaries without the solid swelling more than 50 % in excess liquid.

3.3 *Definitions of Terms Specific to This Standard:*

3.3.1 *oil*—a substantially water immiscible organic liquid that will float on water (density less than 1 g/cm³), typically with surface tension less than 40 x 10⁻³.

3.3.2 *Type I absorbent (roll, film, sheet, pad, blanket, web)*—a material with length and width much greater than thickness and which has both linear form and strength sufficient to be handled either saturated or unsaturated.

3.3.3 *Type II absorbent (loose)*—an unconsolidated, particulate material without sufficient form and strength to be handled except with scoops and similar equipment.

4. Summary of Method

4.1 The absorbent material is tested using established standard methods, where applicable, and specially developed tests for performance factors.

5. Significance and Use

5.1 These methods are to be used as a basis for comparison of absorbents in a consistent manner.

5.2 These tests are not appropriate for adsorbent materials which are covered in Test Method **F726**.

5.3 These methods are not useful for a comparison of absorbents with adsorbents, even though all absorbents exhibit adsorbent properties. Both types of materials have prime areas of utility.

5.4 These methods may not list all the safety and disposal options necessary for safe ultimate disposal of used sorbent material into the environment. Federal, state, and local regulatory rules must be followed.

6. Special Considerations

6.1 *Solubility*—Fluid should not dissolve the absorbent under normal recovery or handling conditions.

6.2 *Reuse*—Used absorbent materials may be recycled under certain conditions. Fluid absorbed cannot be released with squeezing. However, many of the polymeric materials will depolymerize at temperatures at or below those in a refinery pipe still. This means they are recoverable, although in a different form. Along with resource recovery, the harvestability of sorbents will become more important. Lower boiling materials may also be steam stripped from absorbents to recover both fluid and absorbent.

6.3 *Release of Volatiles*—Certain volatile materials picked up by sorbents may create a vapor hazard by increasing the exposed surface area and therefore vapor release. Depending on the material picked up, this may increase fire or health hazard (see **10.4**).

6.4 *Release to an Alternative Material Such as Sand*—The tendency to release sorbed liquid to beaches, ground, clothing of personnel, and so forth, both as liquid and vapor can be determined on a basis of priority (see **11.5**).

6.5 *Penetration*—Absorbents may be useful as sealing devices and the penetration test will allow a uniform means of determining the efficacy of a material for this use.

7. Apparatus

7.1 *Exterior Exposure Tester*, sufficient for use with Fed. Std. No. 141a, Method 6152 (*optional*).

7.1.1 Actual outdoor exposure in a direction averaging the maximum exposure in a sunny area, such as Southern Florida or Arizona, is desired. Exposure should be listed in months with total sun days.

7.1.2 Actual outdoor exposure for a period of three months at a testing site should be listed.

7.2 *Tension Tester*—Commercially available tester (*optional*).

7.2.1 Use of actual weights suspended from test pieces in turn suspended from a continuous reading hanging scale may be used. Shock loading may be simulated by fastening one end of a unit rigidly and attaching the maximum pickup weight to the bottom end hanging free. The weight can be raised 2.5 cm

and released and also 10 cm and again released. This test should be recorded as pass or fail.

7.3 *Continuous Reading Hanging Scales*—A continuous reading hanging scale fitted with a hook or clamp should be used. For testing units, weighing sensitivity shall be $\pm 2\%$. For small samples, postal-type scales may be used (0 to 80 g).

7.4 *Top Loading Balance*, having 0.5-g resolution for samples weighing at minimum 50 g or more. An accuracy of 2% is desired.

7.5 *Measuring Tubes*—10 and 100-mL graduated measuring cylinders of regular laboratory quality.

7.6 *Paper Towels*, for removing excess liquid from the absorbent.

7.7 *Oven-Dried Mason Sand*, for use in checking rate of release. Screen analysis is desired. Optionally, known screen size silica sand can be used.

8. Test Fluids

8.1 Test fluids may be used for general testing, although the actual fluid should be used where possible.

8.2 *Low-Viscosity Materials*—For low-viscosity material (like gasoline), use xylene which has a higher flash point. (For safety, a solution containing 10% methylene chloride can be added to aid in raising flash point.)

8.3 *Polar Solvents*—For polar solvents, use methylisobutylketone (hexone), butylacetate, and so forth.

8.4 *Medium-Viscosity Fluids*—For medium-viscosity fluids, No. 2 fuel oil, diesel fuel, JP-5, Jet A-1 (turbine fuel), or light crude oil (for example, light Arabian or Iranian crude), is recommended.

8.5 *High-Viscosity Fluids*—Nondetergent or C-10 Transformer dielectric oil (specify manufacturer and viscosity) is recommended.

8.6 *Range Finding Fluids*—Ethanol (95%), acetone, ethylene glycol, cyclohexane, 2-nitropropane are suitable fluids.

9. Conditioning

9.1 Condition three absorbent test specimens at room temperature (21 to 26°C) (70 to 80°F) in a closed vessel with 2.5 cm of water in the bottom. Suspend specimens in vapor space without contacting water for not less than 24 h prior to testing. Condition specimens in the fully exposed state with no coverings or wrapping that would hinder the equilibration process.

9.2 Condition three absorbent test specimens totally immersed in water at room temperature (21 to 26°C) (70 to 80°F) in a vessel with a minimum of 10 cm of water covering the absorbent for not less than 24 h prior to testing. Condition specimens in the fully exposed state with no coverings or wrapping which would hinder the equilibration process.

9.3 *Alternative Temperatures*—If temperature conditions other than room temperature are expected to be important, then the sorbent should be conditioned and tested at the temperature of use in addition to those specified in **9.1** and **9.2**.

10. Determination of Physical Characteristics of Absorbents

10.1 *Mildew*—The susceptibility of an absorbent to mildew under normal storage is described in MIL-I-631D. This optional test determines the expected shelf life under conditions which could lead to mildew. This test may be required when it is believed that this condition may exist prior to an emergency.

10.2 *Exterior Exposure*—This optional test may be performed in accordance with Fed. Std. No. 141a, Method 6152. Actual exposure in area of use for one month is preferable. Long-term testing is not necessary for materials that are to be used in emergency situations. For testing purposes both absorbent and adsorbent and other parts of a fabricated unit should be tested or exposed individually and reported.

10.3 *Humidity/Water Resistance*—This test is used to predict the performance of a product stored under high humidity or one that is water-soaked prior to use.

10.3.1 Condition all absorbent test specimens at room temperature (21 to 26°C) (70 to 80°F) in a closed vessel with 2.5 cm of water in the bottom. Suspend the specimens in vapor space without contacting water for 2 days (14 days optional). At the end of the exposure period, test the specimens for oil and water absorbency. Record weights before and after this conditioning.

10.3.2 Weigh specimens that are conditioned in water by being total immersed (9.2) immediately after removal from water and again after wringing out all excess water (typical hand wringer for laundry or equivalent). Test specimens for test fluid and water sorbency following both weighings.

10.4 *Flammability*—This test should indicate either contribution to an existing fire, that is, a UL rating of 94, if desired, or a simple rating of combustible or noncombustible and flashpoint by Cleveland open-cup. (**Warning**—All sorbent materials, even those considered nonhazardous, take on the characteristics of the material they pick up. If the material is flammable, the used absorbent material is flammable. If the fluid picked up is toxic, then the used absorbent should be handled as a toxic substance. Basic active absorbent and simple fabricated units are adequate for this test.)

11. Determination of Expected Performance

11.1 General:

11.1.1 Initial testing for performance can be accomplished with absorbent in the as-received condition. Conditioning as described in Section 9 may be necessary for special use or for special fluids to be absorbed. Good practice requires triplicate testing with results reported as the average.

11.1.2 For all tests, without exception, the fabricated materials or units must remain handleable (without tearing) at the maximum pickup rate reported while being held by a corner of the unit.

11.2 *Oily Material Absorption (Typically Type II Absorbent)*—This test provides a simple method of comparing the absorbing material's inherent capacity to absorb various fluids as well as compare ultimate capacity to do so. This test is run with an excess of fluid.

11.2.1 In a 10-mL graduated cylinder, place 2 mL of absorbent and weigh to determine the weight of absorbent. Place the 2 mL of absorbent into a 100-mL graduated cylinder. Add 50 mL of fluid to be tested, record level, then cap with a foil (aluminum or plastic)-wrapped cork or stopper. Agitate for short periods with a glass stirring rod. If at the end of 2 h there is still free liquid on top of the swollen absorbent or underneath if the fluid has a density greater than the absorbent, place a piece of 200-mesh screen (just slightly smaller than the inside diameter of the cylinder with at least four centering wires bent up at 90°) in the fluid to sit on top of the absorbent. Record the level of the swollen absorbent. If the fluid is much more dense than the absorbent, add an additional minimum weight on top of the screen to force the swollen absorbent to the bottom and then record the level of the screen. If this test gives a swell of less than 20 mL, repeat using 10 mL of absorbent in the 100-mL graduated cylinder. This empirical test may be replaced by a microscopic calibrated swell of a uniform absorbent particle in the fluid.

11.2.2 Swell may also be checked at 24 h for those specimens that have not shown maximum swell in 2 h. It should be recognized that a 2-h maximum swell may be acceptable but a 24-h swell will probably not be useful for a spill control unit without modification. Such a 24-h swell time may require modification of particle size, etc., to provide effective swell within 2 h. The report shall include the time required to reach maximum absorption if less than 2 h.

11.2.3 Increase in volume of the solid absorbent is the property that distinguishes an absorbent from an adsorbent. Free liquid should be poured out of the graduate cylinder and a weighing then made (with the tared screen). The weight of swollen absorbent allows calculation of absorption efficiency:

$$A = [(W_1 - W_2)/W_1] \times 100 \quad (1)$$

where:

W_1 = weight of absorbed material,
 W_2 = weight of unabsorbed material, and
 A = absorption efficiency for the fluid and absorbent being tested.

Type I absorbent material may be tested with inert material present such as sand, fibers, and so forth, that give a special property such as no stir dispersion or sufficient mass to serve as temporary diking. The inert material may be subtracted from the total weights to indicate the absorbent data. The penetration test in 11.4 may also be useful.

11.3 *Rate of Release*—This test can be used to estimate the degree of hazard in the case of flammable or hazardous materials. For those materials with vapor hazards or skin toxicity to humans these are important factors. (**Warning**—see 10.4.)

11.3.1 Place a standard sized (15 by 15 cm) weighed piece of an absorbent unit in a dish of fluid. Add excess fluid to assure total saturation of material. A saturation time of 30 min should be adequate although a 2-h test is well within the useful practical application time. If material to be absorbed is toxic, run this test in a ventilated fume hood.

11.3.2 Following thorough saturation, hang the absorbent units by one corner and weigh immediately (even if dripping).