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Standard Test Method for Silt Density Index (SDI) of Water [1]

This standard is issued under the fixed designation D 4189; 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 the silt density index (SDI) of water. This test method can be used to indicate the quantity of particulate matter in water and is applicable to relatively low (<1.0 NTU) turbidity waters such as well water, filtered water, or clarified effluent samples. Since the size, shape, and nature of particulate matter in water may vary, this test method is not an absolute measurement of the quantity of particulate matter.

1.2 This test method is not applicable for reagent grade water Types I, II, and III of Specification D 1193, or effluents from most reverse osmosis and ultrafiltration systems.

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.*

2. Referenced Documents

2.1 *ASTM Standards:*

D 1129 Terminology Relating to Water [2]

D 1193 Specification for Reagent Water [2]

D 3370 Practices for Sampling Water from Closed Conduits [2]

E 1 Specification for ASTM Thermometers [3]

3. Terminology

3.1 *Definitions*—For definitions of terms used in this test method, refer to Terminology D 1129.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *silt density index (SDI)*—an index calculated from the rate of plugging of a 0.45-µm membrane filter.

4. Summary of Test Method

4.1 Water is passed through a 0.45-µm membrane filter at a constant applied gage pressure of 207 kPa (30 psi), and the rate of plugging of the filter is measured.

4.2 The SDI is calculated from the rate of plugging.

5. Significance and Use

5.1 The SDI can serve as a useful indication of the quantity of particulate matter in water.

5.2 The SDI can be used to determine effectiveness of various processes such as filtration or clarification used to remove particulate matter.

5.3 The SDI has been empirically correlated with the fouling tendency of some water treatment equipment such as reverse osmosis devices.

5.4 The SDI may vary as a function of water temperature, and values obtained at different temperatures may not necessarily be comparable.

5.5 The SDI will vary with the membrane filter manufacturer. Thus, SDI values obtained with filters from different membrane manufacturers cannot be comparable.

6. Apparatus

6.1 *SDI Assembly*, as schematically described in Fig. 1. All wetted parts should be made of high-quality stainless steel or plastic to prevent contamination by corrosion products. Do not use reactive materials such as carbon steel or cast iron. Suitable filter holders, designed to withstand an operating gage pressure of 350 kPa (50 psi) can be obtained from suppliers of membrane filters.

6.2 *Membrane Filter*, 47 mm in diameter, gridded, and with a mean pore size in the range 0.45 ± 0.02 µm, inclusive. Use only filters that are packaged in the same orientation.

6.3 *Graduated Cylinder*, 500-mL capacity.

6.4 *Stopwatch*, graduated in hundredths of a minute.

6.5 *Thermometer*, liquid-in-glass, suitable for measuring the temperature of the water sample; capable of being read to within ± 1°C and conforming to the requirements as prescribed in Specification E 1.

7. Procedure

7.1 Assemble the apparatus as shown in Fig. 1 and set the pressure regulator at 207 kPa (30 psi).

7.2 Before installing the membrane filter, flush the water to be tested through the apparatus to remove entrained contaminants. For sampling, follow the procedure given in Practices D 3370. Discrete samples can be used with appropriate pressurizing apparatus such as a booster pump to obtain a feed supply gage pressure of >276 kPa (>40 psi).

7.3 Measure the temperature of the water.

7.4 Open the membrane filter holder and place a 0.45-µm membrane filter (47 mm in diameter) on the support plate of

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[1] This test method is under the jurisdiction of ASTM Committee D-19 on Water and is the direct responsibility of Subcommittee D19.08 on Membranes and Ion Exchange Materials.

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

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

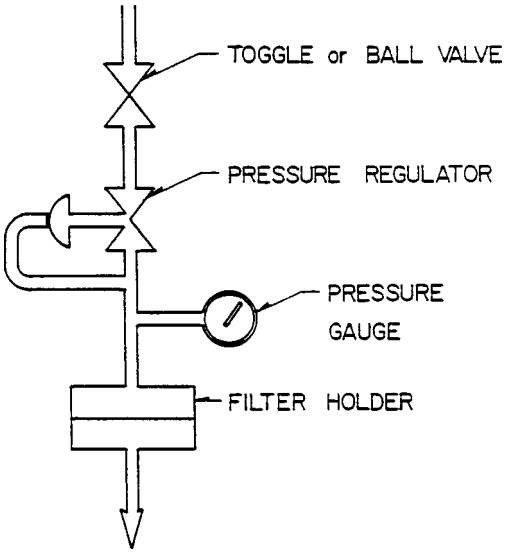

FIG. 1 Apparatus for Measuring the Silt Density Index

the holder. Some filter holders include a foam support pad, which should be used. Place the filter grid side up. Handle the membrane filter only with dull tweezers to avoid puncturing. Avoid touching the membrane filter with the fingers.

NOTE 1—Other membrane filter sizes, that is, 25 mm or 90 mm diameter, can be used.

NOTE 2—Record the manufacturer of the membrane filter and the manufacturer's identification for the membrane filter.

7.5 Make sure the O-ring is in good condition and properly placed. Replace the top half of the filter holder and close loosely.

7.6 Bleed out trapped air by cracking the ball valve. Close the valve and tighten the filter holder.

7.7 Open the ball valve. Simultaneously, using a stopwatch, begin measuring the time required for the flow of 500 mL. Record the time (t_i). Leave the valve open for continued flow.

NOTE 3—Time (t_i) to collect 500 mL should be within± 10 % of the time to collect 500 mL using nonplugging reference water at the same water temperature. The nonplugging reference water can be obtained by filtering distilled water through a 0.2-µm pore size membrane filter.

NOTE 4—If t_i is less than 90 % of the nonplugging time, the filter may be cracked and a new filter should be used. If t_i is more than 110 % of the nonplugging time, then a smaller sample size, that is, 250 mL or 100 mL should be used.

NOTE 5—The 500-mL sample size is based on a 47-mm diameter filter. If a different filter size is used, adjust the sample size in direct proportion to the filter area.

7.8 Measure and record the times to collect additional 500-mL (Note 6) volumes of sample, starting the collection at 5, 10, and 15 min of total elapsed flow time. Measure the water temperature and check the pressure as each sample is collected (Note 7 and Note 8).

NOTE 6—If the initial size was not 500 mL, use the same sample size as used in 7.7.

NOTE 7—The pressure must remain at 207 ± 7 kPa (30± 1 psi) throughout the test.

NOTE 8—The water temperature must remain constant (±1°C) throughout the test. This is necessary because flow rate changes by about 3 %/°C.

7.9 After completion of the test, the membrane filter may be retained for future reference.

8. Calculation

8.1 Calculate the silt density index (SDI_T) as follows:

$$SDI_T = \frac{\% P_{30}}{T} = \frac{\left[1 - \frac{t_i}{t_f}\right] 100}{T}$$

where:

$\% P_{30}$ = percent at 207 kPa (30 psi) feed pressure,
T = total elapsed flow time, min (usually 15 min, see Note 9),
t_i = initial time required to collect 500 mL of sample, s, and
tf = time required to collect 500 mL of sample after test time T (usually 15 min, see Note 9), s.

NOTE 9—For this test method, % *P*30 should not exceed 75 %. If % P_{30} exceeds this value, use a shorter time for *T*; that is, 5 or 10-min measurements in 7.8. If % P_{30} exceeds 75 % after 5 min, other test methods should be used to analyze for particulate matter.

9. Report

9.1 Report the following information:

9.1.1 The SDI, with a subscript indicating the total elapsed flow time (*T*) in minutes,

9.1.2 The water temperature before and after the test, and

9.1.3 The manufacturer of the 0.45-µm membrane filter used for the test, as well as the manufacturer's identification for the membrane filter.

10. Precision and Bias [4]

10.1 The interlaboratory test was performed by nine operators from five laboratories using test waters of their choice, whose SDI values varied from 0.4 to 15. Waters used included RO permeate, deionized water, tap water, and undefined process water. The pooled single operator precision is 0.43.

10.2 Only pooled single operator precision was determined for this test method. The test method is very sensitive to both quantity and size of suspended particles, which contribute to the plugging of the membrane filter. Maintenance of the integrity of the samples cannot be guaranteed through preparation of the bulk mix, subsampling for testing, shipping, and holding. Moreover, approximately 5 gal of sample are required for each SDI test run. Thus, if large stock solutions exhibiting different SDI values could be prepared and if representative 30 to 55 gallon subsamples could be drawn, shipping two or three of these samples to each of six or more laboratories for full-scale testing was not considered to be practical.

10.3 The bias of this test method cannot be determined because the test method is based upon waters of choice, which may differ with each source.

10.4 It is the user's responsibility to ensure the validity of this test method for waters of untested matrices.

[4] Supporting data for this test method are available from ASTM Headquarters. Request RR: D19 – 1151.

11. Keywords

11.1 RO; reverse osmosis; SDI; silt density index