Designation: D6157 – 97 (Reapproved 2011)

Standard Practice for Determining the Performance of Oil/Water Separators Subjected to a Sudden Release[1]

This standard is issued under the fixed designation D6157; 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 describes the testing procedure, any necessary related apparatus, and the sampling technique to be used in determining the performance characteristics of an oil/water separator subjected to the sudden release of a relatively large quantity of hydrocarbons that may appear in its influent in pure form or at high concentration.

1.2 This practice does not address the determination of the performance characteristics of an oil/water separator subjected to surface run-off resulting from rain water draining from improved or unimproved land. In this case, refer to Practice D6104.

1.3 This practice does not address the determination of the performance characteristics of an oil/water separator subjected to *a mechanically emulsified influent such as provided by a pump.*

1.4 This practice does not investigate the ability of the separator to handle debris or suspended solids, that is, grit or tree leaves.

1.5 While the effluent may meet code requirements for total oil and grease content, this practice does not address the presence of soluble organics, that is, benzene, toluene, ethylbenzene and xylene (BTEX's) that may be detected in the effluent. It also does not make any provisions for the effects of detergents, surfactants, soaps or any water soluble matter (that is, salts) or any portion of an essentially insoluble matter that may be found in solution on separation. (Effects of certain water soluble chemicals or solids may be investigated by adding them to the water at predetermined constant concentrations.)

1.6 In order to estimate the effect of water temperature on the performance of the separator, the tests described in this practice must be performed at two water temperatures. The selected temperatures must be at least 10 °C (18 °F) apart, with the temperature ranging from a minimum of 0 °C (32 °F) to a maximum of 50 °C (122 °F).

1.7 This practice does not make any provisions for the variation of pH or temperature during a test run. Refer to Appendix X1 for further detail.

1.8 This practice can be used with a variety of hydrocarbons. It adopts No. 2 fuel oil with a density[2] of 845 kg/m^3 (52.73 lb$_m$/ft^3) and a viscosity[2] of 1.9 to 4.1 centistokes at 40 °C (104 °F) and SAE 90 lubricating oil with a density (See SAE J313) of 930 kg/m^3 (58 lb$_m$/ft^3) at 15.5 °C (60 °F) and a viscosity (See SAE J306) of 13.5 to <24 centistokes at 100 °C (212 °F) as the comparative testing media. It is understood that the results obtained from this practice are only directly applicable to No. 2 fuel oil and SAE 90 lubricating oil for the tested concentrations and only careful interpolation or extrapolation, or both, is allowed to other hydrocarbons. Low viscosity or high density hydrocarbons or hydrocarbons that contain a larger fraction of highly soluble compounds may need to be tested separately.

NOTE 1—No extrapolation outside the range of the tested influent or effluent oil concentrations is allowed as performance may not be linear. Hence, to establish performance at a higher or lower concentration, the separator shall be tested for that specific condition. In addition, linearity must be established prior to using linear interpolation.

1.9 Since regulations are based on effluent total hydrocarbon content, this practice does not set forth any lower limits on oil particle size for the evaluation of separator efficiency. However, a standardized means for mixing oil and water shall be specified to ensure repeatability. It must be noted however that smaller particles, having a greater surface area to volume ratio, rise at a slower rate than their larger counterparts. (Guide F933 requires that 20 % of all oil particles be smaller than or equal to 50 µm and IMO MEPC 60 (30) does not mention any particle size requirements but asks the user to avoid emulsion causing chemicals.)

1.10 Although the tests described in this practice intend to simulate the performance of a separator subjected to a sudden release, they do not cover all possible applications. It is the end

---

[1] This practice is under the jurisdiction of ASTM Committee D19 on Water and is the direct responsibility of Subcommittee D19.06 on Methods for Analysis for Organic Substances in Water.

Current edition approved May 1, 2011. Published June 2011. Originally approved in 1997. Last previous edition approved in 2003 as D6157 – 97 (2003). DOI: 10.1520/D6157-97R11.

[2] Ray E. Bolz and George L. Tuve, CRC Handbook of tables for Applied Engineering Science, 2nd Edition, CRC Press, 1991.

user's responsibility to determine whether his separation requirements are within the scope of this practice.

1.11 A product different from the general description herein may be tested and found to be in compliance with the performance criteria set forth.

1.12 The values stated in SI units are to be regarded as the standard. The inch-pound units given in parentheses are for information only.

1.13 *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:*[3]

D1129 Terminology Relating to Water

D3370 Practices for Sampling Water from Closed Conduits

D4281 Test Method for Oil and Grease (Fluorocarbon Extractable Substances) by Gravimetric Determination

F933 Guide for Evaluation of Oil Water Separation Systems for Spilled Oil Recovery Applications (Discontinued 2001) (Withdrawn 2001)[4]

D6104 Practice for Determining the Performance of Oil/Water Separators Subjected to Surface Run-Off

2.2 *EPA Standards:*

EPA-413.1, "Methods for Chemical Analysis of Water and Wastes," EPA 600/4-79-020[5]

EPA-413.2, "Methods for Chemical Analysis of Water and Wastes," EPA 600/4-79-020[5]

EPA-1664, H-Hexane Extractable Material (HEM) and Silica Gel Treated N-Hexane Extractable Material (SGT-HEM) by Extraction and Gravimetry (Oil and Grease and Total Petroleum Hydrocarbons) EPA-821-B-94-004B[5]

40 CFR Ch. 1 (7-1-95 Edition)[5]

2.3 *SAE Standards:*

SAE J306 Axle and Manual Transmission Lubricant Viscosity Classification[6]

SAE J313 Surface Vehicle Recommended Practice — (R) Diesel Fuels[6]

3. Terminology

3.1 *Definitions*—For definitions of terms used in this practice, refer to Terminology D1129.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *calibration*—the certified evaluation of the accuracy of a measuring instrument as performed by its manufacturer or an independent licensed or accredited third party.

3.2.2 *contaminated run-off*—rain water which has collected oily contaminants from the surfaces it came in contact with and which may appear in the influent to a separator. Unlike a release, the level of contamination in this case is much lower.

3.2.3 *effluent*—the aqueous release from a separator.

3.2.4 *flow totalizer*—a counter, usually attached to a flow meter, that evaluates the total volume of the fluid that has flowed through over a given time period.

3.2.5 *influent*—the oily aqueous input to a separator.

3.2.6 *oily discharge*—any release of oily contaminants into the environment that exceeds the allowable limit.

3.2.7 *re-entrainment*—the condition in which the level of contamination of the effluent water of a separator containing oil is higher than the influent contamination level due to internal remixing. This definition usually applies to situations where clean water passes through a separator that already contains Hydrocarbons stored within and atop the water so as to form an interface.

3.2.8 *release*—any sudden discharge of an oily substance from vessels that are specifically designed to store, contain, or transfer oily products such as storage tanks, pipelines, diked areas, and transfer equipment and which may appear in the influent to a separator.

3.2.9 *separator*—a flow through primary treatment device the primary purpose of which is to separate oil from water.

4. Summary of Practice

4.1 The practice evaluates a separator's ability to inhibit a sudden release from escaping into its effluent. For this, a quantity of hydrocarbon constituting at least the rated oil storage capacity of the separator is released at the separator's rated flow for the test conditions, either in pure form or mixed with water to form a 500 000 mg/L concentration. It is then immediately followed with fresh water. The corresponding effluent hydrocarbon content is determined by obtaining and analyzing grab samples.

4.2 The data generated in this practice are considered valid for the separators tested only. However, the results of these tests may be extrapolated to smaller or larger size separators provided that applicable geometric and dynamic similitude are maintained. Where the use of extrapolation is not applicable, that size unit must be subjected to testing.

4.3 Other concentrations and quantities of hydrocarbons may be used. However, this shall be noted in the report and when referencing this practice.

4.4 For the purpose of this test, the water temperature should be between 50°F and 70°F and the pH of the water between 6 and 9.

5. Significance and Use

5.1 The Clean Water Act promulgated the implementation of water quality standards and contamination limits for a wide

---

[3] 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.

[4] The last approved version of this historical standard is referenced on www.astm.org.

[5] Available from United States Environmental Protection Agency (EPA), Ariel Rios Bldg., 1200 Pennsylvania Ave., NW, Washington, DC 20460, http://www.epa.gov..

[6] Available from SAE International (SAE), 400 Commonwealth Dr., Warrendale, PA 15096-0001, http://www.sae.org.

range of pollutants including oil and grease. Specifically, the USEPA, in 40 CFR Ch. 1, prohibits "the discharges of oil that cause a film or sheen upon or cause discoloration of the surface of the water. . ." Several state and local agencies have adopted this statement in addition to setting concentration limits, that is, 15 mg/L or even 5 mg/L. The purpose of this practice is to evaluate the performance of a separator in regards to the regulations and user requirements when subject to a sudden release. The sudden release may occur in dry weather and local personnel may attempt to hose the contaminated area down or it may occur on a rainy day and enter the separator mixed in with the runoff.

5.2 This practice is not applicable if the influent to a separator is simply runoff from contaminated rainwater. For this case, see Practice D6104.

5.3 This practice is not applicable if the influent to a separator is conveyed by a pumping means.

6. Test Set-Up and Apparatus

6.1 *Water Supply*—The water supply can be either a water main, a water reservoir and a pump, or an elevated storage tank capable of providing the volume and flow rate of water necessary for a test run as described in the procedure. If either a storage tank or reservoir is used, it is suggested that the volume be at least three times the liquid volume of the separator.

6.1.1 *Flow Totalizer or Sight Glass*—The water supply should be equipped with a calibrated means of indicating the total volume of water dispensed, that is, a flow totalizer or a sight glass. The selected device should be within 5 % accuracy.

6.1.2 *Flow Rate Indicator*—The water supply must also be equipped with a calibrated means of controlling and indicating the flow rate, i.e., throttling valve and flow meter, orifice plates, or venturis, to within 5 % of the desired value.

6.2 *Oil Supply*—The oil supply can be either a reservoir with a pump or an elevated storage tank. It should be large enough to store the quantity of oil required for the test.

6.2.1 *Flow Totalizer or Sight Glass*—The oil storage tank should be equipped with a calibrated sight glass or flow totalizer. The selected device should be within 5 % accuracy.

6.2.2 *Flow Rate Indicator*—The oil supply should also be equipped with a calibrated means of controlling and indicating the flow rate, that is, throttling valve and flow meter, orifice plates, or venturis, to within 5 % of the desired value.

NOTE 2—If the separator is to be fed by gravity, the oil storage tank must be elevated above the water storage tank and the piping sized so as to help equalize static head. Elevating the oil storage tank 20 % higher than the water storage tank may help equalize hydrostatic head between the oil and water tanks by adjusting for the difference in specific gravity.

6.3 *Separator*—A separator with an outlet pipe extending far enough to allow grab sampling as described in D3370.

6.4 *Mixer*—A means for mixing the hydrocarbons with the water consisting of a commercially available horizontal PVC pipe section with a minimum surface roughness of 0.000 15 cm (0.000 005 ft) having a length of at least 20 diameters with one end connected directly to the inlet of the separator. An oil injection port shall be provided at the other end of the pipe and at its bottom portion and shall not extend into the pipe more than one third its diameter in order to prevent stratification[7]. The pipe diameter shall be selected such that it runs full and at a Reynolds number, based on its hydraulic diameter, in excess of 70 000 and a velocity in excess of 1 m/s (3.28 ft/s) with water being the liquid medium. The injection port diameter shall be sized to be capable of providing the hydrocarbons into the pipe, at the higher test concentration, an injection velocity approximately in excess of 1 m/s.

6.5 *Influent Sampling Port*—An influent sampling port for temperature and pH reading. (If on-line temperature and pH readers are not available, a small sample should be extracted and the temperature read immediately at the beginning of every test. pH analysis may be performed at a later time.)

7. Procedure

7.1 The separator shall be tested at its rated flow and storage capacities for the sudden release test conditions.

7.2 *The Sudden Release:*

7.2.1 *Pure Hydrocarbon Release*—The volume of the pure hydrocarbon shall be at least equal to the rated storage capacity of the separator and shall be released at the rated flow followed immediately by three volume changes of clean water.

7.2.2 *500 000 mg/L Release*—The 500 000 mg/L of hydrocarbon constituting 10 % of the volume of the separator mixed with water shall be released at the rated flow and immediately followed by three volume changes of clean water. The separator shall contain a volume of hydrocarbons equal to its rated storage capacity minus the 10 % that will constitute the sudden release. For example, a separator with a 1000 L liquid volume and a hydrocarbon storage capacity of 250 L shall be subjected to a sudden release of 100 L of hydrocarbon and shall contain 150 L of hydrocarbons initially. The hydrocarbon being diesel No. 2 fuel with a specific gravity of 0.83, the volume of water required to form the 500 000 mg/L mixture is 66 L and is obtained as follows:

$$V_w = \frac{0.83 \times 100 \times 10^{6}}{500\,000} - 100$$

7.2.2.1 Assuming that the rated flow capacity for the separator under these conditions is 50 L/min, the oil and water shall be simultaneously pumped at 30.12 and 19.88 L/min., respectively, for a period of 3.32 min ((100 + 66)/50).

7.3 Effluent grab samples shall be taken at every one third (⅓) volume change of the separator volume. Samples shall be gathered and handled in accordance with D3370.

7.4 Each sample container shall be labeled with a serial number and a run number, the date of the test, and the initials of the person performing the test.

7.5 The run number, date, water temperature and pH, the number of samples taken, the flow rate, influent oil concentration and the total volume of water, the model number of the separator, and a description of any ancillary equipment shall be

---

[7] Robert H. Perry and Don Green, Perry's Chemical Engineer's Handbook, 6 th Edition, McGraw-Hill, 1984.

recorded and the data sheet signed by a registered or licensed third party present during the test.

7.6 Samples shall be analyzed by a independent testing laboratory certified for the selected method in accordance with Test Method D4281, EPA 413.1, EPA 413.2, EPA-1664 or other EPA approved standard. The analytical standard used must be specified.

7.7 *General Notes:*

7.7.1 All measuring instruments, metering pumps and other auxilliary equipment must be calibrated prior to testing and certified prior to testing.

7.7.2 In the case of custom build equipment, the method of calibration must be clearly described and attached to the report and such calibration must be performed by a certified or registered independent third party.

8. Report

8.1 The report shall clearly indicate the tested separator make and model as well as the manufacturer's description, including all standard ancillary equipment.

8.2 The report shall include a copy of all the laboratory sample analysis reports including the analysis method. The report must bear enough pertinent information in order to correlate it to the particular test that was performed as well as the signature of an official laboratory representative.

8.3 Representation of the data shall contain the separator make and model, the initial volume of oil stored within, the rated oil storage capacity, the rated flow, the type of sudden release, the total number of volume changes, the date the test was performed, the water temperature and pH, the type of oil used, its specific gravity, viscosity and temperature, the flow rate, the diameter and length of the mixing pipe, and the name and signature of person who performed the test.

8.4 All tables shall have the peak and average effluent contamination values listed.

APPENDIXES

(Nonmandatory Information)

X1. EFFECTS OF pH AND TEMPERATURE ON SEPARATION

X1.1 Elevated pH levels may reduce the separation efficiency of a separator whereas reduced pH levels may enhance separation. Similarly, changes in temperature may also affect separation efficiency. For example, a reduction in temperature from 18 °C (65°F) to 10 °C (50 °F) may cause an increase in the specific gravity of the water of only 0.12 %. However, it causes a 25 % increase in the dynamic viscosity of the water. Hence, the net effect of a decrease in temperature is adverse on separation efficiency. The same series of tests may be repeated at different pH levels or temperatures in order to determine their effect on separation.

X2. PARTICLE SIZE AND SEPARATION

X2.1 Finer dispersions of oil in the water entering a separator will result in reduced separator efficiency. In order to predict the performance of a separator in a given application, the oil droplet size distribution during the test must compare to the oil droplet size distribution in the field. To generate finer dispersions, the Reynolds number in the mixing pipe may be raised, a pipe with greater surface roughness may be selected or an orifice plate, or a static mixer may be used. As previously mentioned, this practice relies on a standardized mixing device to obtain a datum for comparison as opposed to using relatively expensive and often unreliable particle size measurement equipment.