



Designation: E1535 – 93 (Reapproved 2006)

## Standard Test Method for Performance Evaluation of Anaerobic Digestion Systems<sup>1</sup>

This standard is issued under the fixed designation E1535; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

### 1. Scope

1.1 This test method is applicable to all anaerobic digestion systems.

1.2 *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:*<sup>2</sup>

E1126 Terminology Relating to Biomass Fuels<sup>3</sup>

2.2 *Standard Methods (SM) for Analysis of Water and Wastewater:*<sup>4</sup>

2540 D Total Suspended Solids

2720 B Sludge Digester Gas (Volume)

4500 F  $\text{NH}_3^+$  Nitrogen (Ammonia)

4500 B Nitrogen (Organic), Total Kjeldahl Nitrogen

5210 B Biochemical Oxygen Demand

5220 B Chemical Oxygen Demand

5520 D Oil and Grease

### 3. Terminology

3.1 *Definition*—see Terminology E1126.

3.1.1 *biogas*—a composition of methane and carbon dioxide and minor constituents produced by the digestion of organic substrates in the absence of oxygen.

### 4. Summary of Test Method

4.1 This test method measures the concentration and mass of the influent and effluent wastes, respectively, as well as other operational parameters such as input energy, output gas pro-

duction, and waste biomass, to provide a methodology for evaluation of the operation of an aerobic digester.

### 5. Significance and Use

5.1 This test method will yield data that will form a performance profile for an anaerobic digester facility. The significance of this profile is that it can be compared directly to another facility's performance profile and yield a measurement of expected facility performance under field conditions.

5.2 This test method will also yield data that can be used to verify the operation of a system to a regulatory agency.

5.3 The single black box technique applied to performance evaluation examines only the overall input/output relationship. This implies that the operation of the facility during the tests will be conducted to achieve design conditions in accordance with established procedures.

### 6. Procedure

6.1 Conduct the test for a predetermined period mutually agreed upon by all parties participating in the testing program. Start the test period when the system manufacturer determines that the system has reached normal operating conditions. Record the time period between the initial loading of the system with waste and the start of the test period. A minimum test period of 90 days is suggested.

6.2 Determine the influent and effluent concentrations of the following, using the methods recommended, total suspended solids (TSS) SM 2540 D,  $\text{NH}_3^+$  nitrogen (ammonia) (AN) SM 4500 F, nitrogen (organic)-total kjeldahl nitrogen (TKN) SM 4500 B, biochemical oxygen demand (BOD) SM 5210 B, chemical oxygen demand (COD) SM 5220 B, and oil and grease (OG) SM 5520 D. The sampling frequency and location of sampling shall be mutually agreed upon by all parties involved in the project. As a minimum, weekly sampling of a composite sample of 24 h of influent and effluent is suggested.

6.3 Measure the gas production continuously, using SM 2720 B, or equivalent. Analyze the gas compositions using a gas chromatograph (GC) to determine the composition of  $\text{CH}_4$ . The GC analysis frequency shall be mutually agreed upon by all parties participating in the testing program.

6.4 Measure the thermal energy input. The most common method of thermal energy input is hot water supplied to the system using a heat exchanger. Monitor the energy input on a

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<sup>2</sup> 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.

<sup>3</sup> Withdrawn. The last approved version of this historical standard is referenced on www.astm.org.

<sup>4</sup> Available from American Public Health Association, 800 I Street, NW Washington, DC 20001.

**TABLE 1 Data Collection Form for Anaerobic Digestion System Performance Evaluation**

(1) Date:	_____
(2) Influent concentrations, mg/L	_____
Total suspended solids (TSS)	_____
Ammonia nitrogen (AN)	_____
Total Kjeldahl nitrogen (TKN)	_____
Biochemical oxygen demand (BOD)	_____
Chemical oxygen demand (COD)	_____
Oil and grease (OG)	_____
(3) Effluent concentrations, mg/L	_____
Total suspended solids (TSS)	_____
Ammonia nitrogen (AN)	_____
Total Kjeldahl nitrogen (TKN)	_____
Biochemical oxygen demand (BOD)	_____
Chemical oxygen demand (COD)	_____
Oil and grease (OG)	_____
(4) Cumulative system parameters measured during test	_____
Volume of waste processed, gal	_____
Waste density, lb/gal	_____
Volume of biogas produced, ft <sup>3</sup>	_____
Biogas methane content, weight %	_____
Solids wasted from reactor, gal	_____
Heating water supplied, gal	_____
Heating water supply temperature, °F	_____
Heating water return temperature, °F	_____
Total continuous horsepower, hp	_____
Chemicals added, name of chemical	_____
Chemicals added, lb	_____
Brief description of facilities included in test program.	_____
Data recorded by: _____	_____

continuous basis by measuring the flow rate of hot water to the system and the influent and effluent flow temperatures, using the reference procedures and equipment.

6.5 Record the horsepower of any motors connected more than 50 % of the time during a 24 h operation.

6.6 Record the weight of any material removed from the system during the test period.

**7. Calculation**

7.1 *Data Collection*—See **Table 1**.

7.2 *Data Calculations*—See **Table 2**.

7.3 *Data Summary*—See **Table 3**.

**8. Precision and Bias**

8.1 The precision and bias of this test method are still under evaluation.

**9. Keywords**

9.1 anaerobic digestion; biogas; biomass; waste treatment

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