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Standard Test Method for Measuring the Throughput of Resource-Recovery Unit Operations[1]

This standard is issued under the fixed designation E1107; 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 is for measuring the throughput, or mass flow rate, of a resource-recovery unit operation, or series of unit operations.

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

1.2.1 *Exception*—Paragraph 9.1.2 indicates the equivalent weight in pounds for samples with particle size greater than 90 mm.

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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.* Specific precautionary information is given in Section 7.

1.4 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D75/D75M Practice for Sampling Aggregates

E868 Test Methods for Conducting Performance Tests on Mechanical Conveying Equipment Used in Resource Recovery Systems (Withdrawn 2013)[3]

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *binary separator*—a mechanical device that separates a single input feed stream into two output feed streams.

3.1.2 *polynary separator*—a mechanical device that separates a single input feed stream into three or more output feed streams.

3.1.3 *processor*—a type of resource recovery unit operation with a single input feed stream and single output stream. Its function is to alter the physical or physico-chemical properties of the input feed stream. The mass flow rates of input and output streams should be equal unless moisture is lost.

3.1.4 *throughput*—the mass flow rate through a unit operation expressed, preferably, in units of kilograms per hour (kg/h) or alternatively in units of pounds per hour (lb/h).

3.1.5 *unit operation*—a basic step in a larger process consisting of multiple steps.

4. Summary of Test Method

4.1 The output streams of a separator or processor are collected over a measured period of time and weighed. Collection of the output stream is either in containers or by stopping, then clearing, portions of conveyor belts or chutes. For processing equipment in which materials separation is not accomplished, the input stream may be sampled if this is more convenient.

5. Significance and Use

5.1 This test method is used to document the mass flow rate of a resource recovery unit operation in a plant and as a means of relating operation to design objectives.

5.2 This test method is also used in conjunction with measurements of the performance of materials separators (particularly recovery and purity). As such, throughput should not generally be measured by sampling the feed since this may change its performance. Processing equipment that does not perform separations can be sampled at either the feed or product streams.

6. Apparatus

6.1 *Collection Bins*—Several size collection bins are required. The size is determined by the size of sample, which in

[1] This test method is under the jurisdiction of ASTM Committee D34 on Waste Management and is the direct responsibility of Subcommittee D34.03 on Treatment, Recovery and Reuse.

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

turn is determined by the throughput of the plant. Some streams can be sampled into drums or barrels.

6.1.1 All containers must be clean and in good mechanical condition, and not have rusting, flaking, or mechanically weakened sections. Containers should be cleaned with water or an air hose prior to use. (**Warning—**Air hoses must be used with appropriate safety equipment to avoid personal injury.)

6.1.2 The tare weight of the containers should be clearly marked with paint and checked periodically. Provision may be made for bin covers for the sampling and containment of materials that can be blown or spilled. Covers must be marked to indicate whether or not they are included in the tare weight of the container.

6.2 *Scales*—The type and size of scales varies with the size of the samples obtained. Containers as small as perhaps a drum to as large as perhaps a tote bin, roll-off container, or even full truck may be used. All scales should have a precision and accuracy of ±0.1 % of reading.

6.3 *Stopwatch*—Flow times are determined with a stopwatch capable of measuring to the nearest 0.1 s.

6.4 *Miscellaneous*—A variety of scoops, shovels, brushes, and similar tools are required to transfer materials.

7. Precautions

7.1 If samples are taken by transferring materials from a conveyor belt, it is essential to measure the belt's speed and use appropriate tools to be certain that all of the material, especially including fine particulate materials, are transferred.

7.2 Because the origin of all of the materials in solid waste is generally unknown, workers must use proper safety precautions when handling samples. Workers shall wear gloves and safety glasses. When appropriate, dust masks shall be worn. Workers shall be cautioned to wash their hands thoroughly before eating or smoking.

7.3 Safety precautions shall be taken when collecting samples or working near moving equipment.

8. Sampling

8.1 Samples are taken after the equipment has reached a steady-state operation. A steady-state operation is arbitrarily assumed after the equipment is operating for at least 30 min under what are considered to be normal conditions, or as otherwise agreed. The composition and type of feed may not be changed during this time.

8.2 After steady-state, samples are taken at agreed intervals.

8.3 The sample is taken by whatever method in Section 11 suits the separator or processor being sampled.

9. Test Specimen and Samples

9.1 The size of sample is taken in relation to the particle size of the material or estimated throughput of the process, or both.

9.1.1 The minimum size of sample is determined by its particle size in accordance with Practice D75/D75M, or by 9.1.2 or 9.1.3, whichever is greater.

9.1.2 For particle sizes greater than 90 mm (not included in Table 1 of Practice D75/D75M), the size of sample is 250 kg (550 lb).

9.1.3 The minimum weight of sample shall correspond to the estimated throughput for 1.0 min or the minimum weight will be determined by the procedure in Test Methods E868.

9.2 Test samples corresponding to 9.1 are weighed without subdivision.

9.3 Three test samples shall be taken for each randomly chosen sampling time. Two of the samples will be weighed; the third shall be retained and weighed if the calculated throughputs based on the first two differ by more than 10 %, as described in 12.4.

9.4 If possible, both binary and polynary separators should normally be sampled at the output sides.

10. Conditioning

10.1 Weigh the samples immediately after they are taken. Take precautions to ensure that they neither gain nor lose weight from natural drying or drainage or from ambient moisture or dirt.

11. Procedure

11.1 Use separate procedures for sampling conveyors, chutes, or discharge containers.

11.2 *Conveyors:*

11.2.1 Conveyors are most conveniently sampled by catching the discharge at the end of the conveyor in the tared container. Take care that the bin is wider than the width of the conveyor and the entire contents of the belt width is collected.

11.2.2 Conveyors can also be sampled by stopping the belt and removing a portion of the belt load. In this method, determine the belt speed by timing the movement of a mark on the belt as it passes between two marks on the sides of the conveyor. Measure the distance between the latter two marks and use the measurement to calculate the belt speed. Alternatively, use a tachometer for determining the speed of the belt. Stop the conveyor and shovel the material lying on a predetermined length of the conveyor into a suitable tared container. Take care to include all fine particulate materials. Also, take care to ensure that the belt load moves at the same speed as the belt and is not hindered by the sides of the conveyor, thus causing slippage.

11.3 *Chutes*—Sample material falling through a chute by placing a tared container of suitable size under the chute and collecting the material for a predetermined length of time, measured with a stopwatch to the nearest 0.1 s. If it is not possible to sample the discharge of a chute, a diverting chute member may have to be added along with a gate. Exercise care at the discharge ends of chutes to ensure that all of the material flowing is collected in the container. Flexible spouts may be fastened (even if temporarily) on the ends of the chutes and directed into the containers.

11.4 *Discharge Containers*—Sample discharge points by using a tared container to collect the material. Preferably, fasten a flexible spout or a diverter to the discharge point to the usual collection bin so that the flow can be suddenly diverted to the tared container without significant spillage. Without such a flexible spout, it may not be possible to accurately time the discharge.

11.5 Sampling and weighing must be done without spilling any of the material. Note any spillage more than dusting. Spillage of more than 1 % of the collected sample, visually estimated, is reason to discard the sample and start over.

11.6 Weigh the tared containers containing the samples immediately and record the filled gross weights. Record weights within 0.1 % of the total filled weight in accordance with the precautions of 10.1.

12. Calculation

12.1 Record the following information:

12.1.1 Method of sampling (11.2.1, 11.2.2, 11.3, or 11.4);

12.1.2 Location;

12.1.3 Time of day and date;

12.1.4 Tare of container;

12.1.5 Weight of filled container; and

12.1.6 Special observations.

12.2 Calculate the sampling time for the procedure in 11.2.2 as follows:

$$\text{Sampling time} = t = L/Y \tag{1}$$

where:

L = length of conveyor swept,
Y = conveyor speed, calculated as $Y = C/T$,
C = measured distance between the two marks on the conveyor sidewall, m, and
T = measured time for the mark on the conveyor belt to move between these two marks, s.

12.2.1 The conveyor speed is in units of meters per second (m/s) and the sampling time t is in units of seconds (s).

12.3 Measure the sampling time for other procedures (11.2.1, 11.3, and 11.4) with the stopwatch.

12.4 Calculate the throughput, Q, on a wet-weight basis for a processor, sampling either the input or output stream as follows:

$$Q = \frac{(W - A)\,3600}{t} \tag{2}$$

where:

W = weight of the filled container,
A = tare (empty) weight of the container, and
t = time of collection of the sample, s.

12.4.1 If W and A are in kilograms, Q is in kilograms per hour.

12.5 Paragraph 12.4 can be used to calculate the throughput of a processor if the input stream is sampled. However, note the information in 9.4.

12.6 A binary or polynary separator may be sampled at each of its output streams with all samples taken at the same time and for equal time intervals. Calculate the throughput for each stream in accordance with 12.4 and sum to obtain the total throughput.

13. Report

13.1 The report shall include the information on the data compilation and calculation sheet (see Fig. 1).

Data Compilation and Calculation Sheet[A]

Date: ______________________________ Location: ________________
Time of Day: _______________________ Operator: ________________

Conveyor Sampling:

Speed = __________________________ = Y
Length of belt swept ___________ = L
Sampling time $t = L/Y$ = ___________________________

Throughput (wet weight basis):

Container No. ______ , Tar Weight A = ________________
Filled Weight W = ________________
Throughput $Q = (W-A)/t$ = ________________

Special Observations:

[A] Repeat calculations using a separate sheet for each processor or separator stream sample.

FIG. 1 Sample Data Compilation and Calculation Sheet

14. Precision and Bias

14.1 There are not yet sufficient data available to compute the precision and bias of this test method.

15. Keywords

15.1 mass flow rate; resource-recovery unit operation; sampling