Designation: ~~D6941 – 05ε1~~ D6941 – 12

Standard Practice for Measuring Fluidization Segregation Tendencies of Powders[1]

This standard is issued under the fixed designation D6941; 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.

~~ε1 NOTE—Section 7.10 and Figure 2 were corrected editorially in July 2007.~~

1. ~~Scope~~ Scope*

1.1 This practice covers an apparatus and procedure for ~~simulating the segregation tendencies of powders by means of the fluidization mechanism.~~creating several specimens of a powder sample that, if the powder is one that segregates by the fluidization mechanism, should be different from one another.

1.2 A powder sample is fluidized then, after the fluidizing gas is turned off, it is separated into three or more specimens that can be analyzed for parameters of interest. The difference in these parameters between the specimens is an indication of the segregation potential of the powder.

1.3 Powders must be capable of being fluidized in order to be tested by this practice.

1.4 Temperature- and ~~humidity-sensitive~~moisture-sensitive powders may need to be tested at different temperatures and moisture contents, as would happen in an industrial environment. ~~Further, the gas supply (type, temperature, and humidity) should also match the industrial conditions.~~

1.5 This standard is not applicable to all bulk solids and segregation mechanisms: while fluidization is a common segregation mechanism experienced by many fine powders, other segregation mechanisms not evaluated by this standard might induce segregation in practice. Practice D6940 covers another common mechanism: sifting.

1.6 The extent to which segregation will occur in an industrial situation is not only a function of the powder and its tendency to segregate, but also the handling equipment (for example, bin design), process (for example, transfer rates), and environment.

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

1.8 This practice offers a set of instructions for performing one or more specific operations. This document cannot replace education or experience and should be used in conjunction with professional judgment. Not all aspects of this practice may be applicable in all circumstances. This ASTM standard is not intended to represent or replace the standard of care by which the adequacy of a given professional service must be judged, nor should this document be applied without consideration of a project's many unique aspects. The word Standard in the title of this document means only that the document has been approved through the ASTM consensus process.

1.9 *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:*[2]

D653 Terminology Relating to Soil, Rock, and Contained Fluids
D2216 Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
D3740 Practice for Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction
D6940 Practice for Measuring Sifting Segregation Tendencies of Bulk Solids

[1] This practice is under the jurisdiction of ASTM Committee D18 on Soil and Rock and is the direct responsibility of Subcommittee D18.24 on Characterization and Handling of Powders and Bulk Solids.

Current edition approved ~~Nov. 1, 2005~~Nov. 1, 2012. Published ~~November 2005~~December 2012. Originally approved in 2003. Last previous edition approved in ~~2004~~2005 as D6941 ~~–04.~~ –05[1]. DOI: ~~10.1520/D6941-05E01.~~10.1520/D6941-12.

[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.

***A Summary of Changes section appears at the end of this standard**

3. Terminology

3.1 *Definitions:*

3.1.1 Definitions of terms used in this test method shall be in accordance with For common definitions of technical terms in this standard, refer to Terminology D653.

3.1.2 *fluidization, n—in powders,* the state in which a powder exhibits fluid-like properties.

3.1.3 *fluidization segregation, n—in powders,* a mechanism that causes vertical segregation, that is, horizontal layering of fine and coarse particles, as resulting from fluidization of the bulk solid.

3.1.4 *segregation, n—in powders,* a process through which blended or uniform powders or bulk solids become non-uniform, with regions of varying composition, for example, particle size.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *high flow-rate, n—in powders,* the first stage flow-rate used to initiate fluidization.

3.2.2 *low flow-rate, n—in powders,* the second stage flow-rate used to maintain fluidization.

3.2.3 *representative sample, n—in powders,* a quantity of the bulk solid to be tested that is representative of that solid in an industrial application being studied. Parameters of interest that may affect whether or not a sample is representative include: include, but are not limited to: moisture, particle size distribution, raw material variation, method of production, aging, chemical composition.

4. Summary of Practice

4.1 A representative sample of a powder is placed in the apparatus.test chamber.

4.2 Pressurized gas (usually air) air), which is blown from the bottom at a series of flow-rates bottom, is ramped up from zero to a pre-determined High Flow-rate, held there, ramped down to a pre-determined Low Flow-rate, then held there, all for specified times, creating a state of fluidization of the powder.

4.3 The airflow is ramped down to zero over a specified time.

4.4 Once the airflow is stopped, the The powder in the test chamber is divided into three samples from the bottom, center, and top of the column.N specimens.

4.5 The samplesspecimens are then available to be tested for differences relevant to the application, for example, particle size or chemical assay.

5. Significance and Use

5.1 Fluidization segregation can cause vertical segregation within bins used to hold and transport powders. This can affect final product quality in industrial applications.

5.2 By measuring a powder's segregation tendency, one can compare results to other powders with known history, or determine if the given powder may have a tendency to segregate in a given process.

5.3 Fine powders generally have a lower permeability than coarse bulk solids and therefore tend to retain air longer. Thus, when a bin is being filled with a fluidizable powder, the coarser particles settle or are driven into the bed while the finer particles remain fluidized near the surface.

5.4 Fluidization, which serves as a driving force for this mechanism of segregation, is likely to occur when fine powders are pneumatically conveyed into a bin, the bin is filled or discharged at high rates, or if sufficient air flow counter to the flow of powder is present within the bin.

NOTE 1—The quality of the result produced by this practice is dependent on the competence of the personnel performing it, and the suitability of the equipment and facilities used. Agencies that meet the criteria of Practice D3740 are generally considered capable of competent and objective testing/sampling/inspection/etc. Users of this practice are cautioned that compliance with Practice D3740 does not in itself assure reliable results. Reliable results depend on many factors; Practice D3740 provides a means of evaluating some of those factors.

Practice D3740 was developed for agencies engaged in the testing and/or inspection of soil and rock. As such it is not totally applicable to agencies performing this practice. However, users of this practice should recognize that the framework of Practice D3740 is appropriate for evaluating the quality of an agency performing this practice. Currently there is no known qualifying national authority that inspects agencies that perform this practice.

6. Apparatus

6.1 The apparatus including critical dimensions is shown in Fig. 1. It consists of the following:

6.2 *Gas Supply with Flow Meter*—A gas supply supply of dry, non-toxic and non-flammable gas capable of fluidizing the powder is required (15 to 30 psig [100 to 200 kPa] range, 25 psig [170 kPa] recommended, maximum flow rate 10 000 required. The recommended gas supply pressure is 170 kPa [25 psig] with a range from 100 to 200 kPa [15 to 30 psig]. The recommended gas supply flow rate is 10 000 cm^3/min recommended). or higher. The gas flow rate mustshall be adjustable during the test-an test. An automated controller may be used for this purpose.

NOTE 2—Generally, clean, dry air is used. If air is not suitable (that is, it reacts with or adversely affects the powder being tested) another gas, such as nitrogen, may be used.

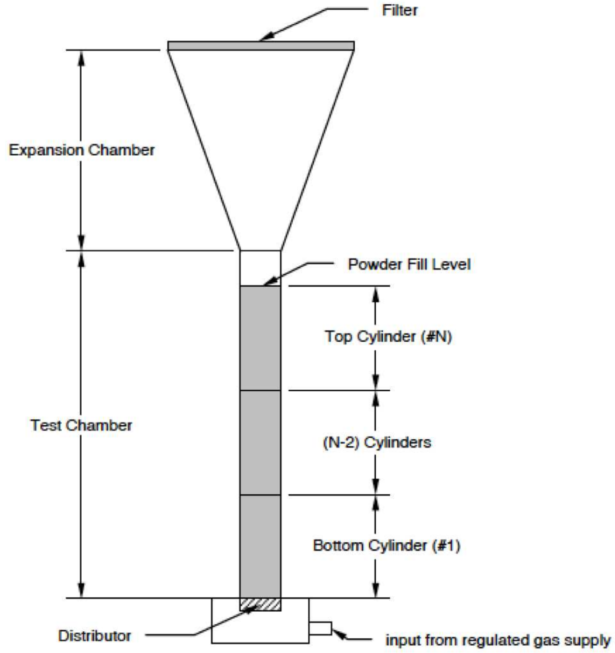

FIG. 1 Apparatus

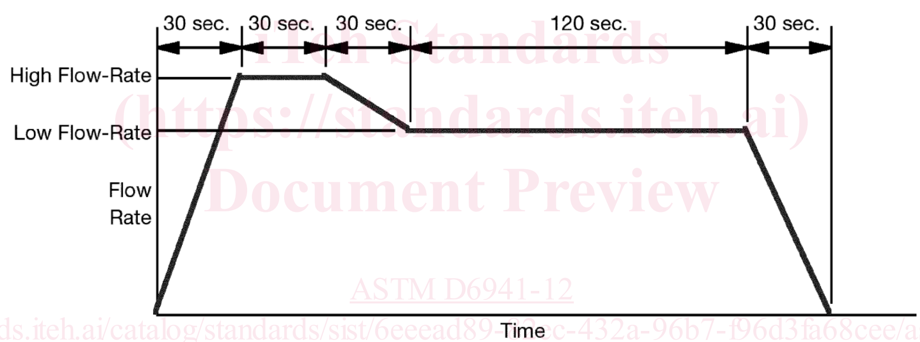

FIG. 2 Timing Profile

6.3 ~~*Cylinders*—~~*Test Chamber*—~~Three transparent cylinders are stacked, identified (from the bottom) as the bottom, center, and top cylinders. The bottom cylinder sits against the diffuser in the~~ This consists of three or more cylinders stacked above the distributor, which is at the top of the air supply plenum. ~~The top cylinder mates to the expansion chamber. When the cylinders are stacked together, they make up the test chamber,~~ These cylinders which, when stacked together have a total height of at least 195 mm, are connected at the top to a conical expansion chamber. The test chamber is where the powder ~~is placed. The assembled test chamber dimensions are 24 mm I.D. by at least 185 mm tall. The test chamber should have at least 25 mm additional height to allow expansion of the powder bed. The cylinders must be held together so they do not separate during the tests and so leakage does not occur, while still able to be separated at the end of the test in a way to allow for sample recovery. This can be done a number of ways, including taping the sections together.~~sample is placed.

6.3.1 *Cylinders*—Each circular cylinder is transparent and has a diameter of 24 6 1 mm I.D. They are stacked, identified as #1 (the bottom) to #N (the top). The bottom cylinder (#1) sits against the distributor in the air supply plenum. The top cylinder (#N) mates to the expansion chamber. The cylinders shall be held together in a manner that prevents separation during the test and prevents leakage. This method must allow separation of the cylinders upon completion of the test to allow specimen recovery.

6.4 *Expansion Chamber*—~~The expansion~~ This conical extension of the test chamber allows the powder to disengage from the air stream. It must be sufficiently tall to prevent the expanded powder bed from contacting the filter at its top and sufficiently steep to cause the powder to slide back into the test chamber when the airflow is turned off.

6.5 *Filter*—The filter prevents powder from being blown out of the ~~apparatus.~~ apparatus while allowing the gas to pass through. The filter material should be appropriate for the application and should not contaminate the powder (which may affect the analysis of the ~~samples),~~specimens), and should provide ~~sufficient~~ containment of the powder (from both a safety perspective and a loss of powder perspective).