Designation: D 6941 – 03

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

This standard is issued under the fixed designation D 6941; 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 covers an apparatus and procedure for simulating the segregation tendencies of powders by means of the fluidization mechanism.

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

1.3 Temperature- and humidity-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.

1.4 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.

1.5 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.

1.6 *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 653 Terminology Relating to Soil, Rock, and Contained Fluids[2]

3. Terminology

3.1 *Definitions*—Definitions of terms used in this test method shall be in accordance with Terminology D 653.

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

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

3.1.3 *segregation*, *n*—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*—the first stage flow-rate used to initiate fluidization.

3.2.2 *hold time*, *n*—the time for which the Low Flow-rate is held.

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

3.2.4 *ramp time*, *n*—the time during which the airflow is reduced from the Low Flow-rate to zero.

3.2.5 *representative sample*, *n*—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: 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.

4.2 Pressurized gas (usually air) is blown from the bottom at a series of flow-rates for specified times, creating a state of fluidization of the powder.

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

4.4 The samples 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.

[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.

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[2] *Annual Book of ASTM Standards*, Vol 04.08.

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.

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 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 cm^3/min). The gas flow rate must be adjustable during the test-an automated controller may be used for this purpose.

NOTE 1—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.

6.3 *Cylinders*—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 air supply plenum. The top cylinder mates to the expansion chamber. When the cylinders are stacked together, they make up the test chamber, 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.

6.4 *Expansion Chamber*—The expansion chamber allows the powder to disengage from the air stream.

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

6.6 *Diffuser*—The diffuser distributes the air uniformly into the test chamber; therefore, a sufficient pressure drop across the diffuser is required.

NOTE 2—A sintered metal disk, such as 5 µm filtration grade porous stainless steel sheet available from Mott Industrial, Farmington CT, may

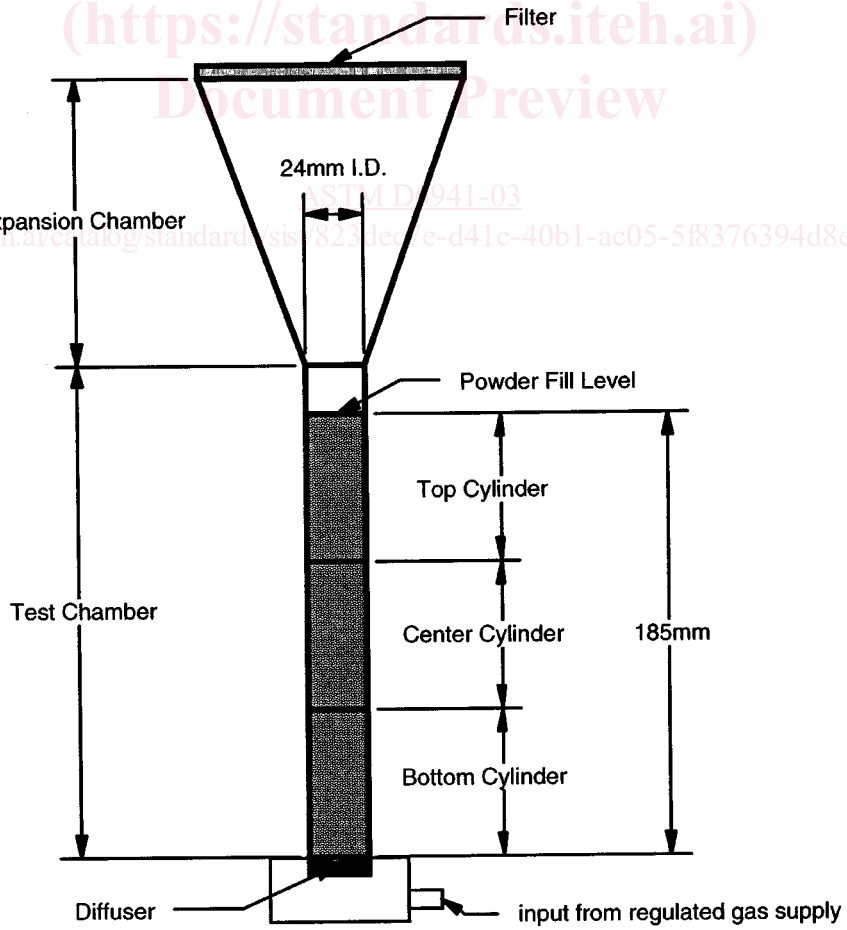

FIG. 1 Apparatus