Designation: D8414/D8414M – 21

Standard Test Method for Measurement of Jet Cup Attrition Index of Catalytic Materials[1]

This standard is issued under the fixed designation D8414/D8414M; 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 The jet cup attrition test is applicable to fluid catalytic cracking (FCC) catalysts, catalyst additives, and catalytic materials.

1.2 Applications for other powdered catalysts have been reported in the literature. The round robin test samples included two FCC catalysts and one powdered alumina.

1.3 *Units*—The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system are not necessarily exact equivalents; therefore, to ensure conformance with the standard, each system shall be used independently of the other, and values from the two systems shall not be combined.

1.4 *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.*

1.5 *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]

E177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods

E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *control factor, CF, n*—unitless value determined by the repetitive analysis of a standard material; it is equal to the (initial value of the control standard)/ (current value of the control standard) = CF.

3.1.1.1 *Discussion*—Refer to 12.1 for details on the standard.

3.1.1.2 *Discussion*—The values used in the calculations are monthly averages.

3.1.2 *jet cup index, JCI, n*—unitless value equal to the "weight percent of 0- to 20-µm [0- to 787-µin.] fines generated per hour" under test conditions.

4. Summary of Test Method

4.1 Of the sample to be tested, 5 g [0.175 oz] is placed into the jet cup of the test apparatus where humidified air is passed through an orifice in the jet cup at high velocity.

4.2 The air impinges on the catalyst and causes particles to collide with each other and the walls of the jet cup. These particle-to-particle and particle-to-wall interactions cause fines to form via attrition. In addition, weaker particles will fracture and form fines.

4.3 The jet cup is attached to a fines disengagement chamber that allows particles less than 20 µm [787-µin.] to pass into a fines collection assembly.

NOTE 1—The fines disengagement chamber is based on the AMINCO-Roller air elutriation particle size analyzer, historically used to measure the 0-20 micron fraction in catalyst.

4.4 The JCI is calculated from the mass of fines collected and is numerically equivalent to the "weight percent of fines generated per hour" under test conditions.

5. Significance and Use

5.1 The jet cup attrition test will provide an estimate of the relative attrition resistance of fluid catalytic cracking (FCC) catalyst, catalyst additives, and catalytic materials.

5.2 The test is designed to simulate the attrition a catalyst or additive undergoes in a fluid catalytic cracking unit but at an accelerated rate.

[1] This test method is under the jurisdiction of ASTM Committee D32 on Catalysts and is the direct responsibility of Subcommittee D32.02 on Physical-Mechanical Properties.

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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.

5.3 The data from this test can be used to rank catalyst according to attrition rate.

5.4 The test requires a relatively small sample size of 5 g [0.175 oz] and a relatively short analysis time of 40 min. This test should be useful to quality control facilities that require fast turnaround time and research and development (R&D) facilities that have limited sample material.

6. Interferences

6.1 There are no known interferences. Factors such as density, particle size distribution, morphology, and intrinsic hardness will affect the results. These and other factors must be considered.

7. Apparatus

7.1 *Pressure Regulator,* to reduce the Instrument grade air supply pressure to 206.8 kPa [30 psig].

7.2 *Mass Flow Controller,* capable of delivering 21.0 ± 0.05 slpm of air into a system with 34 kPa [5 psig] of backpressure. Mass flow controller should not be affected by small amounts of moisture in the air supply, changes in room temperature, or changes in barometric pressure.

7.3 *Humidification Equipment,* capable of humidifying 21 slpm of air to 55 % relative humidity (RH) in a continuous, uninterrupted operation. De-ionized water addition, 16 meg-Ω minimum, can be automatic or manual. The humidifier should have a 70-kPa [10-psi] pressure-relief valve installed.

7.4 *Backpressure Gauge,* 0-100 kPa [0-15 psig].

7.5 *Three-way Air Solenoid Valve.*

7.6 *Timer.*

7.7 *Jet Cup*—See Fig. A1.1 in Annex A1.

7.8 *Fines Disengagement Chamber*—See Fig. A1.2 in Annex A1. Can be welded steel or solid 2-piece with or without a fines release coating.

7.9 *Connector,* to attach the jet cup to the fines disengagement chamber. Commercially available equipment has the jet cup permanently mounted into a holder that forms a positive connection with the fines disengagement chamber. Lab built units use a machined plastic connector with o-rings to make a leak tight seal. The connector can be as simple as a piece of large diameter Tygon®[3] tubing and two hose clamps.

7.10 *Rack or Mounting Brackets,* to support the fines disengagement chamber in an upright position.

7.11 *Tubing,* pre-cleaned stainless steel or food grade tubing.

7.12 *Assorted Tubing Fittings.*

7.13 *Pipe Elbows,* 15 mm [½ in.] NPT × 10 mm [⅜ in.] Barb. Light weight plastic.

7.14 *Rubber Stoppers,* number 5.5 with a hole bored with a #7 cork borer.

7.15 *Ancillary Equipment:*

7.15.1 *Analytical Balance,* 4-place, readable to 0.0001 g, with a minimum range of 30 gms.

7.15.2 *Weigh Boats,* small, disposable plastic.

7.15.3 *Desiccator,* with desiccant.

7.15.4 *Humidity Probe,* with calibration traceable to the National Institutes of Standards and Technology (NIST).

7.15.5 *Oven,* 225 °C [437 °F], vented with 1 CFH (0.5 lpm) air flow.

7.15.6 *Furnace,* muffle, 565 °C [1049 °F], vented with 1 CFH (0.5 lpm) air flow.

7.15.7 *Assorted Borosilicate Glass or Ceramic Dishes and Crucibles.*

8. Reagents and Materials

8.1 *Instrument Grade Air.*

8.2 *De-ionized Water,* 16 meg-Ω, minimum.

8.3 *Collection Thimbles,* 19 by 90 mm [0.7 by 0.4 in.], Whatman #2814199®, or equivalent.[4]

9. Assembling the Apparatus

9.1 Refer to the block diagram, Fig. A1.3, in Annex A1.

9.2 Attach the shutoff valve and the pressure regulator to the source of instrument grade air. No air should be flowing at this time.

9.3 Attach the inlet of the mass flow controller to the exit of the pressure regulator.

9.4 The exit of the mass flow controller is attached to the inlet of the humidifier. The humidifier should have a 70-kPa [10-psi] pressure-relief valve installed. If not, install a tee fitting and a pressure-relief valve at the exit of the humidifier.

9.5 Install a tee fitting and the backpressure gauge, 0-100 kPa [0-15 psig].

9.6 Next, install the three-way air solenoid valve controlled by a timer. The inlet of the valve is attached to the tee fitting used to mount the backpressure gauge. With the timer deactivated, air should be flowing through the vent. Wire the solenoid to a timer capable of timing 20.0 min. Attach a 10-cm [4-in.] length of 1.6-mm [1⁄16-in.] outer diameter (OD) tubing to the vent.

9.7 Attach a hose to the exit of the solenoid valve. Attach the other end of the hose to the jet cup. Keep the hose as short as possible, usually less than 1 m [3 ft].

9.8 Mount the fines disengagement chamber in an upright position.

9.9 Assemble the thimble holders (14.3).

9.9.1 Insert the barb end of the pipe elbow into the rubber stopper.

9.9.2 Prepare a minimum of two thimble holders. Four or more will speed up analysis time.

[3] Tygon® a registered trademark of Saint-Gobain Corporation, 20 Moores Rd, Malvern, PA 19355.

[4] Whatman® is a registered trademark of Cytiva, 100 Results Wy, Marlborough, MA 01752.