Designation: D7964/D7964M – 14

Standard Test Method for Determining Activity of Fluid Catalytic Cracking (FCC) Catalysts in a Fluidized Bed[1]

This standard is issued under the fixed designation D7964/D7964M; 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 covers determining the activity and coke selectivity of either equilibrium or laboratory deactivated fluid catalytic cracking (FCC) catalysts. The activity is evaluated on the basis of mass percent conversion of gas oil feed in a fluidized bed reactor. The coke yield is defined as the mass of carbon laid down on the catalyst, also expressed as a percent of the gas oil feed. The scope of the round robin will be limited to the determination of activity and coke. All other analyses are thus beyond this scope and should be noted as "optional."

1.2 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

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 and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D2887 Test Method for Boiling Range Distribution of Petroleum Fractions by Gas Chromatography

D4463 Guide for Metals Free Steam Deactivation of Fresh Fluid Cracking Catalysts

E105 Practice for Probability Sampling of Materials

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 *activity*—a measure of the rate of a specific catalytic reaction, calculated in the present case by dividing conversion by the difference of 100 minus conversion.

3.1.2 *catalyst/oil (C/O) ratio*—the mass of catalyst used in the test divided by the mass of feed fed to the reactor.

3.1.3 *coke*—mass of carbon laid down on the catalyst during the FCC reaction times 1.083.

3.1.4 *conversion*—the starting mass of reactant feed minus the mass of the liquid product that boils above 221°C [430°F]; this delta is then reported as a percentage of the starting mass of feed.

3.1.5 *delivery time*—this is the time, in seconds, during which feed is introduced to the reactor.

3.1.6 *FCC*—fluid catalytic cracking.

3.1.7 *gasoline*—C_5 compounds through compounds boiling at 221°C [430°F].

3.1.8 *HCO*—the heavy cycle oil product, which is defined to have a minimum boiling point of 343°C [650°F].

3.1.9 *LCO*—the light cycle oil product, which is defined to have a boiling point range of 221 to 343°C [430 to 650°F].

3.1.10 *liquid product*—all products formed in the catalytic reaction that can be condensed in the chiller bath afterward, usually a combination of gasoline, LCO, and HCO, but can contain a trace of C_4 and C_4 minus compounds.

3.1.11 *normalized product yield*—the result obtained when each product yield has been corrected for non-perfect mass balances.

3.1.11.1 *Discussion*—For a run to be judged acceptable, the total recovery, mass % of feed, should be in the range of 96 to 102 % prior to normalization. If the recovery is outside this range the test data should be discarded.

3.1.12 *product yield*—one hundred times the mass of a specific product divided by the mass of feed used in the test.

3.1.13 *selectivity*—same as yield. Selectivity generally refers to how much of a particular product, such as coke, is formed during a chemical reaction; selectivity is related to, but

[1] This test method is under the jurisdiction of ASTM Committee D32 on Catalysts and is the direct responsibility of Subcommittee D32.04 on Catalytic 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.

different from, conversion, which is the total amount of all products formed during the reaction.

4. Summary of Test Method

4.1 A sample of FCC catalyst is contacted with gas oil in a fluidized bed reactor using a specified reaction temperature, a specified mass of catalyst and oil, and specified oil feed rate. Reaction products (liquid product, gas, and coke on catalyst) are analyzed. Conversion, coke, and individual product yields are calculated for each experiment.

4.2 Following analysis of the products, the total recovery (that is, mass balance) of the feed as converted and unconverted products is determined. If the recovery is less than 96 % or greater than 102 %, then the test is rejected as unsatisfactory (an outlier).

4.3 For each catalyst tested, a normalized conversion or activity and a coke mass are determined.

5. Significance and Use

5.1 The fluidized bed test provides data to assess the relative performances of FCC catalysts. Because results are affected by catalyst pretreatment, feedstock characteristics, and operating parameters, this test method is written specifically to address the accuracy and precision when a common catalyst and oil are tested under the same conditions but at different sites, using Kayser Technologies Advanced Catalytic Evaluation (ACE) unit.[3,4] Analytical procedures may vary among the sites. However, significant variations are not expected.

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5.2 The standard reaction temperature for purposes of the accuracy and precision statement is 532°C [990°F]. Other reaction temperatures can be used in practice; however, yield data developed at temperatures other than 532°C [990°F] will not be the same. Also, test precision may be different at other reaction temperatures.

6. Apparatus

6.1 The fluidized bed reactor of this test method is shown in Fig. 1. The full ACE apparatus also includes a feed delivery system and both a gas and a liquid collection system. In a typical gas collection system, water is displaced by the collected gas and the volume of displaced water provides a quantitative measurement of the amount of gas collected. Committee D32 can only suggest and will not recommend nor certify any specific vendor. However, significant variations from the test apparatus of this method most likely will result in significantly different activity and selectivity data from identical catalyst samples.

[3] The fluidized bed reactor described herein is covered by US Patent 6,069,012. Interested parties are invited to identify an alternative(s) to this patented reactor system. Alternative(s) should be submitted to the ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee,[1] which you may attend.

[4] Trademarked, ACE Technology.

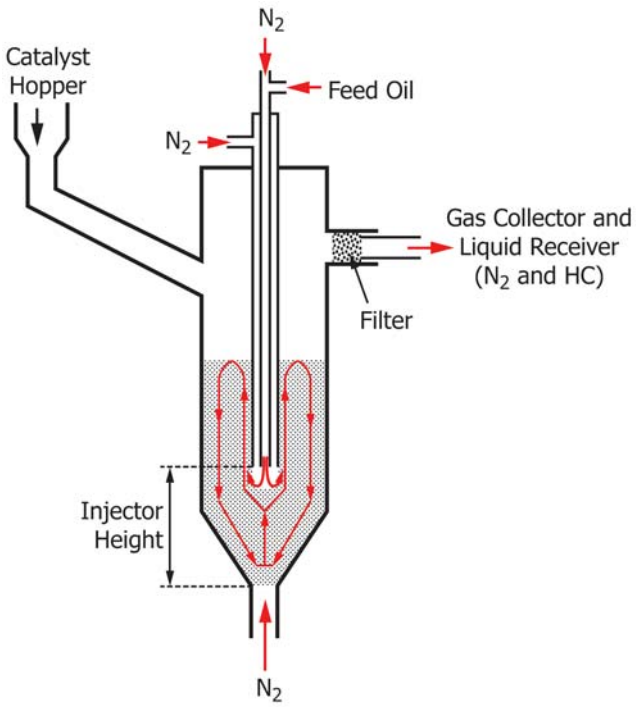

FIG. 1 Fluidized Bed Reactor