



Designation: D7373 – 07

Standard Test Method for Predicting Biodegradability of Lubricants Using a Bio-kinetic Model¹

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1. Scope

1.1 This test method covers a procedure for predicting biodegradability of lubricants using a bio-kinetic model.

1.2 The values stated in SI units are to be regarded as standard. The values given in parentheses are for information only.

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

D2549 Test Method for Separation of Representative Aromatics and Nonaromatics Fractions of High-Boiling Oils by Elution Chromatography

D5864 Test Method for Determining Aerobic Aquatic Biodegradation of Lubricants or Their Components

D6731 Test Method for Determining the Aerobic, Aquatic Biodegradability of Lubricants or Lubricant Components in a Closed Respirometer

3. Terminology

3.1 *Definitions:*

3.1.1 *aromatics fraction, n*—portion of the sample desorbed with the polar eluants. The aromatics fraction is divided into nonpolar and polar based. They may contain aromatics, condensed naphthenic-aromatics, aromatic olefins, and compounds containing sulfur, nitrogen, and oxygen atoms.

3.1.2 *bio-kinetic model, n*—model that can predict the biodegradability of a lubricant.

3.1.3 *biodegradability, n*—ability of a substance to be broken down into simpler substances by bacteria.

3.1.4 *effective composition to biodegradation (ECB), n*—component of material that can be biodegradable by bacteria.

3.1.4.1 *Discussion*—The term ECB is a part of bio-kinetic model is sum of non-aromatic components in a lubricant.

3.1.5 *nonaromatics fraction, n*—portion of the sample eluted with *n*-pentane. The nonaromatics fraction is a mixture of paraffinic and naphthenic hydrocarbons if sample is a straight-run material. If the sample is a cracked stock, the nonaromatics fraction will also contain aliphatic and cyclic olefins.

4. Summary of Test Method

4.1 A weighed amount of sample is charged to the top of a glass chromatographic column packed with activated bauxite and silica gel. To elute the nonaromatics, *n*-pentane is added to the column. When all of the nonaromatics are eluted, non-polar aromatics fraction is eluted by additions of an equal mixture of toluene and *n*-pentane. The ester fraction is eluted by additions of diethyl ether. Then, the polar-aromatics is eluted by chloroform and ethyl alcohol.

4.2 The solvents are completely removed by evaporation, and the residues are weighed and calculated as the nonaromatics, nonpolar aromatics, ester fractions, and polar aromatics of the sample.

4.3 ECB is calculated based on the amount of nonaromatics and ester fractions with their material ECB coefficients. Then, the biodegradability of a lubricant is calculated using the bio-kinetic model.

5. Significance and Use

5.1 This procedure is able to predict the biodegradability of lubricants within a day without dealing with microorganisms.³ Excellent correlation is established between the test results and the conventional biodegradation tests (see Test Method **D5864** and Test Method **D6731**).

6. Apparatus

6.1 *Chromatographic Columns*—as shown in Fig. 1 (see Test Method **D2549**).

¹ This test method is under the jurisdiction of ASTM Committee D02 on Petroleum Products and Lubricants and is the direct responsibility of Subcommittee D02.12 on Environmental Standards for Lubricants.

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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 Rhee, In-Sik, "Development of Bio-kinetic Model for Lubricants," *NLGI Spokesman*, Volume 69, 2005, pp. 22-29.

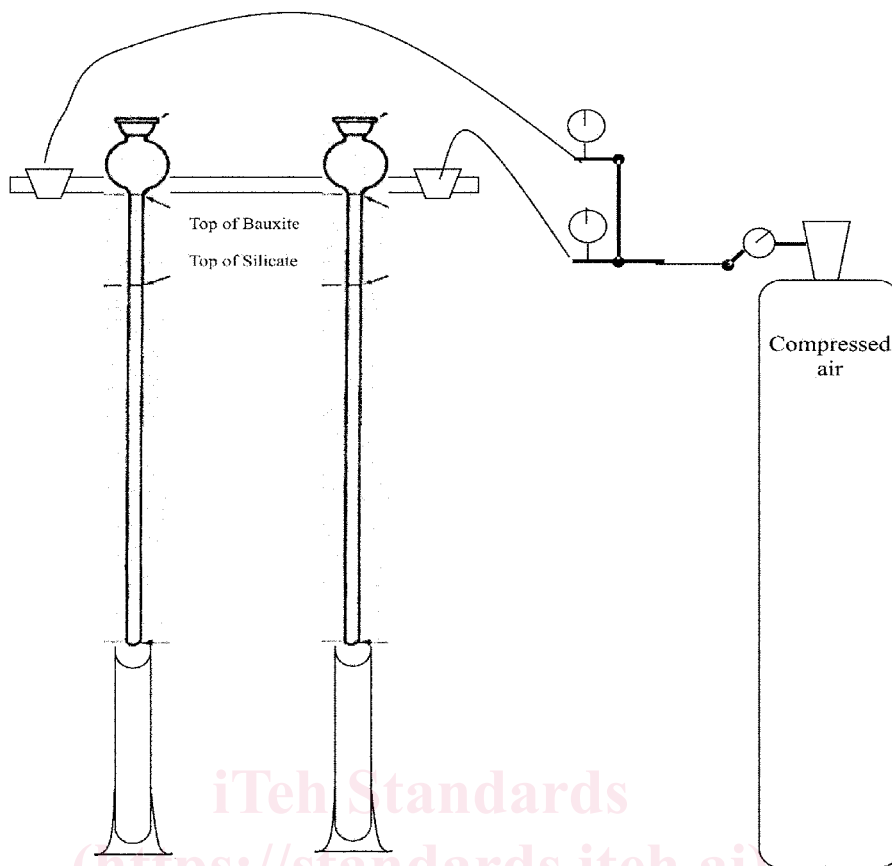


FIG. 1 Test Apparatus

- 6.2 Beakers (100, 250, and 600-mL)—inverted-rim type.
- 6.3 Steam Bath.
- 6.4 Electric Vibrator—for packing column.
- 6.5 Weighing Bottles or Erlenmeyer Flasks—25 and 50 mL.
- 6.6 Graduated Cylinders—50 mL, 100 mL, and 250 mL.

7. Reagents and Materials

7.1 *Purity of Reagents*—Reagent grade chemicals shall be used in this test. Unless otherwise indicated, it is intended that all reagents shall conform to the specifications of the Committee on Analytical Reagents of the American Chemical Society, where such specifications are available. Other grades may be used, provided it is first ascertained that the reagent is of sufficiently high purity to permit its use without lessening the accuracy of the determination.

7.2 *Bauxite, 20- to 60-mesh*—Before use, activate the bauxite by heating at 538°C (1000°F) for 16 h. Transfer the activated material to an airtight container while still hot and protect thereafter from atmospheric moisture.

7.3 *Chloroform*—(Warning—Toxic. May be fatal if swallowed.)

7.4 *Cleaning Solution*—Chromic-sulfuric acid. (Warning—Causes severe burns. A recognized carcinogen, strong oxidizer, contact with organic material may cause fire.)

7.5 *Diethyl Ether*—Anhydrous. (Warning—Extremely flammable.) The ethyl ether used in this test method should be

free of peroxides as determined by the procedure in *Reagent Chemicals, American Chemical Society Specifications*.⁴

7.6 *Ethyl Alcohol, Denatured*—Conforming to Formula 2B of the U.S. Bureau of Internal Revenue. (Warning—Flammable.)

7.7 *Pressuring Gas*—Dry air or nitrogen, delivered to the top of the column at a regulated gage pressure of 0 to 2 psi (13.8 kPa). (Warning—Compressed gas.)

7.8 *n-pentane*—Commercial grade, aromatic-free. Some samples of waxy stocks may not dissolve completely in *n-pentane*, in which case cyclohexane, commercial grade, aromatic-free, may be substituted for *n-pentane*. (Warning—Extremely flammable liquid.)

7.9 *Silica Gel*—100- to 200-mesh.

7.10 *Toluene*—Reagent grade minimum purity. (Warning—Toluene is flammable. Vapor harmful.)

8. Procedure for Composition Analysis

8.1 Clean the column with chromic-sulfuric acid (7.4), followed by distilled or demineralized water, acetone, and dry air or nitrogen.

⁴ *Reagent Chemicals, American Chemical Society Specifications*, American Chemical Society, Washington, DC. For Suggestions on the testing of reagents not listed by the American Chemical Society, see *Annual Standards for Laboratory Chemicals*, BDH Ltd., Poole, Dorset, U.K., and the *United States Pharmacopeia and National Formulary*, U.S. Pharmacopeial Convention, Inc. (USPC), Rockville, MD.