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An American National Standard

Standard Guide for Assessing Biodegradability of Hydraulic Fluids¹

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1. Scope

1.1 This guide provides information to assist in planning a laboratory test or series of tests from which may be inferred information about the biodegradability of an unused fully formulated hydraulic fluid in its original form. Biodegradability is one of three characteristics which are assessed when judging the environmental impact of a hydraulic fluid. The other two characteristics are ecotoxicity and bioaccumulation.

1.2 Biodegradability may be considered by type of environmental compartment: aerobic fresh water, aerobic marine, aerobic soil, and anaerobic media. Test methods for aerobic fresh water, aerobic soil and anaerobic media have been developed that are appropriate for the concerns and needs of testing in each compartment.

1.3 This guide addresses releases to the environment that are incidental to the use of a hydraulic fluid but is not intended to cover situations of major, accidental release. The tests discussed in this guide take a minimum of three to four weeks. Therefore, issues relating to the biodegradability of hydraulic fluid are more effectively addressed before the fluid is used, and thus before incidental release may occur. Nothing in this guide should be taken to relieve the user of the responsibility to properly use and dispose of hydraulic fluids.

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

2. Referenced Documents

2.1 ASTM Standards:

D 5210 Test Method for Determining the Anaerobic Biodegradation of Plastic Materials in the Presence of Municipal Sewage Sludge²

D 5291 Test Methods for Instrumental Determination of Carbon, Hydrogen, and Nitrogen in Petroleum Products and Lubricants³

D 5480 Test for Motor Oil Volatility by Gas Chromatography³

D 5864 Test Method for Determining the Aerobic Aquatic Biodegradation of Lubricants and Their Components⁴

E 1196 Test Method for Determining the Anaerobic Biodegradation Potential of Organic Chemicals⁴

2.2 ISO Standards:

ISO 9439:1990 Technical Corrigendum I, Water Quality—Evaluation in an Aqueous Medium of the Ultimate Biodegradability of Organic Compounds⁵

ISO 4259:1992(E) Petroleum Products—Determination and Application of Precision Data in Relation to Methods of Test⁵

2.3 OECD Standards:

OECD 301B (the Modified Sturm Test) Guidelines for Testing Chemicals⁶

OECD 301F (the Manometric Respirometry Test) Guidelines for Testing of Chemicals⁶

3. Terminology

3.1 Definitions:

3.1.1 *aerobic, adj*—1. taking place in the presence of oxygen; 2. living or active in the presence of oxygen.

3.1.2 *anaerobic, adj*—1. taking place in the absence of oxygen; 2. living or active in the absence of oxygen.

3.1.3 *biodegradation, n*—the process of chemical breakdown or transformation of a substance caused by organisms or their enzymes.

3.1.3.1 *Discussion*—Biodegradation is only one mechanism by which materials are transformed in the environment.

3.1.4 *biomass, n*—any material, excluding fossil fuels, which is or was a living organism or component of a living organism.

3.1.5 *blank, n*—in *biodegradability testing*, a test system containing all system components with the exception of the test substance.

3.1.6 *environmental compartment, n*—a subdivision of the environment based on physical or chemical properties, or both.

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² *Annual Book of ASTM Standards*, Vol 08.03.

³ *Annual Book of ASTM Standards*, Vol 05.03.

⁴ *Annual Book of ASTM Standards*, Vol 11.03.

⁵ Available from American National Standards Institute, 11 W. 42nd St., 13th Floor, New York, NY 10036.

⁶ Available from the Organization for Economic Cooperation and Development, 2 Rue Andre Pascal, S-75775, Paris CEDEX 16.



3.1.6.1 *Discussion*—Examples of environmental compartments are aerobic fresh water, aerobic marine and aerobic soil. The results of test procedures may be applied to environmental compartments but the test systems do not constitute an environmental compartment.

3.1.7 *inoculum, n*—spores, bacteria, single celled organisms or other live materials that are introduced into a test medium.

3.1.8 *preadaptation, n*—the incubation of an inoculum in the presence of the test substance which is done prior to the initiation of the test and under conditions similar to the test conditions.

3.1.8.1 *Discussion*—The aim of preadaptation is to improve the precision of the test method by decreasing variability in the rate of biodegradation produced by the inoculum. Preadaptation may mimic the natural processes which cause changes in the microbial population of the inoculum leading to more rapid biodegradation of the test substance, but it is not expected to change the final degree of biodegradation.

3.1.9 *primary biodegradation, n*—degradation of the test substance resulting in a change in its physical or chemical properties, or both.

3.1.10 *primary biodegradation test, n*—a test which follows the disappearance of a test substance by measuring some attribute of the substance.

3.1.10.1 *Discussion*—The extent to which the results of a primary biodegradation test correspond to the biological conversion of the test substance will depend on the attribute which is being measured.

3.1.11 *sonication, n*—the act of subjecting a material to the shearing forces of high-frequency sound waves.

3.1.11.1 *Discussion*—Sonication of a two phase liquid system may result in the dispersal of one phase as fine droplets in the other phase.

3.1.12 *ultimate biodegradation, n*—degradation achieved when a substance is totally utilized by microorganisms resulting in the production of carbon dioxide (and possibly methane in the case of anaerobic biodegradation), water, inorganic compounds and new microbial cellular constituents (biomass or secretions, or both).

3.1.13 *ultimate biodegradation test, n*—a test which estimates the extent to which the carbon in a product is converted to CO₂ or methane, either directly, by measuring the production of CO₂ or methane, or, in the case of aerobic biodegradation, indirectly by measuring the consumption of O₂.

3.1.13.1 *Discussion*—The measurement of new biomass usually is not attempted.

4. Summary of Guide

4.1 This guide gives two kinds of information which relate to testing of hydraulic fluids for biodegradability. First, it gives information of a general nature relating to biodegradability. For example, it includes definitions of terms not traditionally used by users or producers of hydraulic fluids (Section 3) and a brief discussion of some of the technical issues which are common to most biodegradability tests when they are applied to hydraulic fluids (Section 7). Second, the guide gives more specific information on the methods, advantages, and disadvantages of several of the biodegradation tests frequently used for hydraulic fluids (Section 6).

5. Significance and Use

5.1 This guide discusses ways to assess the likelihood that a hydraulic fluid will undergo biodegradation if it enters an environment that is known to support biodegradation of some substances, for example the material used as the positive control in the test. The information can be used in making or assessing claims of biodegradability of a fluid formula.

5.2 Biodegradation occurs when a fluid interacts with the environment, and so the extent of biodegradation is a function of both the chemical composition of the hydraulic fluid and the physical, chemical and biological status of the environment at the time the fluid enters it. This guide cannot assist in judging the status of a particular environment, so it is not meant to provide standards for judging the persistence of a hydraulic fluid in any specific environment either natural or man-made.

5.3 If any of the tests discussed in this guide gives a high result, it implies that the hydraulic fluid will biodegrade and will not persist in the environmental compartment being considered. If a low result is obtained, it does not mean necessarily that the substance will not biodegrade in the environment, but does mean that further testing is required if a claim of biodegradability is to be made. Such testing may include, but is not limited to, other tests mentioned in this guide or simulation tests for a particular environmental compartment.

6. Test Methods

6.1 *Aerobic Fresh Water Environment*—The most commonly performed tests cover aerobic biodegradation in fresh water. The tests conducted for this compartment may be ultimate biodegradation tests measuring CO₂ production or primary biodegradation tests measuring the disappearance of the test fluid. The test medium is based on high-grade, carbon-free water. Some salts will be included as necessary for maintenance of solution pH and provision of trace minerals necessary for microbial life.

6.1.1 The majority of ultimate biodegradation tests measure produced CO₂. Examples of test procedures for ultimate biodegradability in an aerobic aquatic environment are: the Modified Sturm Test (OECD 301B); the Manometric Respirometry Test (OECD 301F); the U.S. EPA Aerobic Aquatic Biodegradation Test, which also is called the EPA Shake Flask Test and was derived from the Gledhill Test (1);⁷ Test Method D 5864; and the ISO Test 9439:1990. With the exception of Test Method D 5864, these tests were originally designed for water-soluble pure compounds and so the test procedures allow some procedural options that are not suitable for water-insoluble substances, such as addition of the test substance in an aqueous solution or calculation, rather than measurement, of carbon content. In other tests, such as the Manometric Respirometry Test, oxygen consumption is measured as a surrogate for CO₂ production. Oxygen consumption is not a direct measure of ultimate biodegradation but is expected to correlate closely with it. The procedures listed are screening tests suitable for laboratory evaluation of the hydraulic fluid. Although all the tests referred to above specify that the

⁷ The boldface numbers in parentheses refer to the list of references at the end of this standard.