Designation: D4739 – 23

Standard Test Method for Base Number Determination by Potentiometric Hydrochloric Acid Titration[1]

This standard is issued under the fixed designation D4739; 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.

INTRODUCTION

Currently, there are two ASTM test methods under the jurisdiction of Committee D02 used for determining base number by potentiometric titration: Test Method D2896 and Test Method D4739. They are both used throughout the petroleum industry. Test Method D2896 is for new oils and is used in setting specifications since it is more accurate than Test Method D4739. Test Method D4739 shall be used exclusively for the purpose of tracking base number loss as an oil proceeds in service. In many cases, the test methods will provide different results. Some comparisons are given in the Scope and the Significance and Use sections of this test method to distinguish between the two standards and to provide guidance to users.

1. Scope*

1.1 This test method covers a procedure for the determination of basic constituents in petroleum products and new and used lubricants. This test method resolves these constituents into groups having weak-base and strong-base ionization properties, provided the dissociation constants of the more strongly basic compounds are at least 1000 times than that of the next weaker groups. This test method covers base numbers up to 250.

1.2 In new and used lubricants, the constituents that can be considered to have basic properties are primarily organic and inorganic bases, including amino compounds. This test method uses hydrochloric acid as the titrant, whereas Test Method D2896 uses perchloric acid as the titrant. This test method may or may not titrate these weak bases and, if so, it will titrate them to a lesser degree of completion; some additives such as inhibitors or detergents may show basic characteristics.

1.3 When testing used engine lubricants, it should be recognized that certain weak bases are the result of the service rather than having been built into the oil. This test method can be used to indicate relative changes that occur in oil during use under oxidizing or other service conditions regardless of the color or other properties of the resulting oil. The values obtained, however, are intended to be compared with the other values obtained by this test method only; base numbers obtained by this test method are not intended to be equal to values by other test methods. Although the analysis is made under closely specified conditions, this test method is not intended to, and does not, result in reported basic properties that can be used under all service conditions to predict performance of an oil; for example, no overall relationship is known between bearing corrosion or the control of corrosive wear in the engine and base number.

1.4 This test method was developed as an alternative for the former base number portion of Test Method D664 (last published in Test Method D664 – 81).

1.4.1 Colorimetric test methods for base number are Test Method D974, IP 139, and 5102.1 on acid and base number by extraction (color-indicator titration) of Federal Test Method Standard No. 791b. Test results by these methods may or may not be numerically equivalent to this test method.

1.5 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

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

1.7 *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.*

[1] This test method is under the jurisdiction of ASTM Committee D02 on Petroleum Products, Liquid Fuels, and Lubricants and is the direct responsibility of Subcommittee D02.06 on Analysis of Liquid Fuels and Lubricants.

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***A Summary of Changes section appears at the end of this standard**

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D664 Test Method for Acid Number of Petroleum Products by Potentiometric Titration

D974 Test Method for Acid and Base Number by Color-Indicator Titration

D1193 Specification for Reagent Water

D2896 Test Method for Base Number of Petroleum Products by Potentiometric Perchloric Acid Titration

D4057 Practice for Manual Sampling of Petroleum and Petroleum Products

D4175 Terminology Relating to Petroleum Products, Liquid Fuels, and Lubricants

D4177 Practice for Automatic Sampling of Petroleum and Petroleum Products

2.2 *IP Standard:*[3]

IP 139 Petroleum products and lubricants—Determination of acid and base number—Colour-indicator titration method

2.3 *U.S. Federal Test Method:*[4]

Federal Test Method Standard No. 791b Lubricants Liquid Fuels and Related Products; Methods of Testing

3. Terminology

3.1 *Definitions:*

3.1.1 For definitions of terms used in this test method, refer to Terminology D4175.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *base number, n*—the quantity of a specified acid, expressed in terms of the equivalent number of milligrams of potassium hydroxide per gram of sample, required to titrate a sample in a specified solvent to a specified endpoint using a specified detection system.

3.2.1.1 *Discussion*—In this test method, the sample is titrated to a meter reading corresponding to aqueous acidic buffer solution or appropriate inflection point.

3.2.2 *strong base number, n*—the quantity of acid, expressed in terms of the equivalent number of milligrams of potassium hydroxide per gram of sample, that is required to titrate a sample dissolved in the specified solvent from the initial meter reading to a meter reading corresponding to a basic buffer solution.

4. Summary of Test Method

4.1 The sample is dissolved in a mixture of toluene, propan-2-ol (isopropyl alcohol), chloroform, and a small amount of water and titrated potentiometrically with alcoholic hydrochloric acid solution. The test results of this procedure are obtained by titration mode of fixed increment and fixed time additions of the titrant. An endpoint is selected from a titration curve according to the criteria given in Section 12 and used to calculate a base number.

5. Significance and Use

5.1 New and used petroleum products can contain basic constituents that are present as additives. The relative amount of these materials can be determined by titration with acids. The base number is a measure of the amount of basic substances in the oil always under the conditions of the test. It is sometimes used as a measure of lubricant degradation in service. However, any condemning limit shall be empirically established.

5.2 As stated in 1.2, this test method uses a weaker acid to titrate the base than Test Method D2896, and the titration solvents are also different. Test Method D2896 uses a stronger acid and a more polar solvent system than Test Method D4739. As a result, Test Method D2896 will titrate salts of weak acids (soaps), basic salts of polyacidic bases, and weak alkaline salts of some metals. They do not protect the oil from acidic components due to the degradation of the oil. This test method may produce a falsely exaggerated base number. Test Method D4739 will probably not titrate these weak bases but, if so, will titrate them to a lesser degree of completion. It measures only the basic components of the additive package that neutralizes acids. On the other hand, if the additive package contains weak basic components that do not play a role in neutralizing the acidic components of the degrading oil, then the Test Method D4739 result may be falsely understated.

5.3 Particular care is required in the interpretation of the base number of new and used lubricants.

5.3.1 When the base number of the new oil is required as an expression of its manufactured quality, Test Method D2896 is preferred, since it is known to titrate weak bases that this test method may or may not titrate reliably.

5.3.2 When the base number of in-service or at-term oil is required, this test method is preferred because in many cases, especially for internal combustion engine oils, weakly basic degradation products are possible. Test Method D2896 will titrate these, thus giving a false value of essential basicity. This test method may or may not titrate these weak acids.

5.3.3 When the loss of base number value, as the oils proceed in service, is the consideration, this test method is to be preferred and all values including the unused oil shall be determined by this test method. Base numbers obtained by this test method shall not be related to base numbers obtained by another test method such as Test Method D2896.

5.3.4 In ASTM Interlaboratory Crosscheck Programs for both new and used lubricants, historically Test Method D2896 gives a higher value for base number.

6. Apparatus

6.1 *Potentiometric Titration,* automatic or manual, with capability of adding fixed increments of titrant at fixed time intervals (see Annex A1).

6.1.1 The titrimeter must automatically (or manually) control the rate of addition of titrant as follows: Delivery of titrant will be incremental; after delivery of precisely a 0.100 mL increment (see 6.1.2), the delivery is stopped and a fixed time

[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] Available from Energy Institute, 61 New Cavendish St., London, W1G 7AR, U.K., http://www.energyinst.org.

[4] Available from Standardization Documents Order Desk, DODSSP, Bldg. 4, Section D, 700 Robbins Ave., Philadelphia, PA 19111-5098.