



Designation: D3339 – 12 (Reapproved 2017)

# Standard Test Method for Acid Number of Petroleum Products by Semi-Micro Color Indicator Titration<sup>1</sup>

This standard is issued under the fixed designation D3339; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

## 1. Scope

1.1 This test method covers the determination of acidic constituents in new or used petroleum products and lubricants soluble or nearly soluble in mixtures of toluene, and isopropyl alcohol. The test method is especially intended for cases in which the amount of sample available to be analyzed is too small to allow accurate analysis by Test Methods D974 or D664. It is applicable for the determination of acids having dissociation constants in water larger than  $10^{-9}$ . Extremely weak acids having dissociation constants smaller than  $10^{-9}$  do not interfere. Salts titrate if their hydrolysis constants are larger than  $10^{-9}$ .

1.2 This test method can be used to indicate relative changes in acid number that occur in an oil during use under oxidizing conditions. Although the titration is made under definite equilibrium conditions, the method does not measure an absolute acidic property that can be used to predict performance of an oil under service conditions. No general relationship between bearing corrosion and acid number is known.

1.3 Since this test method requires substantially less sample than Test Methods D974 or D664, it provides an advantageous means of monitoring an oxidation test by changes in acid number by (1) minimizing test sample depletion for acid number analyses and thus minimizing the disturbance of the test or (2) allowing additional acid number analyses to be made while maintaining the same test sample depletion and thus providing additional data.

NOTE 1—Some oils, such as many cutting oils, rust-proofing oils, and similar compounded oils, or excessively dark-colored oils, may be more difficult to analyze by this test method due to obscurity of the color-indicator end point. These oils can be analyzed by Test Method D664 provided sufficient sample is available. However, this situation is much less likely using Test Method D3339 than using Test Method D974 due to the use of a more highly dilute sample during the titration and due to the greater stability of the end point color change. The acid numbers obtained by Test Method D3339 may or may not be numerically the same as those

obtained by Test Method D664 but they should be of the same order of magnitude.

NOTE 2—The results obtained using this method have been found to be numerically the same as those obtained using Test Method D974, within the precision of the two methods, for new or oxidized lubricants of the type primarily intended for hydraulic or steam turbine type service. The oxidized lubricants were obtained using the Test Method D943 oxidation test. This correlation is shown by the correlation coefficient  $r = 0.989$  with slope  $s = +1.017$  and intercept  $y = +0.029$ , calculated using the acid numbers obtained using both titration methods for the samples used for the precision statement (12.2).<sup>2</sup>

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

1.5 *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.* For specific warning statements, see Sections 7 and 9, A1.1.4, A2.3.1, and A2.10.1.

1.6 *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:<sup>3</sup>

- D664 Test Method for Acid Number of Petroleum Products by Potentiometric Titration
- D943 Test Method for Oxidation Characteristics of Inhibited Mineral Oils
- D974 Test Method for Acid and Base Number by Color-Indicator Titration
- D1193 Specification for Reagent Water

<sup>1</sup> 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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<sup>2</sup> Use of the correlation coefficient is given in Mack, C., *Essentials of Statistics for Scientists and Technologists*, Plenum Press, New York, NY, 1967, or other publications on statistics.

<sup>3</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

### 3. Terminology

#### 3.1 Definitions:

3.1.1 *acid number, n*—the quantity of a specified base, expressed in 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.

3.1.1.1 *Discussion*—In this test method, acids or salts with dissociation constants greater than  $10^{-9}$ , are titrated to a green end point with *p*-naphtholbenzein indicator.

3.1.2 *used oil, n*—any oil that has been in a piece of equipment (for example, an engine, gearbox, transformer or turbine) whether operated or not.

3.1.2.1 *Discussion*—Typically, in this test method, the acidity of oxidized hydraulic or steam turbine oils is measured.

### 4. Summary of Test Method

4.1 To determine the acid number a sample of the oil is dissolved in a solvent consisting of toluene, isopropyl alcohol, and a small amount of water. The resulting single-phase solution is titrated at room temperature under a nitrogen atmosphere with standardized 0.01 *M* potassium hydroxide (KOH) in isopropyl alcohol to the stable green color of the added *p*-naphtholbenzein indicator.

### 5. Significance and Use

5.1 This test method measures the acid number of oils obtained from laboratory oxidation tests using smaller amounts of sample than Test Methods **D974** or **D664**. It has specific application in Test Method **D943** in which small aliquots of oil are periodically removed for testing by Test Method **D3339**. This test method, therefore, provides a means of monitoring the relative oxidation of oils, by measuring changes in acid number, at different time intervals and under the various oxidizing test conditions.

### 6. Apparatus (Refer to Fig. 1)

6.1 *Titration Buret*—A micro scale, automatic buret with 0.01 mL subdivisions and at least a 2 mL buret capacity.

6.2 *Titrant Reservoir*—The preferred reservoir is one that is integral with the automatic buret, such as shown in Fig. 1. A titrant reservoir separate from the automatic buret may be used if the line connecting the reservoir with the buret is all glass. Exposure of the titrant to light should be minimized by use of amber glass for the reservoir, by wrapping the reservoir with foil such as aluminum foil, or by other suitable means. Also, the tube in the reservoir for titrant withdrawal is adjusted so that the end of the tube is about 20 mm from the bottom of the reservoir so that any precipitate that may collect on the bottom of the reservoir will not be disturbed. To further avoid disturbing any precipitate in the reservoir, movement of the reservoir must be minimized.

6.2.1 With either type of reservoir all entrances and exits to the buret and reservoir must be connected to absorption tubes to remove atmospheric carbon dioxide and water, for example, tubes containing 10 mesh to 20 mesh anhydrous calcium sulfate as desiccant and soda-lime as carbon dioxide absorbent. Precautions must be taken to prevent introduction of any soda-lime into the titrant reservoir or buret.

6.3 *Titration Beaker*—100 mL capacity tall-form Berzelius beaker without pouring spout. Approximate dimensions are 47 mm in inside diameter and 79 mm in height.

6.4 *Titration Beaker Purging Stopper*—A stopper to enclose the titration beaker. The stopper must be composed of an elastomeric material, such as neoprene, that is essentially unaffected by the titration solvent. Approximate stopper dimensions are 53 mm top diameter, 45 mm bottom diameter, and 25 mm height. The stopper is fitted with a 8 mm outside diameter glass inlet tube extending 15 mm  $\pm$  2 mm beyond the bottom of the stopper and with a 7 mm  $\pm$  1 mm inside diameter hole. The inlet tube and hole are placed on opposite sides of the stopper with a center-to-center separation distance of 30 mm  $\pm$  1 mm.

6.5 *Purge Gas Rotameter*, capable of indicating a flow rate of 10 L/h.

6.6 *Stirrer Motor*, variable speed, magnetically linked.

NOTE 3—A propeller may also be used instead of a magnetic stirrer to mix the samples.

6.7 *Stirring Bar*, cylindrical, TFE-fluorocarbon encased, 25.4 mm long and 7.9 mm in diameter.

6.8 *Pipet*, capable of transferring 0.100 mL  $\pm$  0.002 mL of titration indicator solution.

6.9 *Titration Solvent Buret*—A 500 mL or larger capacity buret with 5 mL subdivisions. The top of the buret is stoppered and connected with an absorption tube, as in 6.2, to remove atmospheric carbon dioxide and water. An alternative means of dispensing the titration solvent may be used provided a dispensing repeatability within  $\pm$  1 mL for 40 mL is obtainable and the solvent in the dispenser is isolated from atmospheric carbon dioxide and water.

NOTE 4—An automated photometric device may also be used for detecting the titration end point. However, the precision estimates given in Section 13 may not apply to this mode of titration.

### 7. Reagents and Materials

7.1 *Purity of Reagents*—Reagent grade chemicals shall be used in all tests. 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 or to other such recognized standards for reagent chemicals.<sup>4</sup> Other grades may be used, provided it is first ascertained that the reagent is of sufficient high purity to permit its use without lessening the accuracy of the determination.

7.2 *Purity of Water*—All references to water shall be understood to mean freshly distilled (carbon dioxide-free) water conforming to Specification **D1193**, Type II or III.

<sup>4</sup> *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.

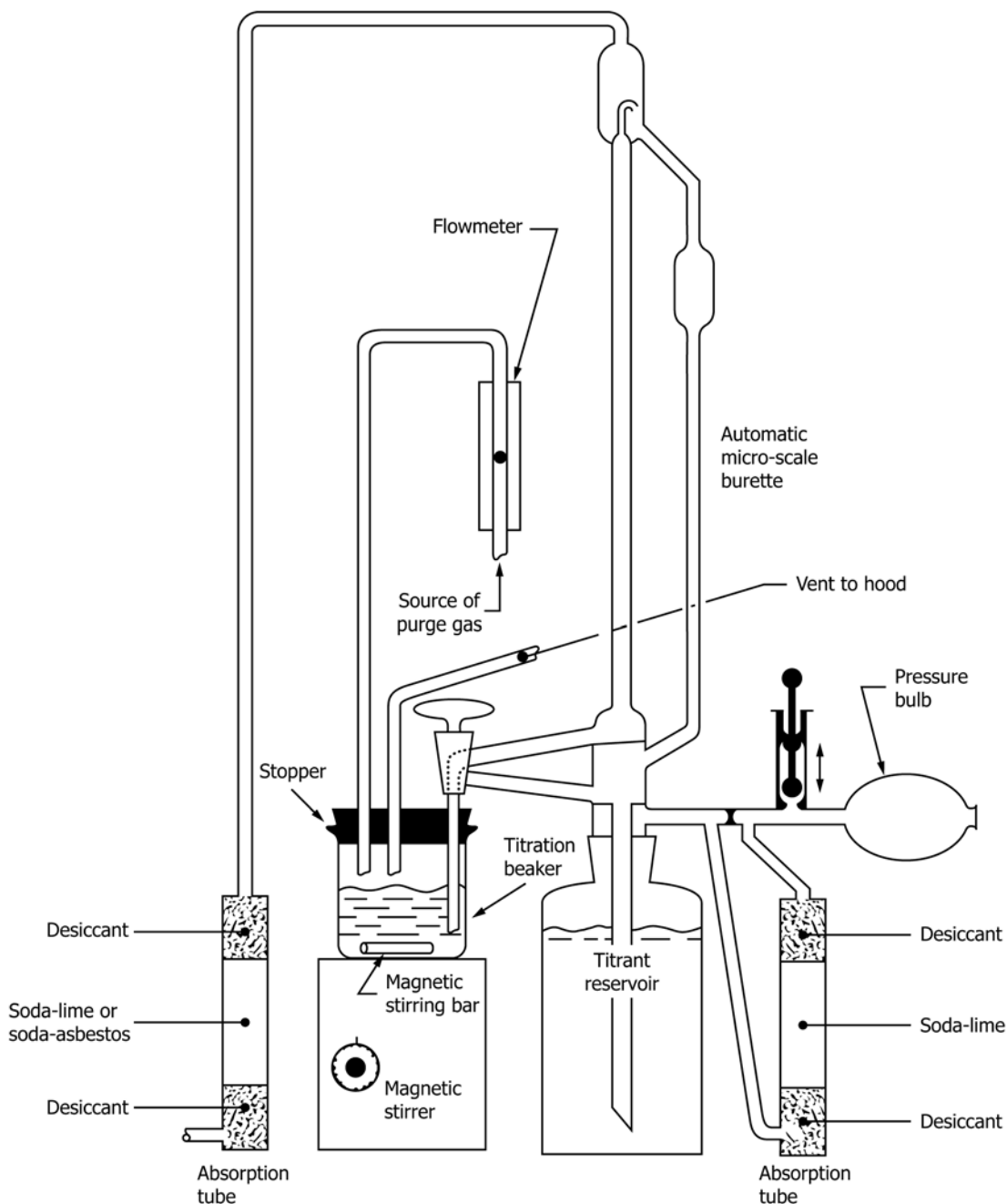


FIG. 1 Schematic Drawing of Typical Apparatus

7.3 *Ethyl Alcohol*—(Warning—Flammable. Denatured—Cannot be made nontoxic.) USP 200 proof or denatured alcohol according to Formula 30 of the U. S. Bureau of Internal Revenue.

7.4 *Propanol-2-ol, (Isopropyl Alcohol) Anhydrous*, (Warning—Flammable, see also Note 5.) containing less than 0.9 % water.

NOTE 5—It has been reported that, if not inhibited against it, propanol-2-ol can contain peroxides. When this occurs, an explosive mixture is possible when the storage vessel or other equipment such as a dispensing bottle, are near empty and approaching dryness.

7.5 *p-Naphtholbenzein Indicator*<sup>5,6</sup> Solution—The *p*-naphtholbenzein must meet the specifications given in Annex A1. Prepare a solution containing 10 g of *p*-naphtholbenzein per litre of titration solvent.

<sup>5</sup> In a 2006 study, only Kodak, Baker (Mallinkrodt), Fluka, and Aldrich were found to meet the specifications in Annex A1. However, Kodak brand is no longer available.

<sup>6</sup> Supporting data have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR:D02-1626. Contact ASTM Customer Service at service@astm.org.

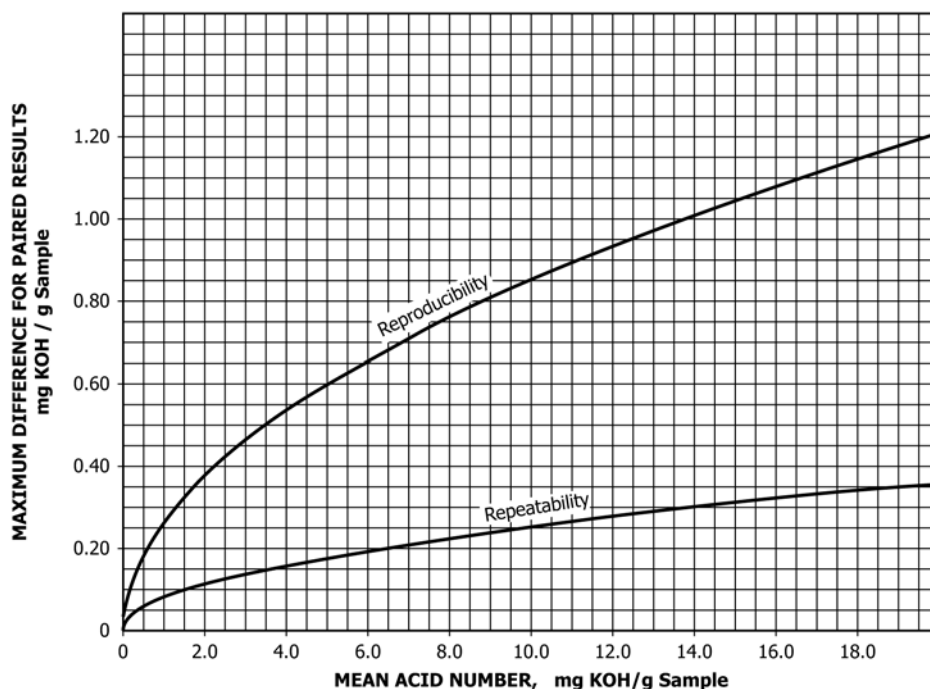


FIG. 2 Precision Curves

7.6 Nitrogen, dry and carbon dioxide-free.

7.6.1 In order to obtain repeatable results and a stable end point color change, it is especially important that the nitrogen purge gas be free of carbon dioxide. Purified grade nitrogen has been found to be satisfactory.

7.7 Phenolphthalein Indicator Solution—Dissolve 0.10 g of solid pure phenolphthalein in 50 mL of water and 50 mL of ethyl alcohol.

7.8 Titration Solvent—Consisting of 5.0 mL ± 0.1 mL of water, 495 mL ± 1 mL of anhydrous propanol-2-ol, and 500 mL ± 1 mL of toluene.

7.9 Potassium Hydroxide Solution, Standard Alcoholic (0.01 M), (Warning—Corrosive.)

NOTE 6—Commercially available reagents may be used in place of laboratory preparations.

7.9.1 Preparation, Add 3 g of solid KOH to approximately 1 L of anhydrous propanol-2-ol (isopropyl alcohol) (containing less than 0.9 % water) in a 2 L Erlenmeyer flask. Boil the mixture gently on a steam bath for 10 min to 15 min while stirring to prevent caking of solids on the bottom of the flask. Add about 1 g of barium hydroxide and again boil gently for about 10 min. Cool to room temperature, stopper to prevent contact with the room atmosphere and allow to stand overnight (about 16 h). Filter the supernatant liquid through a 10 μm TFE-fluorocarbon membrane filter while avoiding unnecessary exposure to the atmosphere and then dilute the solution (approximately 0.05 M) with anhydrous isopropyl alcohol to a total volume of about 5 L (Note 7). Store the titrant in a chemically resistant dispensing bottle out of contact with cork, rubber, or saponifiable stopcock lubricant and protected by a guard tube containing soda-lime. Minimize exposure of the

titrant to light by storing in the dark or in an amber bottle or by wrapping the bottle with aluminum foil.

NOTE 7—Care should be taken to ensure a final normality of 0.011 ± 0.002.

NOTE 8—Because of the relatively large coefficient of cubic expansion of organic liquids, such as propanol-2-ol, the standard alcoholic solutions should be standardized at temperatures close to those employed in the titrations of samples.

7.9.2 Standardization—The titrant is standardized (Note 8) against dried (at least 1 h at 110 °C), pure potassium hydrogen phthalate using the method described in 9.1 for the acid number analysis, with the exception that water (40 mL ± 1 mL) is used as the solvent and 6 drops of phenolphthalein solution is used as the indicator. The blank is obtained in the same manner except that the potassium hydrogen phthalate is excluded. Standardize the titrant frequently enough to detect changes of 0.0003 M. The mean molarity determined by at least duplicate analyses is used as the titrant molarity for the acid number calculations.

7.10 Toluene (Warning—Flammable. Vapor harmful.) Nitration-grade, or equivalent.

## 8. Preparation of Used Oil Samples

8.1 Strict observance of the sampling procedure described in 8.2 is necessary, since the sediment itself is acidic or basic or has adsorbed acidic or basic material from the sample. Failure to obtain a representative sample causes serious errors.

8.2 Heat the sample (Note 9) of used oil to 60 °C ± 5 °C in the original container and agitate until all sediment is homogeneously suspended in the oil (Note 10). If the original container is of opaque material, or if it is more than three fourths full, transfer the entire sample to a clear glass bottle

**TABLE 1 Size of Sample<sup>A</sup>**

Total Acid Number Range, mg KOH/g Sample	Sample Weight Range, g
< 0.01	5.0 to 2.0
0.01 < 0.1	2.0 to 1.5
0.1 < 0.5	1.5 to 1.0
0.5 < 3.0	1.0 to 0.2
> 3.0	0.2 to 0.1

<sup>A</sup> Dark colored samples with total acid numbers of 0.1 or less may require use of smaller size samples to minimize interference of the sample color with the indicator colors.

having a capacity at least one third greater than the volume of the sample. Transfer all traces of sediment from the original container to the bottle by violent agitation of portions of the sample in the original container. After complete suspension of all sediment, strain the sample or a convenient aliquot of the sample through a 100-mesh screen for the removal of large contaminating particles (Note 11).

NOTE 9—When samples are visibly free of sediment, the heating procedure may be omitted.

NOTE 10—As used oil can change appreciably in storage, samples should be tested as soon as possible after removal from the lubricating or test system and the dates of sampling and testing should be noted.

NOTE 11—When samples are visibly free of sediment, the straining procedure may be omitted.

## 9. Procedure

9.1 *Sample Titration*—Weigh to the nearest 0.1 mg the required amount of sample into a clean, tared titration beaker. Guidelines for determining the amount of sample required are given in Table 1. Place the magnetic stirring bar into the beaker taking care not to splash the sample. Pour 40 mL of titration solvent into the titration beaker, using part of this volume of solvent to wash down any sample that may have splashed onto the sides of the beaker above the solvent-sample solution level. Add 0.100 mL ± 0.002 mL of *p*-naphtholbenzein indicator solution to the solvent-sample solution. Immediately assemble the titration beaker with the purging stopper, previously connected with the rotameter and nitrogen purge gas. Insert the buret tip into the beaker through the hole in the stopper. Adjust the position of the buret tip so that the purge gas can freely exit through the hole (**Warning**—The purge gas must be able to exit freely or otherwise dangerous pressures could develop. Also, the vapor from this treatment contains toluene and should be removed with adequate ventilation.) and the bottom of the buret tip is approximately 10 mm above the surface of the solution. Immediately start the purge gas flow through the beaker at a relatively fast rate, for example, about 30 L/h to 40 L/h, to purge the atmosphere in the beaker rapidly, and then start mixing the solution using the magnetic stirrer. Adjust the purge gas flow rate to 10 L/h ± 1 L/h after purging at the faster flow rate for 15 s to 30 s. Adjust the stirring rate to mix the solution efficiently but without splashing the solution or mixing purge gas into the solution.

NOTE 12—In routine analysis, the indicator may be pre-mixed with the titration solvent before adding to the sample.

9.1.1 Titrate the sample at a temperature below 30 °C with the standardized 0.01 M KOH titrant. The indicator color changes are from the starting orange to a bright yellow and then to green. When the solution first turns green, reduce the increment size to dropwise (manual buret) or between 0.01 mL and 0.05 mL (automated buret). Continue until a persistent green end point is reached and held for a minimum of 15 s after the addition of the last increment (Note 13). This end point can be anticipated by the initial change to yellow, which occurs very close to the end point. Record the quantity of titrant required to obtain the stable end point.

NOTE 13—Several drops of titrant can be required to obtain the stable end point color after reaching a yellow-green color with used oil samples having relatively high total acid numbers, for example, an acid number of about 3 or greater.

9.2 *Blank Titration*—Make a blank titration each day that samples are analyzed. Conduct this titration using the procedure described in 9.1 except omit the sample. Record the quantity of titrant required to obtain the stable green end point.

## 10. Calculation

10.1 Calculate the acid number of the sample as follows:

$$\text{Acid number, mg KOH/g} = 56.10 M (A - B)/W \quad (1)$$

where:

*A* = millilitres of titrant required for titration of the sample (9.1),

*B* = millilitres of titrant required for titration of the blank (9.2),

*M* = molarity of the titrant (7.9.2), and

*W* = grams of sample used (9.1).

## 11. Report

11.1 Report the result as follows:

$$\text{Acid Number, (Test Method D 3339)} = (\text{Result}) \quad (2)$$

11.2 Report the acid number values as follows:

Acid Number	Report Results
< 0.01	< 0.01
0.01 to < 1.0	Report to the nearest 0.01
1.0 to < 10	Report to the nearest 0.1
10.0 to 20	Report to the nearest 1.0

## 12. Quality Control Checks

12.1 Confirm the performance of the test procedure by analyzing a quality control (QC) sample that is, if possible, representative of the samples typically analyzed.

12.2 Prior to monitoring the measurement process, the user of the method needs to determine the average value and control limits of the QC sample.<sup>7</sup>

12.3 Record the QC results and analyze by control charts or other statistically equivalent technique to ascertain the statistical control status of the total testing process.<sup>7</sup> Any out-of-control data should trigger investigation for root cause(s). The results of this investigation may, but not necessarily, result in instrument recalibration.

<sup>7</sup> MNL7, *Manual on Presentation of Data and Control Chart Analysis*, 6th ed., ASTM International, W. Conshohocken, PA, 1990.

12.4 The frequency of QC testing is dependent on the criticality of the quality being measured, the demonstrated stability of the testing process, and customer requirements. Generally, a QC sample should be analyzed each testing day. The QC frequency should be increased if a large number of samples are routinely analyzed. However, when it is demonstrated that the testing is under statistical control, the QC testing frequency may be reduced. The QC precision should be periodically checked against the precision listed in the Precision and Bias Section of this method to ensure data quality.

12.5 It is recommended that, if possible, the type of QC sample that is regularly tested be representative of the sample routinely analyzed. An ample supply of QC sample material should be available for the intended period of use, and must be homogeneous and stable under the anticipated storage conditions. Because the acid number can vary while an out-of-control situation arises, the stability of the QC sample can be a source of the error.

### 13. Precision and Bias

13.1 This precision section applies only to new and used petroleum-based, inhibited steam turbine and hydraulic oils. Insufficient data are available on other oils coming within the scope of this test method so no precision is given for such oils.

13.2 The precision of this test method as determined by statistical examination of interlaboratory results is as follows:

13.2.1 *Repeatability*—The difference between two test results, obtained by the same operator with the same apparatus

under constant operating conditions on identical test material, would in the long run, in the normal and correct operation of this test method, exceed the following values only in one case in twenty (see also Fig. 2):

Acid Number 0.05 to 20.0	Repeatability $0.08 (X)^{1/2}$
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where:

$X$  = mean acid number of sample.

13.2.2 *Reproducibility*—The difference between two single and independent results obtained by different operators working in different laboratories on identical test material would, in the long run, in the normal and correct operation of this test method, exceed the following values only in one case in twenty (see also Fig. 2):

Acid Number 0.05 to 20.0	Reproducibility $0.27 (X)^{1/2}$
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where:

$X$  = mean acid number of sample.

13.3 *Bias*—The procedure in this test method has no bias because the value of the acid number can be defined only in terms of this test method.

### 14. Keywords

14.1 acid number; petroleum products; semi-micro color indicator titration

## ANNEXES

### A1. SPECIFICATIONS FOR *p*-NAPHTHOLBENZEIN

A1.1 *p*-Naphtholbenzein shall conform to the following requirements:

A1.1.1 *Appearance*—Red amorphous powder.

A1.1.2 *Chlorides*—Less than 0.5 %.

A1.1.3 *Solubility*—Ten grams shall dissolve completely in 1 L of titration solvent A2.7.3.

A1.1.4 *Minimum Absorbance*—Dissolve 0.1000 g  $\pm$  0.0001 g of the *p*-naphtholbenzein in 250 mL of methanol. (**Warning**—Flammable. Vapor harmful. Can be fatal or cause blindness if swallowed or inhaled. Cannot be made nonpoisonous.) Pipette 2 mL of this solution into a 100 mL volumetric flask which contains approximately 40 mL of the pH 12 buffer. Dilute to the mark with the pH 12 buffer, stopper the flask, and shake well. Place this final diluted solution into a 1 cm cell and record the absorbance at 650 nm using a Beckman DU or

equivalent spectrophotometer, using water as the blank. The measured absorbance should be greater than 0.480 AU.

A1.1.5 *pH Range*:

A1.1.5.1 Indicator turns to the first clear green at a relative pH of  $11 \pm 0.5$  when tested by the method for pH range of *p*-naphtholbenzein indicator as described in A2.3.1.

A1.1.5.2 Requires not more than 0.5 mL of 0.01 M KOH solution above that for blank to bring indicator solution to the first clear green.

A1.1.5.3 Requires not more than 1.0 mL of 0.01 M KOH solution above that for blank to bring indicator solution to a blue color.

A1.1.5.4 Initial pH of indicator solution is at least as high as that of the blank.

A1.1.5.5 Buffer is made by mixing 50 mL of 0.05 M dibasic sodium phosphate solution with 26.9 mL of 0.1 M sodium hydroxide solution.

## A2. TEST METHOD FOR DETERMINING pHr RANGE OF *p*-NAPHTHOLBENZEIN INDICATOR

### A2.1. Scope

A2.1.1 This test method is intended for determining the acceptability of *p*-naphtholbenzein indicator for use in Test Method D3339 with regard to color change over a pHr range.

### A2.2. Terminology

A2.2.1 *Definitions of Terms Specific to This Standard:*

A2.2.1.1 *pHr, n*—an arbitrary term which expresses the relative hydrogen ion activity in the toluene-isopropanol-water medium.

A2.2.1.2 *Discussion*—For the purpose of this test method, the pHr acidity scale is defined by two standard buffer solutions which have been designated pHr 4 and pHr 11. The exact relation between pHr and the true pH of a toluene-isopropanol-water solution is not known and cannot be readily determined.

### A2.3. Summary of Test Method

A2.3.1 A prescribed amount of indicator is titrated electrometrically through the various color changes with alcoholic potassium hydroxide (**Warning**—Flammable.) and results plotted against meter readings converted to pHr units.

### A2.4. Significance and Use

A2.4.1 This procedure is used to establish the pHr values of the various color changes of the *p*-naphtholbenzein indicator.

### A2.5. Apparatus

A2.5.1 *Meter, Glass Electrode, Calomel Electrode, Stirrer, Beaker and Stand*, as specified in the Appendix to Test Method D664.

### A2.6 Purity of Reagents

A2.6.1 Reagent grade chemicals shall be used in all tests. 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.<sup>4</sup> 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.

A2.6.2 References to water shall be understood to mean distilled water.

### A2.7. Reagents

A2.7.1 *Potassium Hydroxide Solution, Standard Alcoholic (0.2 M)*—Prepare, store, and standardize in accordance with Test Method D664.

A2.7.2 *Hydrochloric Acid Solution, Standard Alcoholic (0.2 M)*—Prepare and standardize in accordance with Test Method D664.

A2.7.3 *Titration Solvent*—Add 500 mL ± 1 mL of toluene and 5 mL ± 0.1 mL of water to 495 mL ± 1 mL of anhydrous propanol-2-ol (isopropyl alcohol). The titration solvent should be made up in large quantities.

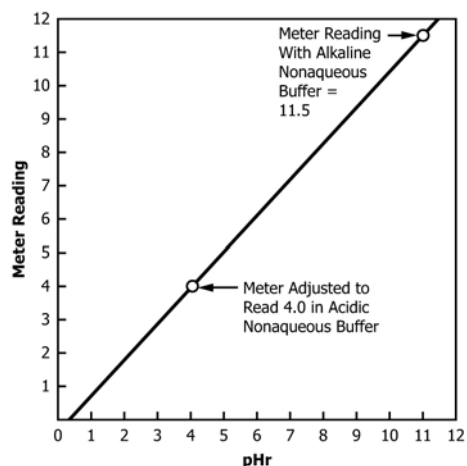


FIG. A2.1 Calibration Curve for Conversion of pH Meter Readings to pHr

A2.7.4 *Acidic Buffer Solution (pHr = 4.0)*—Prepare a stock solution in accordance with Test Method D664. Add 10 mL of buffer stock solution to 100 mL of titration solvent. Use the diluted solution within 1 h.

A2.7.5 *Alkaline Buffer Solution (pHr = 11.0)*—Prepare a stock solution in accordance with Test Method D664. Add 10 mL of buffer stock solution to 100 mL of titration solvent. Use the diluted solution within 1 h.

A2.7.6 *Potassium Chloride Electrolyte*—Prepare a saturated solution of potassium chloride (KCl) in water.

A2.7.7 *Naphtholbenzein Indicator Solution*—Prepare as described in 7.5.

### A2.8 Preparation of Electrode System

A2.8.1 Prepare the electrode system in accordance with Test Method D664.

### A2.9 Standardization of Apparatus

A2.9.1 Prior to each test or series of tests, set the meter to read on the pH scale, insert the electrodes into a beaker containing the acidic nonaqueous buffer solution at a temperature of 25 °C ± 2 °C and stir the solution vigorously. When the pH meter reading becomes constant, adjust the asymmetry potential dial of the instrument so that the meter reads 4.0.

A2.9.2 Remove the acidic buffer, clean the electrodes, and immerse them in water for several minutes. Dry the electrodes and insert them in a beaker containing alkaline nonaqueous buffer solution at 25 °C ± 2 °C. When the pH meter reading has become steady, record the exact value. If the reading is within 0.2 pH units of 11.0, the initial acidity, pHr, of unknown solutions may be read directly from the dial of the meter. If the reading is not within 0.2 units of 11.0 prepare a correction graph as shown in Fig. A2.1. Use this graph to convert pH meter readings to initial acidity, pHr.

**A2.10. Procedure**

A2.10.1 Titrate 100 mL of titration solvent (**Warning—Flammable.**) with 0.01 M KOH solution until the meter indicates a pHr between 13 and 14.

A2.10.2 Add 0.5 mL of indicator solution to a fresh portion of titration solvent and after cleaning the electrodes titrate with 0.01 M KOH solution until the meter indicates a pHr between 13 and 14.

A2.10.3 During the titration, plot the volume of titrant against the pHr or meter reading and note on the curve the various color changes at the corresponding pHr values.

NOTE A2.1—The following color changes, in order, are intended as a guide:

Amber to olive green  
Olive green to clear green  
Clear green to bluish green  
Bluish green to blue

A2.10.4 Plot the blank titration on the same paper used for the indicator.

**A2.11. Calculation**

A2.11.1 Subtract the volume of titrant used in the blank titration from that used for the indicator solution titration at the same pHr corresponding to the definite color changes between 10 to 12 pHr.

**A2.12. Precision and Bias**

A2.12.1 *Precision*—The precision of this procedure has not been determined, and there are no plans to develop one.

A2.12.2 *Bias*—The procedures in this test method have no bias because the values can only be defined in terms of the test method.

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