



Designation: D 2868 – 96

Standard Test Method for Nitrogen Content (Kjeldahl) and Hide Substance Content of Leather¹

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1. Scope

1.1 This test method covers the determination of the nitrogen content of all types of leather. The nitrogen content is used to calculate the hide substance (protein fiber) content of leather.

NOTE 1—This test method is essentially a composite of Method 6441 of Federal Test Method Standard No. 311 and Method B 5 of the American Leather Chemists Association.

1.2 *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 2813 Practice for Sampling Leather for Physical and Chemical Tests²

E 180 Practice for Determining the Precision of ASTM Methods for Analysis and Testing of Industrial Chemicals³

3. Summary of Test Method

3.1 The ground leather specimen prepared according to an accepted procedure⁴ is digested with acid in the presence of a catalyst to convert the nitrogen to ammonium ion. The ammonium ion formed is nonvolatile under these highly acid conditions.

3.2 The acid mixture is then made alkaline and the ammonia liberated is distilled into a boric acid solution which absorbs the ammonia.

3.3 The amount of ammonia in the boric acid is then determined by back titration with standardized acid using a

sharp color change indicator (green to purple) to determine the end point.

4. Significance and Use

4.1 The nitrogen content as determined by this test method is normally considered to be related to the amount of hide substance (protein fiber) present in the leather sample. A factor of 5.62 is normally used to calculate the hide substance from the nitrogen content.

4.1.1 The 5.62 factor represents the average result of many analyses of animal hides, but it cannot be considered to be accurate since it varies somewhat from hide to hide of the same type, from type of hide to type of hide, and also with the thickness of hide retained in the final leather (split thickness as compared to original hide thickness). As a result of these variations, the true factor for any given leather may be expected to vary from 5.44 to 5.80 or about $\pm 3\%$.⁵

4.2 A given leather sample may contain nitrogenous substances other than hide substance (protein fiber) which will be analyzed for by this test method, such as resins, dyestuffs, etc., that contain nitrogen. Therefore, although this test method is fairly accurate for determining the nitrogen content of leather, its use for determining hide substance may result in large errors.

4.3 The hide substance value derived from this determination has a large bearing on other chemical determinations of a given leather. Any errors, such as those described in 4.1.1 and 4.2, will be carried over into these other analytical calculations.

5. Apparatus

5.1 *Kjeldahl Apparatus* consisting of:

5.1.1 *Kjeldahl Flask*, of 500 or 800-mL capacity for digestion of the sample.

5.1.2 *Heater*, (gas or electric) for the Kjeldahl flask with fume hood or other exhaust system.

5.1.3 *Distillation Apparatus*, consisting of an efficient vapor trap that can be sealed tightly in the top of the Kjeldahl flask and a condenser connected to the top of the trap. All elements of the distillation system shall be constructed of block tin,

¹ This test method is under the jurisdiction of ASTM Committee D-31 on Leather and is the direct responsibility of Subcommittee D31.06.01 on General Methods. This test method was developed in cooperation with the American Leather Chemists Assn. (Standard Method B 5 – 1954).

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² *Annual Book of ASTM Standards*, Vol 15.04.

³ *Annual Book of ASTM Standards*, Vol 15.05.

⁴ Acceptable procedures are published in *Journal of the American Leather Chemists Association*, Vol 51, 1956 p. 497; or *Official Methods of Analysis*, Am. Leather Chemists Assn., available through the Office of the Secretary-Treasurer, Campus Station, Cincinnati, Ohio 45221; see Practice D 2813.

⁵ Dahl, S., "Determination of Hide Substance in the Kjeldahl Method," in *Chemistry and Technology of Leather*, Vol 4, Reinhold Publishing Co., New York, NY, 1965.

borosilicate glass, or other materials known not to react with hot ammonia vapor.

6. Reagents

6.1 *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.⁶ 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.

6.2 *Purity of Water*—Unless otherwise indicated, references to water shall be understood to mean distilled water or water of equal purity.

6.3 *Boric Acid Indicator Solution*—Dissolve 40 g of boric acid (H_3BO_3) (borax-free) in water, add 10 mL of mixed indicator solution (5.5) and dilute to 1 L.

6.4 *Catalyst Digestion Mixture*^{7,8}—20.0 g K_2SO_4 + 0.6 g CuSO_4 + 0.2 g pumice.

6.5 *Mixed Indicator Solution*—Dissolve 0.060 g of methyl red indicator and 0.040 g of methylene blue indicator in 100 mL of 95 % ethyl alcohol.

6.6 *Sodium Hydroxide, Concentrated Solution* (450 g/L)—Dissolve 450 g of sodium hydroxide (NaOH) pellets (98 %) in water and dilute to 1 L.

6.7 *Sodium Hydroxide, Standard Solution* (0.1 N)—Dissolve 10 mL of the concentrated NaOH solution (6.6) in 1 L of boiled and cooled water. Determine the exact normality by titration against the standard sulfuric acid (6.11) using the mixed indicator (6.5) for the end point.

6.8 *Sodium Thiosulfate Solution* (80 g/L)—Dissolve 80 g of sodium thiosulfate ($\text{Na}_2\text{S}_2\text{O}_3 \cdot 5\text{H}_2\text{O}$) in water and dilute to 1 L.

6.9 *Sucrose* ($\text{C}_{11}\text{H}_{22}\text{O}_{11}$).

6.10 *Sulfuric Acid* (sp gr 1.84)—Concentrated sulfuric acid (H_2SO_4), free from nitrogen.

6.11 *Sulfuric Acid, Standard* (0.3 N)—Dissolve 9 mL of concentrated H_2SO_4 (5.10) in water and dilute to 1 L. Determine the exact normality by titration against an equivalent solution of a primary standard such as anhydrous sodium carbonate or tris (hydroxymethyl) amino methane.

7. Standardization

7.1 *Blanks*—Run a blank determination substituting 1.0 g of sucrose in place of the leather specimen by the procedure shown in Section 8. Calculate the blank results, as shown in Section 9.

7.2 *Standard*—Tris (hydroxymethyl) amino methane can be used as an internal nitrogen standard for the method. Weigh out

to 0.001 g approximately 1 g of tris (hydroxymethyl) amino methane and transfer to the Kjeldahl flask. Run this standard by the same procedure shown in Section 8. One gram of this reagent is equal to 0.1156 g of N_2 or 8.255 meq of N_2 .

8. Procedure

8.1 *Sample and Specimen*—Weigh out two specimens from the ground sample² of 1.5 ± 0.1 g accurately to 0.001 g and record the weight of each specimen.

NOTE 2—The specimens for all chemical tests to be performed on the leather should be weighed at the same time to keep the moisture content constant among the specimens. If only the nitrogen content is being analyzed for, then specimens for moisture analysis should be weighed out at the same time as those for the nitrogen analyses.

8.2 *Digestion*—Transfer the specimen to a Kjeldahl flask, being careful that all the powder is shaken down into the main bulb of the flask. Add 10 ± 0.5 g of the catalyst digestion mixture, a few glass beads or other anti-bumping agents, and 25 mL of H_2SO_4 . Mix the contents by gently swirling until all of the powder is wet by the acid. Place the flask over the heater in the fume hood with the flask inclined at about 45° . Adjust the heat so that the contents boil gently (the condensate line should be within the neck of the flask) and maintain this boiling for 1.5 h. Cool and dilute with 250 to 300 mL of water. Add 25 mL of $\text{Na}_2\text{S}_2\text{O}_3$ solution and swirl the flask gently to mix the contents thoroughly. Set aside for 5 to 10 min with occasional shaking.

8.3 Distillation:

8.3.1 Measure out 125 mL of the H_3BO_3 solution with a graduate and transfer to a 500-mL Erlenmeyer receiving flask. Place the receiving flask under the outlet tube from the condenser so that the end of the tube dips below the surface of the H_3BO_3 solution.

8.3.2 Carefully pour an amount of the concentrated NaOH solution sufficient to make the contents of the flask strongly alkaline slowly down the side of the digestion flask so that the caustic settles to the bottom and does not mix with the acid layer. The amount of concentrated NaOH solution required is about 95 mL. Connect the Kjeldahl flask to the trap immediately and be sure that the rubber stopper is tightly in place. Swirl the contents gently to mix the two layers and then heat sufficiently to boil the solution in the flask. Continue heating until 150 to 200 mL has distilled over and been collected in the H_3BO_3 solution in the receiver. Disconnect the flask and trap before turning off the heat to prevent sucking the solution from the receiver back into the flask. Disconnect the condenser outlet tube and rinse it off into the receiver. Dilute the contents of the receiver to approximately 350 mL.

8.3.3 *Titration*—Titrate the receiver contents immediately with the 0.3 N H_2SO_4 (5.11) to a purple end point (pH about 4.9). Blank determinations run in accordance with 7.1 may require titration with alkali (if they are purple at the end of the distillation). In this case, titrate with the 0.1 N NaOH solution.

9. Calculations

9.1 *Blank*—If the blank was acid (purple) and required titration by the 0.1 N NaOH solution, then convert this value to equivalent millilitres of 0.3 N H_2SO_4 as follows:

$$B = \text{blank, ml of standard} = V_b N_b / N_a \quad (1)$$

⁶ *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 *Analar Standards for Laboratory Chemicals*, BDH Ltd., Poole, Dorset, U.K., and the *United States Pharmacopeia and National Formulary*, U.S. Pharmaceutical Convention, Inc. (USPC), Rockville, MD.

⁷ Dahl, S., and Oehler, R., "The Determination of Nitrogen in Leather by the Kjeldahl Method," *JALCA*, Vol 46, 1951, pp. 317–355.

⁸ Available as a prepared catalyst mixture from some laboratory supply companies, for example, E. H. Sargent Co. Kjeldahl Tablets SC 12984.