



Designation: D521 – 02 (Reapproved 2019)

Standard Test Methods for Chemical Analysis of Zinc Dust (Metallic Zinc Powder)¹

This standard is issued under the fixed designation D521; 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.

1. Scope

1.1 These test methods cover procedures for the chemical analysis of metallic zinc powder in the form commercially known as zinc dust for use as a pigment in paints.

1.2 The analytical procedures appear in the following order:

	Sections
Moisture and Other Volatile Matter	7
Coarse Particles	8
Matter Soluble in Hexane	9 and 10
Total Zinc	11 and 12
Metallic Zinc	13 and 14
Zinc Oxide	15
Calcium	16 and 17
Lead	18
Iron	19
Cadmium	20
Chlorine	21 and 22
Sulfur	23 and 24

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

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

1.5 *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:*²

D214 Test Method for Sieve Analysis of Metal Powders

¹ These test methods are under the jurisdiction of ASTM Committee D01 on Paint and Related Coatings, Materials, and Applications and are the direct responsibility of Subcommittee D01.31 on Pigment Specifications.

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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.

D185 Test Methods for Coarse Particles in Pigments
D280 Test Methods for Hygroscopic Moisture (and Other Matter Volatile Under the Test Conditions) in Pigments
D1193 Specification for Reagent Water
D6580 Test Method for The Determination of Metallic Zinc Content in Both Zinc Dust Pigment and in Cured Films of Zinc-Rich Coatings
E40 Method for Chemical Analysis of Slab Zinc (Spelter) (Withdrawn 1993)³
E68 Method for Polarographic Determination of Lead and Cadmium in Zinc (Withdrawn 1980)³

3. Significance and Use

3.1 These test methods compile procedures which can be used to check the composition of purity of metallic zinc powder. This information is useful to both the formulator and users.

4. Treatment of Sample

4.1 Store the laboratory sample in a tightly stoppered bottle to protect it from oxidation. Mix the whole sample thoroughly before taking portions for analysis.

5. Purity of Reagents

5.1 *Purity of Reagents*—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.⁴ 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.

5.2 *Purity of Water*—Unless otherwise indicated, references to water shall be understood to mean reagent water conforming to Type II of Specification **D1193**.

³ The last approved version of this historical standard is referenced on www.astm.org.

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 *Analar 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.

6. Precision

6.1 Precision statements have not been established.

MOISTURE AND OTHER VOLATILE MATTER

7. Procedure

7.1 Determine moisture and other volatile matter in accordance with Method A of Test Methods **D280**, except heat the sample for only 1 h.

COARSE PARTICLES

8. Procedure

8.1 Determine the percent of coarse particles in the pigment in accordance with Test Methods **D185** or **B214**.

MATTER SOLUBLE IN HEXANE

9. Reagent

9.1 *Hexane*—Pure hexane or commercial hexane or petroleum ether of boiling point not higher than 75°C. Redistill before using.

10. Procedure

10.1 Place 100 g of the pigment in an extraction thimble in a Soxhlet extraction apparatus. Record the tare weight of the receiving flask. Charge the flask with a suitable volume of hexane and extract the sample for 4 h, subjecting the specimen to not less than 20 extractions in this time. Make a blank determination at the same time.

10.2 Remove the receiving flask, evaporate or distill off the hexane on a steam bath, and dry the flask at $105 \pm 2^\circ\text{C}$ for 1 h. Cool and weigh.

10.3 Calculate the percent of matter soluble in hexane, allowing for any material found in the blank.

TOTAL ZINC

11. Reagents

11.1 *Potassium Ferrocyanide, Standard Solution*—Dissolve 22 g of potassium ferrocyanide ($\text{K}_4\text{Fe}(\text{CN})_6 \cdot 3\text{H}_2\text{O}$) in water and dilute to 1 L. To standardize, transfer 0.2 g of metallic zinc or freshly ignited zinc oxide (ZnO) to a 400-mL beaker. Dissolve in 10 mL of hydrochloric acid (HCl), sp gr 1.19 and 20 mL of water. Drop in a small piece of litmus paper, add ammonium hydroxide (NH_4OH) until slightly alkaline, then add HCl until just acid, and then 3 mL more of HCl . Dilute to about 250 mL with hot water and heat nearly to boiling. Run in the $\text{K}_4\text{Fe}(\text{CN})_6$ solution slowly from a buret, while stirring constantly, until a drop tested on a white porcelain plate with a drop of the uranyl indicator solution shows a brown tinge after standing 1 min. Do not allow the temperature of the solution to fall below 70°C during the titration. Run a blank using the same amounts of reagents and water as in the standardization. The standardization must be made under the same conditions of temperature, volume, and acidity as obtained when the sample is titrated. Calculate the strength of the $\text{K}_4\text{Fe}(\text{CN})_6$ solution in terms of grams of zinc as follows:

$$Z = W/(V_1 - B) \quad (1)$$

where:

Z = zinc equivalent of the $\text{K}_4\text{Fe}(\text{CN})_6$ solution, g/mL,
 W = zinc used (or equivalent to the ZnO used), g,
 V_1 = $\text{K}_4\text{Fe}(\text{CN})_6$ solution required for titration of the standard, mL, and
 B = $\text{K}_4\text{Fe}(\text{CN})_6$ solution required for titration of the blank, mL.

11.2 *Uranyl Nitrate Indicator Solution*—Dissolve 5 g of uranyl nitrate ($\text{UO}_2(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$) in 100 mL of water.

12. Procedure

12.1 Transfer 0.25 g of the sample to a 400-mL beaker, moisten with alcohol, and dissolve in 10 mL of HCl (sp gr 1.19) and 20 mL of water.

12.2 Continue with the procedure used in standardizing the $\text{K}_4\text{Fe}(\text{CN})_6$ solution as described in **10.1**, beginning with the addition of the litmus paper and the adjustment of the acidity with NH_4OH and HCl .

12.3 *Calculation*—Calculate the percent of total zinc, T , as follows:

$$T = [(V_2 - B_2)Z/S_1] \times 100 \quad (2)$$

where:

V_2 = $\text{K}_4\text{Fe}(\text{CN})_6$ solution required for titration of the specimen, mL,
 B_2 = $\text{K}_4\text{Fe}(\text{CN})_6$ solution required for titration of the blank, mL,
 Z = zinc equivalent of the $\text{K}_4\text{Fe}(\text{CN})_6$ solution, g/mL, and
 S_1 = sample used, g.

METALLIC ZINC

NOTE 1—Sections **12** and **13** cover a rapid method for determining metallic zinc, intended for routine analysis. The results are inclined to be somewhat low, and for highest accuracy and particularly for referee tests, the hydrogen evolution method should be used.⁵

NOTE 2—Metallic zinc may also be determined in accordance with Test Method **D6580**.

13. Reagents

13.1 *Ferric Chloride Solution*—Prepare a solution containing 20 g of ferric chloride ($\text{FeCl}_3 \cdot 6\text{H}_2\text{O}$) and 20 mL of 20 % sodium acetate ($\text{NaC}_2\text{H}_3\text{O}_2$) solution per 100 mL. It is advisable to make up only one day's supply at a time (50 mL are required for each determination).

13.2 *Potassium Permanganate, Standard Solution (0.1 N, 1 mL = 0.008 g TiO_2)*—Dissolve 3.16 g of KMnO_4 in water and dilute to 1 L. Let stand 8 to 14 days, siphon off the clear solution (or filter through a medium porosity fritted disk), and standardize against the National Institute of Standards and Technology (NIST) standard chemical No. 40 of sodium oxalate ($\text{Na}_2\text{C}_2\text{O}_4$) as follows: In a 400-mL beaker dissolve 0.2500 to 0.3000 g of the NIST sodium oxalate in 250 mL of hot water (80 to 90°C) and add 15 mL of H_2SO_4 (1+1). Titrate at once with the KMnO_4 solution, *stirring the liquid vigorously*

⁵ Wilson, L. A., "The Evaluation of Zinc Dust: A Proposed Method of Analysis," *Proceedings, ASTEA, Am. Soc. Testing and Mats.*, Vol 18, Part II, 1918, p. 220.