



## Standard Specification for Mineral Lubricating Oil Used in Steam or Gas Turbines<sup>1</sup>

This standard is issued under the fixed designation D 4304; 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 approval. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

### 1. Scope\*

1.1 This specification covers mineral oils used in steam and gas turbine lubrication systems where the performance requirements demand a highly refined mineral base oil compounded with rust and oxidation inhibitors plus selected additives as needed to control foam, wear, demulsibility, and so forth. This standard may also be applied to “combined cycle” turbine systems, where a single lubricant circulating system is used to supply oil to a steam and gas turbine configured in tandem either on a single or separate shaft for enhanced energy efficiency.

1.2 This specification is intended to define the properties of mineral oil-based turbine lubricating oils that are functionally interchangeable with existing oils of this type, are compatible with most existing machinery components, and with appropriate field maintenance, will maintain their functional characteristics.

1.3 This specification is intended to define only new lubricating oil before it is installed in the machinery.

1.4 This specification is intended to be used as a guide. It is possible that oils that do not meet this specification may perform satisfactorily in some turbines.

### 2. Referenced Documents

#### 2.1 ASTM Standards:<sup>2</sup>

- D 92 Test Method for Flash and Fire Points by Cleveland Open Cup Tester
- D 97 Test Method for Pour Point of Petroleum Products
- D 130 Test Method for Corrosiveness to Copper from Petroleum Products by Copper Strip Test
- D 445 Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and the Calculation of Dynamic Viscosity)
- D 664 Test Method for Acid Number of Petroleum Products

by Potentiometric Titration

- D 665 Test Method for Rust-Preventing Characteristics of Inhibited Mineral Oil in the Presence of Water
  - D 892 Test Method for Foaming Characteristics of Lubricating Oils
  - D 943 Test Method for Oxidation Characteristics of Inhibited Mineral Oils
  - D 974 Test Method for Acid and Base Number by Color-Indicator Titration
  - D 1401 Test Method for Water Separability of Petroleum Oils and Synthetic Fluids
  - D 1500 Test Method for ASTM Color of Petroleum Products (ASTM Color Scale)
  - D 2272 Test Method for Oxidation Stability of Steam Turbine Oils by Rotating Pressure Vessel
  - D 2422 Classification of Industrial Fluid Lubricants by Viscosity System
  - D 3339 Test Method for Acid Number of Petroleum Products by Semi-Micro Color Indicator Titration
  - D 3427 Test Method for Air Release Properties of Petroleum Oils
  - D 4052 Test Method for Density and Relative Density of Liquids by Digital Density Meter
  - D 4057 Practice for Manual Sampling of Petroleum and Petroleum Products
  - D 4310 Test Method for Determination of the Sludging and Corrosion Tendencies of Inhibited Mineral Oils
  - D 5182 Test Method for Evaluating the Scuffing Load Capacity of Oils (FZG Visual Method)
  - D 6304 Test Method for Determination of Water in Petroleum Products, Lubricating Oils, and Additives by Coulometric Karl Fischer Titration
- #### 2.2 ISO Standards:
- ISO 4406 Particle Count Analysis

### 3. Terminology

#### 3.1 Definitions:

3.1.1 *Type I mineral oils, n*—oils for steam and gas turbine lubricating systems where the machinery does *not* require lubricants with enhanced load carrying capacity.

3.1.1.1 *Discussion*—Type I oils usually are available in ISO VG 32, 46, 68 and 100 (see Classification D 2422). Such oils normally contain rust and oxidation inhibitors in addition to

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<sup>2</sup> 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.

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

other additives as required to meet the specified performance characteristic. Type I oils are generally satisfactory for turbine sets where bearing temperatures do not exceed 110°C.

3.1.2 *Type II mineral oils, n*—oils for steam and gas turbine lubricating systems where the machinery requires enhanced load carrying capacity.

3.1.2.1 *Discussion*—Type II oils usually are available in ISO VG 32, 46, 68, 100, and 150. These oils are similar to Type I but contain additional anti-wear additives for use in turbines equipped with a gearbox. Oils ISO VG 68 and above have been used in marine, hydro, or water turbines.

3.1.3 *Type III mineral oils, n*—oils for heavy duty gas or combined cycle turbine lubricating systems where the lubricant shall withstand higher temperatures and exhibit higher thermal stability than Type I mineral oils.

3.1.3.1 *Discussion*—Type III oils usually are available in ISO VG 32 and 46. Such oils are normally comprised of a highly refined mineral base oil with suitable rust and oxidation inhibitors in addition to other additives as needed to meet specified performance characteristics. Type III oils are formulated for use in turbine sets where bearing temperatures may exceed 110°C. The turbine lubrication systems using Type III oils may be equipped with a gearbox that may require the

selection of oils that contain additional anti-wear additives to impart the specified load carrying capacity.

3.1.4 *functional properties, n*—those properties of the mineral lubricating oil that are required for satisfactory operation of the machinery. These properties are listed in Section 5.

#### 4. Sampling and Testing

4.1 *Sampling*—Generally, take all oil samples in accordance with Practice D 4057.

4.2 Use the ASTM and other test methods described in Tables 1-3.

#### 5. Functional Property Requirements

5.1 Mineral lubricating oils conforming to the specification shall meet the functional property limits specified in 5.2 and 5.3 and Table 1 and Table 2. The significance of these properties is discussed in Appendix X1.

5.2 Requirements for Type I oils are shown in Table 1.

5.3 Requirements for Type II oils are shown in Table 2.

#### 6. Keywords

6.1 gas turbine oil; mineral oil; R and O oils; steam turbine oil; turbine lubricating oils; turbine lubrication systems

**TABLE 1 Requirements for Type I Turbine Oils**

NOTE—The nature of some tests are such that they are not necessarily run on each batch. The values are representative.

Property	ASTM Test Method	Limits			
Physical:					
ISO—viscosity grade	D 2422	32	46	68	100
Flash point, °C, min	D 92	180	180	180	180
Pour point, °C, max	D 97 <sup>A</sup>	−6	−6	−6	−6
Viscosity, cSt (mm <sup>2</sup> /s) 40°C	D 445	28.8–35.2	41.4–50.6	61.2–74.8	90–110
Visual examination at 20°C	...			clear and bright	
Chemical:					
Total Acid Number, mg KOH/g, max	D 974 <sup>B</sup>	report	report	report	report
Performance					
Emulsion characteristics:					
at 54°C, minutes to 3 mL emulsion, max	D 1401	30	30	30	...
at 82°C, minutes to 3 mL emulsion, max		...	...	...	60
Foaming characteristics:					
Sequence I, tendency/stability, mL, max	D 892	50/0	50/0	50/0	50/0
Air release, 50°C, minutes max	D 3427	5	7	10	17
Rust preventing characteristics	D 665, Procedure A	Pass	Pass	Pass	Pass
Copper corrosion, 3 h at 100°C, max	D 130	1	1	1	1
Oxidation stability <sup>C</sup> :					
Hours to neut. No. 2.0, min	D 943	2000	2000	1500	1000
Minutes to 175 kPa drop, min	D 2272	350	350	175	150

<sup>A</sup> Lower pour point may be required for some applications.

<sup>B</sup> Test Method D 664 may be used as an alternative test method.

<sup>C</sup> Test Method D 943 is the accepted test method for oxidation stability of new steam turbine oils in the United States and Canada. It is recognized that Test Method D 943 is a lengthy procedure. Test Method D 2272 is a shorter test for quality control. See X1.3.6 for significance of Test Method D 2272.