Designation: ~~D6158 – 14~~ D6158 – 16

Standard Specification for Mineral Hydraulic Oils[1]

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1. Scope*

1.1 This specification covers mineral ~~oils~~ and synthetic oils of the types API groups I, II, III, and IV used in hydraulic systems, where the performance requirements demand fluids with one of the following characteristics:

1.1.1 A refined base oil or synthetic base stock (Class HH),

1.1.2 A refined mineral base oil or synthetic base stock with rust and oxidation inhibitors (Class HL), ~~and~~

1.1.3 A refined mineral base oil or synthetic base stock with rust and oxidation inhibitors plus anti-wear characteristics (Class HM),

1.1.4 A refined mineral base oil or synthetic base stock with rust and oxidation ~~inhibitors plus antiwear characteristics (Class HM).~~inhibitors, anti-wear characteristics, and increased viscosity index higher than 140 (Class HV),

1.1.5 A refined mineral base oil or synthetic base stock with rust and oxidation inhibitors plus anti-wear characteristics meeting a higher performance level than an HM fluid to address higher demanding hydraulic systems (Class HMHP), and

1.1.6 A refined mineral base oil with rust or synthetic base stock and oxidation inhibitors, anti-wear characteristics, and increased viscosity index higher than 140 meeting a higher performance level than an HV fluid to address higher demanding hydraulic systems (Class HVHP).

1.2 This specification defines the requirements of mineral oil-based or synthetic-based hydraulic fluids that are compatible with most existing machinery components when there is adequate maintenance.

1.3 This specification defines only new lubricating oils before they are installed in the hydraulic system.

1.4 This specification defines specific types of hydraulic oils. It does not include all hydraulic oils. Some oils that are not included may be satisfactory for certain hydraulic applications. Certain equipment or conditions of use may permit or require a wider or narrower range of characteristics than those described herein.

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

1.5.1 *Exception*—In X1.3.9 on Wear Protection, the values of pump pressure are in MPa, and the psi follows in brackets as a reference point immediately recognized by a large part of the industry.

1.6 The following safety hazard caveat pertains to the test methods referenced in this specification. *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 limitation prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D92 Test Method for Flash and Fire Points by Cleveland Open Cup Tester

D97 Test Method for Pour Point of Petroleum Products

D130 Test Method for Corrosiveness to Copper from Petroleum Products by Copper Strip Test

D445 Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and Calculation of Dynamic Viscosity)

D471 Test Method for Rubber Property—Effect of Liquids

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

D665 Test Method for Rust-Preventing Characteristics of Inhibited Mineral Oil in the Presence of Water

D892 Test Method for Foaming Characteristics of Lubricating Oils

[1] This specification is under the jurisdiction of ASTM Committee D02 on Petroleum Products, Liquid Fuels, and Lubricants and is the direct responsibility of Subcommittee ~~D02.N0.10~~D02.N0 on ~~Specifications~~Hydraulic Fluids.

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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.

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

D943 Test Method for Oxidation Characteristics of Inhibited Mineral Oils
D974 Test Method for Acid and Base Number by Color-Indicator Titration
D1298 Test Method for Density, Relative Density, or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method
D1401 Test Method for Water Separability of Petroleum Oils and Synthetic Fluids
D2070 Test Method for Thermal Stability of Hydraulic Oils
D2270 Practice for Calculating Viscosity Index from Kinematic Viscosity at 40 and 100°C
D2422 Classification of Industrial Fluid Lubricants by Viscosity System
D2619 Test Method for Hydrolytic Stability of Hydraulic Fluids (Beverage Bottle Method)
D2983 Test Method for Low-Temperature Viscosity of Lubricants Measured by Brookfield Viscometer
D3427 Test Method for Air Release Properties of Hydrocarbon Based Oils
D4052 Test Method for Density, Relative Density, and API Gravity of Liquids by Digital Density Meter
D4310 Test Method for Determination of Sludging and Corrosion Tendencies of Inhibited Mineral Oils
D5182 Test Method for Evaluating the Scuffing Load Capacity of Oils (FZG Visual Method)
D5950 Test Method for Pour Point of Petroleum Products (Automatic Tilt Method)
D6080 Practice for Defining the Viscosity Characteristics of Hydraulic Fluids
D6973 Test Method for Indicating Wear Characteristics of Petroleum Hydraulic Fluids in a High Pressure Constant Volume Vane Pump
D7043 Test Method for Indicating Wear Characteristics of Non-Petroleum and Petroleum Hydraulic Fluids in a Constant Volume Vane Pump
D7752 Practice for Evaluating Compatibility of Mixtures of Hydraulic Fluids

2.2 *Other Standards:*
ISO 13357-1 Petroleum Products—Determination of the Filterability of Lubricating Oils—Part 1: Procedure for Oils in the Presence of Water[3]
ISO 13357-2 Petroleum Products—Determination of the Filterability of Lubricating oils—Part 2: Procedure for Dry Oils[3]
DIN 51350-6 Testing of Shear Stability of Lubricating Oils Containing Polymers[4]
CEC L-45-A-99 Viscosity Shear Stability of Transmission Lubricants (KRL Taper Roller Bearing Rig)[5]

3. Classification

3.1 *Type HH Hydraulic Oils*—Non-inhibited refined mineral oils or synthetic base stock for hydraulic systems that do not have specific requirements of oxidation stability, rust protection, or anti-wear properties. Type HH oils are usually intended for total loss systems or very light-duty equipment.

3.2 *Type HL Hydraulic Oils*—Refined mineral oils or synthetic base stock with improved rust protection and oxidation stability for hydraulic systems where relatively high temperatures and long periods of operation time are expected, and where there is the possibility of water or humidity that could rust metal parts of the machinery. These oils are intended for use in systems where no ~~metal-to-metal~~ metal-to-metal contact is expected between the moving parts. Usually, systems working at low pressures specify HL oils. Some high-pressure piston pumps can operate satisfactorily on these oils.

3.3 *Type HM Hydraulic Oils*—Oils of HL type with improved anti-wear properties, for general hydraulic systems, especially for those working at high pressures and where the possibility of ~~metal-to-metal~~ metal-to-metal contact between the moving parts exists. Type HM oils are usually specified for hydraulic systems with vane pumps, or when the system is intended to work at maximum pump capacity for long periods of time.

3.4 *Type HV Hydraulic Oils*—Oils of HM type with improved viscosity/temperature properties, for general hydraulic systems where equipment is intended to operate over a wide range of ambient temperatures.

3.5 *Type HMHP Hydraulic Oils*—Oils of HM meeting a higher performance level to meet the changing needs of hydraulic systems, especially for those working at high pressures and temperatures intended to work at maximum pump capacity for long periods of time.

3.6 *Type HVHP Hydraulic Oils*—Oils of HMHP type with improved viscosity/temperature properties, for more demanding hydraulic systems where equipment is intended to operate over a wide range of ambient temperatures.

4. Classification Requirements

4.1 *Type HH*—The requirements for this type of oil are presented in Table 1 and include Viscosity Grades ISO VG from 10 to 150, in accordance with Classification D2422.

[3] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.
[4] Available from Deutsches Institut für Normung e.V.(DIN), Am DIN-Platz, Burggrafenstrasse 6, 10787 Berlin, Germany, http://www.din.de.
[5] Available from Coordinating European Council (CEC), Services provided by Kellen Europe, Avenue Jules Bordet 142 - 1140, Brussels, Belgium, http://www.cectests.org.

TABLE 1 Requirements for Type HH Mineral Oil or Synthetic Base Stock Hydraulic Fluids

Properties	Test Method ASTM (Other)	Parameters	Limits							
~~**Physical**~~										
Physical:										
~~ISO viscosity grade~~	~~D2422~~		~~10~~	~~15~~	~~22~~	~~32~~	~~46~~	~~68~~	~~100~~	~~150~~
ISO-viscosity grade	D2422		10	15	22	32	46	68	100	150
Viscosity	D445	kinematic viscosity at 40 °C, mm^2/s	9.0–11.0	13.5–16.5	19.8–24.2	28.8–35.2	41.4–50.6	61.2–74.8	90.0–110	135–165
~~Viscosity, ≤ 750 cP~~	~~D2983~~	~~temperature, °C~~	~~report~~	~~report~~	~~report~~	~~report~~	~~report~~	~~report~~	~~report~~	~~report~~
Viscosity, ≤750 mPa·s	D2983	temperature, °C	report	report	report	report	report	report	report	report
Viscosity index	D2270		report	report	report	report	report	report	report	report
Specific gravity	D1298[A]		report	report	report	report	report	report	report	report
Appearance	Visual		clear and bright	clear and bright	clear and bright	clear and bright	clear and bright	clear and bright	clear and bright	clear and bright
Flash point	D92	temperature, °C, min	125	145	165	175	185	195	205	215
Pour point	D97[B]	temperature, °C, max	–15	–12	–9	–6	–6	–6	–6	–6
~~**Chemical**~~										
Chemical:										
~~Acid number~~	~~D974/D 664~~	~~mg KOH/g, max~~	~~0.05~~	~~0.05~~	~~0.05~~	~~0.05~~	~~0.05~~	~~0.05~~	~~0.05~~	~~0.05~~
Acid number	D974/D664	KOH, mg/g, max	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
~~**Performance**~~										
Performance:										
~~Elastomer compatibility~~	~~D471~~	~~100 °C ± 1 °C/288 h ± 2 h SRE-NBR 1 Elastomer (DIN53 538, Part 1 or~~	~~report~~	~~report~~	~~report~~	~~report~~	~~report~~	~~report~~	~~report~~	~~report~~
Elastomer compatibility	D471	100 °C ± 1 °C/288 h ± 2 h NBR-1 Elastomer ~~AMA 524, Part 1)~~								
		~~relative volume change, percent C~~	~~report~~	~~report~~	~~0 to 15~~	~~0 to 12~~	~~0 to 12~~	~~0 to 10~~	~~0 to 10~~	~~0 to 10~~
		relative volume change, percent	report	report	0 to 15	0 to 12	0 to 12	0 to 10	0 to 10	0 to 10
		~~change in Shore A hardness, rating C~~	~~report~~	~~report~~	~~0 to –8~~	~~0 to –7~~	~~0 to –7~~	~~0 to –6~~	~~0 to –6~~	~~0 to –6~~
		change in Shore A hardness, rating	report	report	0 to –8	0 to –7	0 to –7	0 to –6	0 to –6	0 to –6

[A] Test Method D4052 can also be used.
[B] Test Method D5950 can also be used.

4.2 *Type HL*—The requirements for this type of oil are presented in Table 2 and include Viscosity Grades ISO VG from 10 to 150, in accordance with Classification D2422.

4.3 *Type HM*—The requirements for this type of oil are presented in Table 3 and include Viscosity Grades ISO VG from 10 to 150, in accordance with Classification D2422.

4.4 *Type HV*—The requirements for this type of oil are presented in Table 4 and include Viscosity Grades ISO VG from 10 to 150, in accordance with Classification D2422.

4.5 *Type HMHP*—The requirements for this type of oil are presented in Table 5 and include Viscosity Grades ISO VG from 22 to 150 in accordance with Classification D2422.

4.6 *Type HVHP*—The requirements for this type of oil are presented in Table 6 and include Viscosity Grades ISO VG from 22 to 150 in accordance with Classification D2422.

5. Inspection

5.1 Inspection of the material shall be agreed upon between the purchaser and the supplier.

6. Packaging and Package Marking

6.1 The material shall be suitably packaged to permit acceptance by the carrier and to afford adequate protection from normal hazards of handling and shipping. Packaging shall conform to applicable carrier rules and regulations.

6.2 Packaging and labeling shall comply with state or federal regulations.

6.3 Each container shall be plainly marked with the manufacturer's name and brand, production code or lot number, type of material, volume content, and any other information required by state or federal law.

7. Keywords

7.1 antiwear protection; guideline; hydraulic oils; mineral oils; rust and oxidation protection; synthetic base stocks; viscosity index

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TABLE 2 Requirements for Type HL Mineral Oil or Synthetic Base Stock Hydraulic Fluids (Rust and Oxidation)

Properties	Test Method ASTM (Other)	Parameters	Limits							
Physical:										
~~ISO-viscosity grade~~	~~D2422~~		~~10~~	~~15~~	~~22~~	~~32~~	~~45~~	~~68~~	~~100~~	~~150~~
ISO-viscosity grade	D2422		10	15	22	32	46	68	100	150
Viscosity	D445	kinematic viscosity at 40 °C, mm^2/s	9.0–11.0	13.5–16.5	19.8–24.2	28.8–35.2	41.4–50.6	61.2–74.8	90.0–110	135–165
~~Viscosity, ≤ 750 cP~~	~~D2983~~	~~temperature, °C, max~~	~~–33~~	~~–23~~	~~–15~~	~~–8~~	~~–2~~	~~4~~	~~10~~	~~16~~
Viscosity, ≤750 mPa·s	D2983	temperature, °C, max	–33	–23	–15	–8	–2	4	10	16
Viscosity index	D2270	min	90	90	90	90	90	90	90	90
Specific gravity	D1298[A]		report	report	report	report	report	report	report	report
Appearance	visual, at 20 °C		clear and bright	clear and bright	clear and bright	clear and bright	clear and bright	clear and bright	clear and bright	clear and bright
Flash point	D92	temperature, °C, min	125	145	165	175	185	195	205	215
Pour point	D97[B]	temperature, °C, max	–33	–24	–21	–18	–15	–12	–12	–12
Chemical:										
~~Acid Number~~	~~D974/D 664~~	~~mg KOHg~~	~~report~~	~~report~~	~~report~~	~~report~~	~~report~~	~~report~~	~~report~~	~~report~~
Acid Number	D974/D664	KOH, mg/g	report	report	report	report	report	report	report	report
Performance:										
~~Rust prevention~~	~~D665A[B]~~	~~visual evaluation pass or fail~~	~~pass~~	~~pass~~	~~pass~~	~~pass~~	~~pass~~	~~pass~~	~~pass~~	~~pass~~
Rust prevention	D665A[C]	visual evaluation pass or fail	pass	pass	pass	pass	pass	pass	pass	pass
	~~D665B[B]~~		~~pass~~	~~pass~~	~~pass~~	~~pass~~	~~pass~~	~~pass~~	~~pass~~	~~pass~~
	D665B[C]	visual evaluation pass or fail	pass	pass	pass	pass	pass	pass	pass	pass
Corrosion	D130	copper corrosion, 3 h at 100 °C, visual, max	2	2	2	2	2	2	2	2
Water separation	D1401	time (mins) to 3 mL emulsion at 54 °C, max	30	30	30	30	30	30	...	...
		time (mins) to 3 mL emulsion at 82 °C, max	...	...	...	...	...	...	60	60
~~Elastomer compatibility~~	~~D471~~	~~100 °C ± 1 °C/288 h ± 2 h SRE-NBR 1 Elastomer~~								
Elastomer compatibility	D471	100 °C ± 1 °C/288 h ± 2 h NBR-1 Elastomer ~~(DIN 53 538, Part 1 or AAMA 524 Part 1)~~								
		relative volume change, percent	report	report	0 to 15	0 to 12	0 to 12	0 to 10	0 to 10	0 to 10
		change in Shore A hardness, rating	report	report	0 to –8	0 to –7	0 to –7	0 to –6	0 to –6	0 to –6
Foam	D892	Sequence I, tendency/stability, mL, max	150/0	150/0	150/0	150/0	150/0	150/0	150/0	150/0
		Sequence II, tendency/stability, mL, max	75/0	75/0	75/0	75/0	75/0	75/0	75/0	75/0
		Sequence III, tendency/stability, mL, max	150/0	150/0	150/0	150/0	150/0	150/0	150/0	150/0
~~Air release~~	~~D3427~~	~~time, (mins. at 50 °C, max)~~	~~5~~	~~5~~	~~5~~	~~5~~	~~10~~	~~10~~	~~...~~	~~...~~
Air release	D3427	time, mins. at 50 °C, max	5	5	5	5	10	10	...	...
		~~time, (mins. at 75 °C, max)~~	~~...~~	~~...~~	~~...~~	~~...~~	~~...~~	~~...~~	~~report~~	~~report~~
		time, mins. at 75 °C	...	...	...	...	...	...	report	report
~~Oxidation stability~~	~~D943~~	~~time for acid number of 2 mg KOH/g, h, min~~	~~1000~~	~~1000~~	~~1000~~	~~1000~~	~~1000~~	~~1000~~	~~1000~~	~~1000~~
Oxidation stability	D943	time for KOH acid number of 2 mg/kg, h, min	1000	1000	1000	1000	1000	1000	1000	1000
Sludge tendency	D4310	total insoluble sludge, mg, max	200	200	200	200	200	200	200	200
		copper in oil/water/sludge, mg	report	report	report	report	report	report	report	report
Thermal stability	D2070	copper appearance, visual max	report	report	report	5	5	5	report	report
		~~steel appearance, visual max~~	~~report~~	~~report~~	~~report~~	~~1~~	~~1~~	~~1~~	~~report~~	~~report~~
		steel appearance, visual max	report	report	report	2	2	2	report	report

Properties	Test Method ASTM (Other)	Parameters	Limits								
		sludge, mg/100 mL, max	report	report	report	25	25	25	report	report	

[A] Test Method D4052 can also be used.
[B] Test Method D5950 can also be used.
[C] Test Method D665 ~~— soak —~~ soak time is 24 h.