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.

Designation: D8029 – 17

Standard Specification for Biodegradable, Low Aquatic Toxicity Hydraulic Fluids[1]

This standard is issued under the fixed designation D8029; 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 This specification covers performance requirements for biodegradable hydraulic fluids with low aquatic toxicity used in industrial/mobile hydraulic applications.

1.2 In some cases, biodegradable fluids have been found to perform differently than traditional mineral oils, thus separate performance requirements are desirable.

1.3 *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.*

1.4 *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]

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)

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

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 °C and 100 °C

D2422 Classification of Industrial Fluid Lubricants by Viscosity System

D2983 Test Method for Low-Temperature Viscosity of Automatic Transmission Fluids, Hydraulic Fluids, and Lubricants using a Rotational 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

D5864 Test Method for Determining Aerobic Aquatic Biodegradation of Lubricants or Their Components

D6081 Practice for Aquatic Toxicity Testing of Lubricants: Sample Preparation and Results Interpretation

D6546 Test Methods for and Suggested Limits for Determining Compatibility of Elastomer Seals for Industrial Hydraulic Fluid Applications

D6731 Test Method for Determining the Aerobic, Aquatic Biodegradability of Lubricants or Lubricant Components in a Closed Respirometer

D6866 Test Methods for Determining the Biobased Content of Solid, Liquid, and Gaseous Samples Using Radiocarbon Analysis

D7043 Test Method for Indicating Wear Characteristics of Non-Petroleum and Petroleum Hydraulic Fluids in a Constant Volume Vane Pump

D7373 Test Method for Predicting Biodegradability of Lubricants Using a Bio-kinetic Model

[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 on 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**

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D7752 Practice for Evaluating Compatibility of Mixtures of Hydraulic Fluids

2.2 *EPA Standards:*[3]

OPPTS 835.3110 Ready Biodegradability

OPPTS 850.1010 Aquatic Invertebrate Acute Toxicity Test, Freshwater Daphnids

OPPTS 850.1075 Fish Acute Toxicity Test, Freshwater and Marine

OPPTS 850.5400 Algal Toxicity, Tiers I and II

2.3 *OECD Standards:*[4]

OECD Test No. 107 Partition Coefficient (N-Octanol/Water), Shake Flask Method

OECD Test No. 117 Partition Coefficient (N-Octanol/Water), High Performance Liquid Chromatography Method

OECD Test No. 123 Partition Coefficient (1-Octanol/Water): Slow-Stirring Method

OECD Test No. 201 Freshwater Alga and Cyanobacteria, Growth Inhibition Test

OECD Test No. 202 Daphnia sp. Acute Immobilisation Test

OECD Test No. 203 Fish, Acute Toxicity Test

OECD Test No. 301 Ready Biodegradability

OECD Test No. 305 Bioaccumulation in Fish: Aqueous and Dietary Exposure

2.4 *CEC Standards:*[5]

CEC Test Method L-45-99 Viscosity Shear Stability of Transmission Lubricants

2.5 *ISO Standards:*[6]

ISO 9408 Water Quality—Evaluation of Ultimate Aerobic Biodegradability of Organic Compounds in Aqueous Medium by Determination of Oxygen Demand in a Closed Respirometer

ISO 9439 Water Quality—Evaluation of Ultimate Aerobic Biodegradability of Organic Compounds in Aqueous Medium—Carbon Dioxide Evolution Test

ISO 14593 Water Quality—Evaluation of Ultimate Aerobic Biodegradability of Organic Compounds in Aqueous Medium—Method by Analysis of Inorganic Carbon in Sealed Vessels (CO_2 Headspace Test)

ISO 17025 General Requirements for the Competence of Testing and Calibration Laboratories

3. Terminology

3.1 *Definitions:*

3.1.1 *acute ecotoxicity, n*—the propensity of a test material to produce adverse behavioral, biochemical, or physiological effects in non-human organisms or populations in a short period, usually not constituting a substantial portion of their life span.

3.1.2 *acute ecotoxicity test, n*—a comparative ecotoxicity test in which a representative subpopulation of organisms is exposed to different treat rates of a test material and is observed for a short period, usually not constituting a substantial portion of their life span.

3.1.3 *bioaccumulation, n*—the net accumulation of a substance by an organism as a result of uptake from all environmental sources.

3.1.4 *biodegradation, n*—the process of chemical breakdown or transformation of a material caused by organisms or their enzymes.

3.1.4.1 *Discussion*—Biodegradation is only one mechanism by which materials are transformed in the environment.

3.1.5 *hydraulic fluid, n*—a liquid used in hydraulic systems for lubrication and transmission of power.

4. Biodegradable Hydraulic Fluid Performance Requirements

4.1 Table 1 summarizes the environmental behavior requirements.

4.2 Table 2 summarizes the physical property and performance requirements.

4.3 This specfication assumes that all biodegradable hydraulic fluids shall have a minimum impact on human health, which is documented in the safety data sheet offering a labeling-free product in accordance with globally harmonized system (GHS) regulation.

5. Compatibility of Mixtures of Hydraulic Fluids

5.1 As a general guideline, different fluids should not be mixed.

5.2 Compatibility should be evaluated according to Practice D7752.

6. Keywords

6.1 aquatic toxicity; bioaccumulation; biodegradable; environmentally acceptable lubricants (EAL); fluids; hydraulics

[3] U.S. EPA Prevention, Pesticides, and Toxic Substances (7101); available from United States Environmental Protection Agency (EPA), William Jefferson Clinton Bldg., 1200 Pennsylvania Ave., NW, Washington, DC 20460, http://www.epa.gov.

[4] Available from Organisation for Economic Cooperation and Development (OECD), 2 rue André Pascal, 75775 Paris Cedex 16, France, http://www.oecd.org.

[5] Available from Coordinating European Council (CEC), Services provided by Kellen Europe, Avenue Jules Bordet 142 - 1140, Brussels, Belgium, http://www.cectests.org.

[6] Available from International Organization for Standardization (ISO), ISO Central Secretariat, BIBC II, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland, http://www.iso.org.

TABLE 1 Environmental Behavior Requirements

NOTE 1—The bioconcentration factor (BCF) shall be assessed according to OECD 305, Part C.13 of the Annex to Regulation (EC) No 440/2008, or equivalent test methods.

NOTE 2—Since most substances used in lubricants are quite hydrophobic, the BCF value should be based on the lipid weight content and care must be shown to ensure a sufficient exposure time.

NOTE 3—The log octanol/water partition coefficient (log K_{ow}) shall be assessed according to Part A.8 of the Annex to Regulation (EC) No 440/2008 or OECD 107, OECD 117, OECD 123, or equivalent test methods.

NOTE 4—In case of an organic substance other than a surfactant where no experimental value is available, a calculation method can be used.

NOTE 5—The following calculation methods are allowed: CLOGP, LOGKOW (KOWWIN), and SPARC. Estimated log K_{ow} values by any of these calculation methods <3 or >7 indicates that the substance is not expected to bioaccumulate.

NOTE 6—If a substance is evaluated for the formulation and main constituents, the LC 50 of fluids must be at least 100 mg/L. If a substance is evaluated for each constituent substance, rather than the complete formulation and main compounds, then constituents comprising less than 20 % of fluids can have an LC 50 between 10 mg/L and 100 mg/L or a no observed effect concentration (NOEC) between 1 mg/L and 10 mg/L, constituents comprising less than 5 % of fluids can have an LC 50 between 1 mg/L and 10 mg/L or a NOEC between 0.1 mg/L and 1 mg/L, and constituents comprising less than 1 % of fluids can have an LC 50 less than 1 mg/L or a NOEC between 0 mg/L and 0.1 mg/L.

Characteristics of Tests	Units	Requirements	EPA Standard
Ultimate Biodegradability, min[A]	%	60	Test Method D5864[B] /OPPTS 835.3110 [former 712-C-98-076]
	%	67	Test Method D6731[B] /OPPTS 835.3110 [former 712-C-98-076]
Bioaccumulation[C]		Log K_{ow} <3 or >7	OECD Test No. 117[D]
		BCF ≤ 100 L/kg	OECD Test No. 305[D]
Acute Aquatic Toxicity			
Acute fish toxicity, 96 h, LC50, min[A]	mg/L	100	OPPTS 850.1075[E] [former 712-C-96-118]
Acute Daphnia toxicity, 48 h, EC50, min[A]	mg/L	100	OPPTS 850.1010[F] [former 712-C-96-114]
Acute Algae toxicity, 72 h, EC50, min[A]	mg/L	100	OPPTS 850.5400[G] [former 712-C-96-164]
Renewability	%	Report	Test Methods D6866

[A] Biodegradability and aquatic toxicity tests should be performed according to Good Laboratory Practice (GLP) or ISO 17025. Water-soluble fluids shall be tested in accordance with the test method cited. Fluids with low water solubility shall be tested using water-accommodated fractions, prepared according to Practice D6081. Biodegradation testing may be done on the lubricant formulation or the main components. Lubricant formulations must contain at least 90 % (w/w (weight in weight concentration)) of a constituent substance or constituent substances (only stated substances present above 0.10 % shall be assessed) that each demonstrate either the removal of at least 70 % of dissolved organic carbon, production of at least 67 % of the theoretical carbon dioxide, or consumption of at least 60 % of the theoretical oxygen demand within 28 days. For lubricant formulations, the 10 % (w/w) of the formulation that need not meet the above biodegradability requirements, up to 5 % (w/w) may be nonbiodegradable (but not bioaccumulative) while the remainder must be inherently (20 % to <60 %) biodegradable.

[B] Test Methods D5864, D6731, and D7373 or comparable methods OECD 301B, OECD 301F, ISO 9408, ISO 9439, or ISO 14593. Please note that Test Method D7373 is not a comparable method to other methods listed herein but can be used as a screening test before using the other methods.

[C] Bioaccumulation needs only be determined on constituent substances that are present above 0.1 % in the final formula and that are classified as neither readily biodegradable nor inherently biodegradable.

[D] Bioaccumulation does not need to be established when the substance (*a*) has a molecular weight >800 g/mol; (*b*) has a molecular diameter >1.5 nm (>15 Å); or (*c*) is a polymer and its molecular weight fraction below 1000 g/mol is less than 1 %.

[E] OPPTS 850.1075 or equivalent OECD Test No. 203.

[F] OPPTS 850.1010 or equivalent OECD Test No. 202.

[G] OPPTS 850.5400 or equivalent OECD Test No. 201.

TABLE 2 Physical Property and Performance Requirements

Properties	Test Method ASTM (Other)	Parameters	Limits					
ISO–viscosity grade	D2422		15	22	32	46	68	100
Viscosity of fresh oil	D445	kinematic viscosity at 40 °C, mm^2/s	13.5–16.5	19.8–24.2	28.8–35.2	41.4–50.6	61.2–74.8	90.0–110
Viscosity <750 mm^2/s	D2983	temperature, °C, max.	–23	–15	–8	–2	4	10
Viscosity index	D2270		report	report	report	report	report	report
Viscosity change after shear	CEC-L-45-99A	kinematic viscosity at 100 °C, mm^2/s after shearing for 20 h	max. 10%	max. 10%	max. 10%	max. 10%	max. 10%	max. 10%
Specific gravity	D1298[A]		report	report	report	report	report	report
Appearance		Visual, 20 °C	clear and bright	clear and bright	clear and bright	clear and bright	clear and bright	clear and bright
Flash point	D92	temperature, °C, min	165	175	185	195	205	215
Pour point	D97	temperature, °C, max	–24	–21	–18	–15	–12	–12
Acid number	D974/D664	mg KOH/g	report	report	report	report	report	report
Rust prevention	D665A	visual evaluation after 24 h, pass or fail	pass	pass	pass	pass	pass	pass
	D665B	visual evaluation after 24 h, pass or fail	report	report	report	report	report	report
Corrosion	D130	copper corrosion, 3 h at 100 °C, visual, max	2	2	2	2	2	2
Water separability[B]	D1401	time (mins) to 3 mL emulsion max at 54 °C	30	30	30	30	30	...
		time (mins) to 3 mL emulsion max at 82 °C	...	...	...	...	...	60
Elastomer compatibility	D6546	SRE-FKM;[C] 168 h/100 °C SRE-HNBR;[C] 168 h/100 °C SRE-NBR;[C] 168 h/60 °C	...	...	...	...	...	...
		relative volume change, %	0 to +20	0 to +15	0 to +12	0 to +12	0 to +10	0 to +10
		change in Shore A hardness, ratings	0 to –10	0 to –8	0 to –7	0 to –7	0 to –6	0 to –6
Foam	D892	Sequence I tendency/stability mL, max	50/0	50/0	50/0	50/0	50/0	50/0
		Sequence II tendency/stability mL, max	50/0	50/0	50/0	50/0	50/0	50/0
		Sequence III tendency/stability mL, max	50/0	50/0	50/0	50/0	50/0	50/0
Air release	D3427	time (min) at 50 °C, max	7	7	10	13	15	...
		time (min) at 75 °C max	...	...	...	...	...	report
Oxidation stability	D943 no water	time for acid number of Δ2 mg KOH/g, h	1000	1000	1000	1000	1000	1000
Sludge tendency	D4310 mod. no water	total insoluble sludge, mg, max	200	200	200	200	200	200
		copper oil/sludge, mg	report	report	report	report	report	report
Thermal stability	D2070	copper appearance, visual	report	report	5	5	5	report
		steel appearance, visual	report	report	2	2	2	report
		sludge, mg/100 mL	report	report	25	25	25	report
Wear inhibition	D7043	weight loss vanes + ring (mg), 66 °C max.	50	50	50	50	...	...
		weight loss vanes + ring (mg), 80 °C max.	...	...	...	...	50	50

[A] Test Method D4052 can also be used.

[B] Water separability is not applicable for water soluble or emulsifiable hydraulic fluids.

[C] The sole source of supply of the apparatus known to the committee at this time is German Bundesanstalt für Materialforschung und –prüfung (BAM), Fachbereich 7.5 Unter den Eichen 87 12205 Berlin. www.bam.de. If you are aware of alternative suppliers, please provide this information to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee,[1] which you may attend.

SUMMARY OF CHANGES

Subcommittee D02.N0 has identified the location of selected changes to this standard since the last issue (D8029 – 16) that may impact the use of this standard. (Approved Aug. 1, 2017.)

(1) Revised Table 1 and Table 2.

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