



Standard Specification for Biodegradable Fire Resistant Hydraulic Fluids¹

This standard is issued under the fixed designation D7044; 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 classifications for biodegradable fire-resistant hydraulic fluids that are used in the industrial/mobile and mining industries.

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 to determine the applicability of regulatory limitations prior to use.

2. Referenced Documents

- 2.1 ASTM Standards:²
- D95 Test Method for Water in Petroleum Products and Bituminous Materials by Distillation
- D664 Test Method for Acid Number of Petroleum Products by Potentiometric Titration
- 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 (Specific Gravity), 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
- D2422 Classification of Industrial Fluid Lubricants by Viscosity System
- D2532 Test Method for Viscosity and Viscosity Change After Standing at Low Temperature of Aircraft Turbine Lubricants
- D2783 Test Method for Measurement of Extreme-Pressure Properties of Lubricating Fluids (Four-Ball Method)³

- D2882 Test Method for Indicating Wear Characteristics of Petroleum and Non-Petroleum Hydraulic Fluids in Constant Volume Vane Pump⁴
- D3427 Test Method for Air Release Properties of Petroleum Oils
- D4052 Test Method for Density and Relative Density of Liquids by Digital Density Meter
- D5182 Test Method for Evaluating the Scuffing Load Capacity of Oils (FZG Visual Method)
- D6046 Classification of Hydraulic Fluids for Environmental Impact
- D6304 Test Method for Determination of Water in Petroleum Products, Lubricating Oils, and Additives by Coulometric Karl Fischer Titration
- D6546 Test Methods for and Suggested Limits for Determining Compatibility of Elastomer Seals for Industrial Hydraulic Fluid Applications
- E70 Test Method for pH of Aqueous Solutions With the Glass Electrode
- 2.2 DIN Standards:⁵
- DIN 51348 Testing of fire resistant governor fluids; determination of hydrolytic stability
- DIN 51354-2 Testing of Lubricants; FZG Gear Test Rig Part 1: Method A/8,3/90 for Lubricating Oils
- DIN 51373 Testing of Fire Resistant Heat Transfer Fluids; Determination of Resistance to Oxidation Including an Assessment of the Catalyst Plates
- DIN 51389-2 Determination of lubricants; mechanical testing of hydraulic fluids in the vane-cell-pump; method A for anhydrous hydraulic fluids
- DIN 51777-2 Testing of Mineral Oil Hydrocarbons and Solvents; Determination of Water Content according to Karl Fischer; Indirect Method
- 2.3 ISO Standards:⁶
- ISO 2049 Petroleum Products Determination of Color (ASTM Scale)
- ISO 2160 Petroleum Products Corrosiveness to Copper Copper Strip Test

Copyright © ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959, United States.

¹ This specification is under the jurisdiction of ASTM Committee D02 on Petroleum Products and Lubricants and is the direct responsibility of Subcommittee D02.N0 on Hydraulic Fluids.

Current edition approved Nov. 1, 2004. Published November 2004. Originally approved in 2004. Last previous edition approved in 2004 as D7044–04.

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.

³ Withdrawn.

 $^{^{\}rm 4}$ Withdrawn. The last approved version of this historical standard is referenced on www.astm.org.

 $^{^{\}rm 5}$ Available from Deutsches Institut für Normung e. V. (DIN), 10772, Berlin, Germany.

⁶ Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036.

- ISO 2592 Determination of Flash and Fire Points Cleveland Open Cup Method
- ISO 3104 Petroleum Products Transparent and Opaque Liquids - Determination of Kinematic Viscosity and Calculation of Dynamic Viscosity
- ISO 3105 Glass Capillary Kinematic Viscometers— Specifications and Operating Instructions
- ISO 3448 Industrial Liquid Lubricants ISO Viscosity Classification
- ISO 3675 Crude Petroleum and Liquid Petroleum Products
 Laboratory Determination of Density Hydrometer Method
- ISO 3733 Petroleum Products and Bituminous Materials Determination of Water - Distillation Method
- ISO 4263-1 Petroleum and Related Products Determination of the Aging Behavior of Inhibited Oils and Fluids – TOST Test – Part 1: Procedure for Mineral Oils
- ISO 4404-1 Petroleum and Related Products Determination of the Corrosion Resistance of Fire-Resistant Fluids – Part 1: Water-Containing Fluids
- ISO 4406 Hydraulic Fluid Power—Fluids—Method for Coding the Level of Contamination by Solid Particles
- ISO 5884 Aerospace—Fluid Systems and Components— Methods for System Sampling and Measuring the Solid Particle Contamination of Hydraulic Fluids
- ISO 6072 Compatibility between Fluids and Standard Elastomeric Materials
- ISO 6245 Petroleum Products Determination of Ash
- **ISO 6247** Petroleum Products Determination of Foaming Characteristics of Lubricating Oils
- ISO 6296 Petroleum Products Determination of Water Potentiometric Karl Fischer Titration Method
- ISO 6618 Petroleum Products and Lubricants Determination of Acid or Base Number – Color Indicator Titration Method
- ISO 6619 Petroleum Products and Lubricants— Neutralization Number—Potentiometric Titration Method
- ISO 6743-4 Lubricants, Industrial Oils and Related Products (class L) – Classification – Part 4: Family H (Hydraulic Systems)
- ISO 7120 Petroleum Products and Lubricants Petroleum Oils and Other Fluids - Determination of Rust Preventing Characteristics in the Presence of Water
- ISO 7745 Hydraulic Fluid Power—Fire-resistant (FR) Fluids—Guidelines for Use
- ISO 9120 Petroleum and Related Products Determination of Air Release Properties of Steam Turbine and Other Oils – Impinger Method
- ISO 12185 Crude Petroleum and Petroleum Products Determination of Density - Oscillating U-Tube Method
- ISO 12922 Lubricants, Industrial Oils and Related Products (class L) – Family H (Hydraulic Systems) – Specifications for Categories HFAE, HFAS, HFB, HFC, HFDR, and HFDU
- ISO 12937 Petroleum Products Determination of Water Coulometric Karl Fischer Titration Method
- ISO 14935 Petroleum and Related Products Determination of Wick Flame Persistence of Fire Resistant Fluids

- ISO 15029-1 Petroleum and Related Products Determination of Spray Ignition Characteristics of Fire Resistant Fluids – Part 1: Spray Flame Persistence – Hollow-Cone Nozzle Method
- ISO 15380 Lubricants, Industrial Oils and Related Products (Class L)—Family H (Hydraulic Systems)— Specifications for Categories HETG, HEPG, HEES, and HEPR
- 2.4 Lux Standards:⁷
- Lux 3.1.3 Stabilized Flame Heat Release Spray Test
- Lux 5.2.3 Determination of the Emulsion Stability of HFB Fluids at Medium Temperature
- Lux 5.2.4 Determination of the Emulsion Stability of HFB...LT Fluids at Low Temperature
- Lux 5.3.1 Determination of aging Properties of HFC Fluids
- Lux 5.8 Determination of the Shear Stability of Hydraulic Fluids
- Lux 5.9.1 Determination of the Corrosion Inhibiting Properties of HFA, HFC, and HFD Fluids

2.5 Other Standards:

CETOP RP 65H Manifold Ignition Test⁸

CETOP RP 67H Antiwear Vane Pump Test for Hydraulic Fluids⁸

IP 281 ⁹

3. Terminology

3.1 *Definitions:*

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

3.1.2 *biodegradable*, *n*—any substance containing <10 % wt. O₂ content which undergoes ≥ 60 % biodegradation as theoretical CO₂ in 28 days and ≥ 67 % biodegradation as theoretical O₂ uptake in 28 days, or any hydraulic fluid containing ≥ 10 % wt. O₂ content which undergoes ≥ 60 % biodegradation as theoretical CO₂ or as theoretical O₂ uptake in 28 days.

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

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

3.1.4 *fire-resistant fluid*, *n*—any liquid that is able to withstand fire or give protection from fire.

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

4. Classification

4.1 The following classifications of fire-resistant hydraulic fluids, except for HEPG, were taken from ISO 6743-4.

U.K.

⁷ European Commission, Safety and Health Commission for the Mining and Other Extractive Industries, "Requirements and Tests Applicable to Fire-Resistant Hydraulic Fluids Used for Power Transmission and Control (Hydrostatic and Hydrokinetic)," Seventh Edition, Doc. N4746/10/91 EN, Luxembourg, April 1994.

⁸ Available from the Comité Européen des Transmissions Oléohydrauliques et Pneumatiques (CETOP), Lyoner Straße 18, 60528, Frankfurt am Main, Germany. ⁹ Available from Energy Institute, 61 New Cavendish St., London, WIG 7AR,

🖽 D7044 – 04a

TABLE 1 Specifications for Categories HFAE and HFAS Fluids According to ISO 12922

Type HFAE: These are oil-in-water emulsions, typically with more than 80 % water content (+5°C to + 50°C, ISO 7745)

Type HFAS: These are chemical solutions in water, typically more than 80 % water content (+5°C to +50°C,

	ISO 7745)			•
	•	Specific	cation	
Characteristic or Test	Unit	Finished Emulsion Category HFAE ^A	Finished Solution Category HFAS ^A	Standard or Test Method
Appearance		В	С	
Water content, min.	% (V/V)	80	80	D95, D6304
Foam at: +25°C max. ^D	ml/ml	300/10	300/10	D892
+50°C max.	ml/ml	300/10	300/10	
+25°C max.	ml/ml	300/10	300/10	
pH at 20°C		6.7 to 11.0	6.7 to 11.0	E70
Emulsion stability (50°C/600 h), max.	Rating	2A-2R	В	D1401
-free oil	% (v/V)	Trace	В	
cream, max.% (v/V)	% (v/V)	0.5	В	
Corrosion protection	Rating	E	E	(ISO 4404)
Elastomer compatibility NBR1, EPDM1 and FPM1 elastomer, 60°C/168 h		E	E	D6546
relative volume change, max.	%	7	7	
relative hardness change: min.	IRHD	-7	-7	
max.	IRHD	+2	+2	
change in tensile strength	%	E	E	
elongation at break		E	E	

^A These products are normally supplied as concentrates, and should be used with the correct water quantity as specified by the supplier (viscosity of concentrate to be 350 mm²/s maximum at 20°C).

^B The requirement is not relevant to this fluid type.

Composition

^C The appearance of the delivered fluid shall be clear and bright and free of any visible particulate matter, under normal visible light at ambient temperature, using a clear container of approximately 10 cm diameter.

^D For fluids with a viscosity greater than 10 mm²/s at 20°C.

E Report only on request.

4.1.1 *HFA*—Fire resistant hydraulic fluids that may be further classified as:

4.1.1.1 *HFAE*—Oil-in-water emulsions containing more than 80 % by weight water and typically in the range 95 to 99 % by weight water.

4.1.1.2 *HFAS*—Chemical solutions. Not containing emulsions and typically contains more than 80 % by weight water.

4.1.2 *HFB*—Water-in-oil emulsions containing approximately 60 % by weight oil.

4.1.3 *HFC*—Aqueous monomer and polymer polyglycol solutions. Water content not less than 35 % by weight.

4.1.4 *HFD*—Phosphate ester or polyolester-based, water-insoluble fire-resistant fluids.

4.1.5 *HFDR*—Phosphate ester-based fluids.

4.1.6 *HFDU*—Water-free fluids based on chemical compounds other than phosphate esters and chlorinated hydrocarbons.

4.1.7 *HEPG*—Anhydrous "environmentally friendly" polyalkylene glycol-derived hydraulic fluids that may be water soluble or insoluble.

5. Classification Requirements

5.1 *Type HFA Hydraulic Fluids*—The requirements for this type of fluid are presented in Table 1.

5.2 *Type HFB Hydraulic Fluids*—The requirements for this type of fluid are presented in Table 2 and include ISO viscosity grades from 46 to 100, in accordance with Classification D2422 (ISO 3448).

5.3 *Type HFC Hydraulic Fluids*—The requirements for this type of fluid are presented in Table 2 and include ISO viscosity grades from 22 to 68, in accordance with Classification D2422 (ISO 3448).

5.4 *Type HFD Hydraulic Fluids*—The requirements for this type of fluid are presented in Table 2 and include ISO viscosity grades from 15 to 100, in accordance with Classification D2422 (ISO 3448).

5.5 *Type HEPG Hydraulic Fluids*—The requirements for this type of fluid are presented in Table 3 and include ISO viscosity grades from 22 to 68, in accordance with Classification D2422 (ISO 3448).

6. Inspection

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

7. Packaging and Package Marking

7.1 The fluid 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.

7.2 Packaging and labeling shall comply with state and federal regulations.

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

🕼 D7044 – 04a

ABLE 2 Specifications fo	r Categories HFB,	HFC and HFD Fluids	According to ISO 12922

Unternational of lets Unit Finished Emulsion Catagory HFD ⁰ Catagory HFD ⁰ (R-U classes) Catagory HFD ⁰ (R-U classes) Method Viscosity grade, ISO VG 46 - 68 - 100 22 - 32 - 46 - 68 15 - 22 - 32 - 46 - 68 EO 3448 ^C 100 Appearance 0 # # # # Water content % (V/V) 24 d 0 0 100 So C max. milm 0 300/10 300/10 300/10 So C max. milm 0 300/10 300/10 300/10 Ar relases at CPC max. milm 0 20,25; 25 8; 10; 12; 15; 25; 30 D3427 Finished Satubily, 100 h at 20°C, mil 1 0 0 0 accumulated free water mil 10 0 0 0 0 change in water content at 25 ml % 5 0 0 0 0 change in water content at 125 ml % 5 0 0 0 0 change in water content at 25 ml %	Composition	Type HFB: These are water-in-oil emulsions (+5°C to +50°C, ISO 7745) Type HFC: These are water polymer solutions, typically with more than 35 % water content (-20°C to +50°C, ISO 7745) Type HFDR: These are synthetic fluids free of water consisting of phosphate esters (-20°C to +70°C/150°C ⁴ , ISO 7745) Type HFDU: These are synthetic fluids free of water but of other compositions than HFDR (-20°C to +70°C/150°C ⁴ , ISO 7745)					
Viscosity grade, ISO VG 44 - 68 - 100 22 - 22 - 44 - 68 15 - 22 - 42 - 46 - 68 ISO SA48 ^C Appearance 5 0 2 -2 -2 -4 -6 15 - 22 - 42 - 46 - 68 15 - 42 - 42 - 46 - 68 15 - 22 - 42 - 46 - 68 15 - 22 - 42 - 46 - 68 15 - 22 - 42 - 46 - 68 15 - 22 - 42 - 45 - 68 15 - 22 - 42 - 45 - 68 15 - 22 - 42 - 45 - 68 15 - 22 - 42 - 45 - 68 15 - 22 - 42 - 45 - 68 15 - 12 - 42 - 45 - 42	Characteristic or Test	Unit		Finished Solution		 Standard or Test Method 	
Appearance 0 ℓ ℓ ℓ ℓ ℓ 0 (S0 2733) DBS 0624 (S0 2733) DBS 02733 DBS 0273 DBS 0273 DBS 0273 DBS 02733 DBS 0273 DBS 02733 DBS 0273 DBS 02733 DBS 0273 DBS 0273 DBS 0273 DBS 0273 DBS 0273 <thds 0273<="" th=""> <thds 02733<="" th=""> <thd< th=""><th>Viscosity grade, ISO VG</th><th></th><th>, .</th><th>U,</th><th>15 - 22 - 32 - 46 - 68 -</th><th>ISO 3448^C</th></thd<></thds></thds>	Viscosity grade, ISO VG		, .	U ,	15 - 22 - 32 - 46 - 68 -	ISO 3448 ^C	
$\begin{array}{cccc} \mbox{rescale} & rescale$							
Near Contain S, (V/V) \geq 40 D	••					DOS DOOL	
Foam at 29°C max. m/m/m a 300/10 000/10 D882 50°C max. m/m a 300/10 a a 10°C max. m/m a	Water content	• • •					
Chain at a both max Internit D Solution Solution Solution Solution 100°C Chack milmin p 300010 Solution Solution 100°C Chack milmin p 300010 Solution Solution Ar release at 50°C max min p 20,20;25;25 8;10;12;15;25;30 D3427 Final Stability, 1000 h at 20°C, min p 20,20;25;25 8;10;12;15;25;30 D3427 change in water content at 425 ml % 5 p p p change in water content at 425 ml % 5 p p p change in water content at 420 ml ml 1 p p p change in water content at 5 ml ml 1 p p p commutation free water ml 1 p p p commutation tability, 336 h at 10 p p p p corrosion protection Rating p p p p	F					· /	
minimage						D892	
25°C max. mil mi p 300/10 solution Nr release at 5°C max. min p 20, 20; 25; 25 6; 10; 12; 15; 25; 30 D3427 Endision stability, 1000 h at 20°C, min p 20, 20; 25; 25 6; 10; 12; 15; 25; 30 D3427 Change in water content at 25 ml % 5 p p change in water content at 25 ml % 5 p p surface oil ml 10 p p surface oil ml 10 p p surface oil ml 10 p p surface oil ml 2 p p caccumulated free water ml 1 p p caccumulated free water ml 1 p p p corrosion protection Rating p p p p corosion protection Rating p p p p corosion protection Rating p p							
Mir release at 50°C max. min r 0 0 Wirelease at 50°C max. min p $20, 20; 25; 25; 8; 10; 12; 15; 5; 30 D3427 Finalison stability. 1000 h at 20°C, max r 6,7,11,0 p 5: 5 0 D change in water content at 425 ml \% 5 D D D change in water content at 125 ml \% 5 D D D accumulated free water ml 10 0 D D surface oil ml 3 D D D conscillation stability. 46 h at 70°, maximum D D D D conscillation free water ml 1 D D D accumulated free water ml 1 D D D conscillation free water ml 1 D D D conscillation free water ml 1 D D D $			D	300/10			
Mir release at 50°C max. min p 20: 20: 25: 25 8: 10: 12: 15: 25: 30 D9427 Envision stability, 1 000 h at 20°C, 0 0 0 0 max. 0 0 0 0 0 change in water content at 125 ml % 5 0 0 0 caccumulated free water ml 10 0 0 0 0 Envision stability, 36 h at 0 0 0 0 0 0 Torison stability, 36 h at 10 0			F				
pH at 20°C p 6,7,11,0 b b F70 max 0			D	20; 20: 25: 25	8; 10; 12: 15: 25: 30	D3427	
Emulsion stability, 1 00 h at 20°C, max change in water content at 425 ml % 5 0 0 surface oil ml 125 ml % 5 0 surface oil ml 125 ml % 5 0 surface oil ml 125 ml % 5 0 Emulsion stability, 48 h at 70°C, maximum surface oil ml 3 0 0 accumulated free water ml 1 0 accumulated free water mater content 15 ml % 10 accumulated free water ml 1 0 accumulated free water ml 1 0 accumulater free water mater ml 1 0 accumulater free water mater ml 1 0 accumulater free water ml 1 0 accumulater			D	, , ,	D, 11, 12, 13, 20, 30		
max openage in water content at 125 ml % 5 0 0 change in water content at 125 ml % 5 0 0 accumulated free water ml 10 0 0 surface oil ml 3 0 0 surface oil ml 3 0 0 consultated free water ml 3 0 0 consultated free water ml 3 0 0 surface oil max 2 0 0 0 accumulated free water ml 15 0 0 0 mean change in water content at 5 ml % 15 0 0 0 corosion protection Rating Pass Pass (Vil LUX 5.9.1) (Vil LUX 5.9.1) stocosity change at 20°C, max. % ±15 r ±10 0 viscosity change at 20°C, max. % 5 8 0 0 stocosity change at 20°C, max. %				-, ,			
the targe in water content at 22 min the second state of the state of							
Using en in water Content at L2 min min 10 0 0 accumulated free water min 2 0 0 surface oil min 3 0 0 surface oil min 3 0 0 surface oil min 3 0 0 Enulsion stability, 356 h at 0 0 0 0 CVII LUX 5.2.1 10°/166 h at 20°C, maximum 0 0 0 accumulated free water min 1 0 0 0 mean change in water content at 5 ml % 15 0 0 0 Scorosin protection Rating Pass Pass 0 (VII LUX 5.9.1) Stoosity change at 20°C, max. % ±15 r ±10 0 viscosity change at 20°C, max. % ±15 r ±10 0 viscosity change at 20°C, max. % 5 8 0 0 socosity change at 20°C, max. % 5 <td>change in water content at 425 ml</td> <td>%</td> <td>5</td> <td></td> <td></td> <td></td>	change in water content at 425 ml	%	5				
balactorial free water mil 10 0 (VII LUX 5.2.3) cmulsion stability, 48 h at 70°C, maximum mil 3 0 (VII LUX 5.2.3) surface of the water mil 1 0 (VII LUX 5.2.4) trudison stability, 38 h at 10°C/166 h at +20°C, max. max change in water content at 5 ml % 10 0 0 (VII LUX 5.2.4) max change in water content at 5 ml % 10 0 0 (VII LUX 5.2.4) cad number max change in water content at 5 ml % 10 0 0 (VII LUX 5.2.4) trudicated free water mil 1 0 (VII LUX 5.2.4) cad number max change in water content at 5 ml % 10 0 (VII LUX 5.2.4) trudicated free water mil 1 1 0 (VII LUX 5.2.4) trudicated free water mil 1 1 0 (VII LUX 5.2.4) trudicated free water mil 1 1 0 (VII LUX 5.2.4) trudicated free water mil 1 1 0 (VII LUX 5.2.4) trudicated free water mil 1 1 0 (VII LUX 5.2.4) trudicated free water mil 1 1 0 (VII LUX 5.2.4) trudicated free water mil 1 1 0 (VII LUX 5.2.4) trudicated free water mil 1 1 0 (VII LUX 5.2.4) trudicated free water mil 1 1 0 (VII LUX 5.2.4) trudicated free water mil 1 1 0 (VII LUX 5.2.4) trudicated free water mil 1 1 0 (VII LUX 5.2.4) trudicated free water mil 1 1 0 (VII LUX 5.2.4) trudicated free water mil 1 1 0 (VII LUX 5.2.4) trudicated free water mil 1 1 0 (VII LUX 5.2.4) trudicated free water mil 1 1 0 (VII LUX 5.2.4) trudicated free water mil 1 1 0 (VII LUX 5.2.4) trudicate mater mil 1 1 0 (VII LUX 5.2.4) trudicate mater mil 1 1 0 (VII LUX 5.2.4) trudicate mater mater mil 1 1 0 (VII LUX 5.2.4) trudicate mater mater mil 1 1 0 (VII LUX 5.2.4) trudicate mater mater mater mil 1 0 (VII LUX 5.2.4) trudicate mater m		%					
accumulate in the value in the		ml	10				
surface oil methods and method		ml	2	D	D		
baliate of the state of the st				D	0	(VII LUX 5.2.3)	
accountation the value in the							
$\begin{array}{c c c c c c c c c c c c c c c c c c c $		mi	1	D	D		
surface oil ml 2 0 0 accumulated free water ml 1 0 0 max change in water content at 5 ml % 10 0 0 Acd number mg P P P D Corrosion protection Rating Pass 0 0 0 Shear stability. 100 bar/250 cycles ^{c3} (VII LUX 5.3.1) (VII LUX 5.3.1) (VII LUX 5.3.1) (VII LUX 5.3.1) viscosity change at 40°C, max. % ±15 F ±10 0 viscosity change at 10°C, max. % ±0 0 ±7 0 viscosity change at 10°C, max. % 5 8 0 2 Viscosity change at 10°C, max. % 5 8 0 2 PH change, max. mg ±0.50 0 ±10 0 Stacid number change, max. % 5 8 0 2 Pelstomer compatibility: 68°C/168 h D D 7 0 2						(VII LUX 5.2.4)	
solvation of the set		ml	0	D	D		
$\begin{array}{c c c c c c c c c c c c c c c c c c c $							
mean change in water content at 5 ml%1000Acid numbermgF0FD664, D974Acid numberKOH'g00(ISO 4404)Corosion protectionRatingPassPass0(ISO 4405)Shear stability, 100 bar/250 cycles ⁶ 00DPassPass(VII LUX 5.1)Viscosity change at 20°C, max.% ± 15 F ± 10 (VII LUX 5.1)Viscosity change at 40°C, max.% ± 15 F ± 5 PH change, max.%00 ± 7 pH change, max.%580acid number change, max.mg ± 0.50 0 ± 0.50 Vestority change, max.%770Vestority change, max.%770Vestority change, max.%770Vestority change, max.%770Vestority change, max.%770Vestority change, max.%770Vestority change in tensile strength%FF0Vestority change in tensile strength%007/2Vestority change intensile strength%007/2Vestority change intensile strength%007/2Vestority change intensile strength%007/2Vidation stablityMG007/23.3, NT FIRE 03				D	D		
Acid numbermgFDFD664, D974KOH/gPassPassD(ISO 4404)(ISO 4404)Corrosion protectionRatingPassPassD(ISO 4404)Shear stability, 100 bar/250 cyclesGViscosity change at 20°C, max.% ± 15 F ± 10 viscosity change at 40°C, max.% ± 15 F ± 5 ± 5 viscosity change at 10°C, max.% D D ± 7 PH change, max.%58D 2 vater content change, max.%58D 2 Vater content change, max.%58D 2 Callastomer compatibility: 68°C/168 hNBR 1" elastomer compatibility: 68°C/168 hNBR 1" elastomer compatibility: 68°C/168 hD F F Vistable hardness change mini/maxiIRHD $-7/+2$ $-7/+2$ D $-7/+2$ Change in tensile strength% F F DD6546FPM 1", ISPIM 1", NBR 1" elastomers F F DD6546FPM 1", NBR 1" elastomers F F F F • relative volume change, max.% D D $-7/+2$ D • change in tensile strength% F F F F • change in tensile strength% D D F • relative volume change, max.% D D F • relative volume change, max.% D D F • rela				D	D		
Corrosion protection Rating Pass Pass Pass Pass (Vil LUX 5.9.1) bear stability, 100 bar/250 cycles ⁰ viscosity change at 20°C, max. % ±15 F ±10 viscosity change at 40°C, max. % ±15 F ±5 viscosity change at 40°C, max. % ±15 F ±10 ph change, max. % 5 8 acid number change, max. % 5 8 card number change, max. % 5 8 Pass Pass Pass Pass Pass Pass (SO 15029-1, VII LUX 5.9.1) viscosity change at 10°C, max. % 7 7 relative houme change, max. % 7 7 relative houme change, max. % 7 7 relative houme change, max. % 7 relative volume change, max. % 7 relative houme change, max. % 7 relative houter changes houme relative set for the se	5			D	F	D664 D974	
Corrosion protectionRating BatingPass D Pass D D (SO 4404) Pass D Shear stability, 100 bar/250 cycles D D D Pass D (VII LUX 5.9.1)Shear stability, 100 bar/250 cycles $\%$ ± 115 F ± 10 V viscosity change at 40°C, max. $\%$ ± 115 F ± 15 F yiscosity change at 40°C, max. $\%$ D D ± 7 D pH change, max. $\%$ D ± 1.0 D D water content change, max.mg ± 0.50 D ± 0.50 D Density at 15°Ckg/m³ F F D $D6546$ NBR 1'' elastomers V F F D $D6546$ visclastic hereases change, min/maxiIRHD $-7/+2$ D D e relative volume change, max. $\%$ F F D V relative hardness change, min/maxiIRHD D D T V relative hardness change, min/maxiIRHD D D F V relative hardness change, min/maxiIRH						,	
Shear stability, 100 bar/250 cycles ^G (VII LUX 5.8) viscosity change at 20°C, max. % ± 15 F ± 10 viscosity change at 10°C, max. % D D ± 7 pH change, max. % 5 8 D acid number change, max. % 5 8 D construction of the second secon	Corrosion protection					· /	
viscosily change at 20°C, max. % ± 15 F ± 10 viscosily change at 20°C, max. % ± 15 F ± 5 viscosily change at 40°C, max. % D D ± 1.0 D water content change, max. B D ± 1.0 D water content change, max. B D ± 0.50 D ± 0.50 Consider the second secon	Shear stability, 100 bar/250 cycles ^G				1 435	· /	
viscosity change at 40°C, max. % ± 15 F ± 5 viscosity change at 100°C, max. % D D ± 1.0 D pH change, max. D ± 1.0 D water content change, max. M ± 0.50 D ± 0.50 Construct of the second secon		%	±15	F	±10	(111 2071 010)	
viscosity change at 100°C, max. % D D ± 7 pH change, max. D ± 1.0 D water content change, max. mg ± 0.50 D ± 0.50 KOH/g D ± 0.50 Consisty at 15°C Kg/m^3 F F F $D1298, D4052$ Density at 15°C Kg/m^3 F F D D1298, D4052 Density at 15°C Kg/m^3 F F D D5546 D5546 D D D DT relative volume change, max. $%$ F F $D= longation at break % F F D= longation at break % F F D= leastomer compatibility: 100°C/168 h D D T/+2= change in tensile strength % D D F= clastomer change, max. % D D F= clastomer change, max. % D D S T= clastomer schange, mini/maxi IRHD D D D T/+2= change in tensile strength % D D S F= clastomer schange, mini/maxi RHD D D D F= clastomer schange, max. % D D F= clastomer schange, max. % D D F= clastomer schange, max. % D D S F= clastomer schange, max. % D D D T T/+2 T/+2$,			F			
prividings, max. P_{1} (b) marks, P_{2} (b) P_{2} (c) P_{2				D			
acid number change, max. mg ±0.50 p ±0.50 Acid number change, max. mg ±0.50 p ±0.50 Eastomer compatibility: 68°C/168 h D6546 NBR 1" elastomers • relative volume change, max. % 7 7 7 D • relative schange mini/maxi IRHD -7/42 -7/42 D • change in tensile strength % F F D • elongation at break % F P • relative volume change, max. % D • relative volume change, max. % D • change in tensile strength % F • relative volume change, max. % D • elongation at break % D • relative volume change, max. % D • change in tensile strength % D • change in tensile	pH change, max.		D	±1.0			
KOH rulinber change, max. Ing L0.00 L0.00 Volt KOH/g F F Density at 15°C kg/m³ F F Density at 15°C Density at 15°C KOH/g Destain Density at 15°C kg/m³ F F F Destain Destain Destain Value increase * relative volume change, max. % 7 7 D • relative volume change, max. % 7 7 D • change in tensile strength % F F D • change in tensile strength % F F D • elongation at break % F F D Elastomer compatibility: 100°C/168 h Destain Destain Destain FPM 1H ⁴ , EPDM 1H ⁴ , NBR 1H ⁴ elastomers * D D 7 • relative volume change, max. % D D -7/+2 • change in tensile strength % D D F • elongation at break % D D F • strange in tensile strength % D D F • strange in tensile strength % D D S Spray ignition characteristics	water content change, max.	%	5		D		
Density at 15°C kg/m ³ F F F P D1298, D4052 Elastomer compatibility: 68°C/168 h NBR 1 ^{<i>H</i>} elastomers • relative volume change, max. % 7 7 7 <i>D</i> • telative hardness change mini/maxi IRHD -7/+2 -7/+2 <i>D</i> • change in tensile strength % <i>F F D</i> elastomer compatibility: 100°C/168 h FPM 1 ^{<i>H</i>} , EPDM 1 ^{<i>H</i>} , NBR 1 ^{<i>H</i>} elastomers • relative volume change, max. % <i>D D T</i> • relative volume change, mini/maxi IRHD <i>D D D T</i> • relative volume change, mini/maxi IRHD <i>D D D T</i> • delongation at break % <i>D D F</i> • elongation at break % <i>D D F</i> • longation threak <i>Rating Pass Pass Pass</i> (ISO 15029-1, VII L 3.1.3, NT FIRE 03 Mainfold ignition test <i>Rating Pass Pass Pass</i> (ISO 14935) Mainfold ignition test <i>Rating Pass Pass Pass</i> (ISO 14935) Mainfold ignition test <i>Rating D D 1</i> ,5 Mass losses, max. <i>MG D D I</i> ,5 Mass losses, max. <i>KOH/g D D I</i> (iron), 2 <i>mg (copper)</i> Ageing properties <i>PH</i> value increase	acid number change, max.	mg	± 0.50	D	±0.50		
Eastomer compatibility: 68°C/168 h NBR 1 ^{<i>H</i>} elastomers • relative volume change, max. % 7 7 0 • relative hardness change mini/maxi IRHD -7/+2 -7/+2 0 • change in tensile strength % <i>F F</i> 0 • elongation at break % <i>F F</i> 0 Elastomer compatibility: 100°C/168 h FPM 1 ^{<i>H</i>} , EPDM 1 ^{<i>H</i>} , NBR 1 ^{<i>H</i>} elastomers • relative volume change, max. % <i>D D</i> 7 • relative hardness change, mini/maxi IRHD <i>D D</i> -7/+2 • change in tensile strength % <i>D D F</i> • elongation at break % <i>D D F</i> • elongation at break % <i>D D F</i> • elongation at break % <i>D D F</i> • elongation characteristics Rating <i>I I</i> (ISO 15029-1, VII L Spray ignition characteristics Rating <i>I I I</i> (ISO 15029-1, VII L 3.1.3, NT FIRE 03 Vick flame persistence Rating Pass Pass Pass (ISO 14935) Validation stability Action test Rating <i>D D I</i> ,5 Mass losses, max. MG <i>D D I</i> ,5 Mass losses, max. MG <i>D D I</i> (iron), 2 (copper) Ageing properties <i>D 4 D</i> (VII LUX 5.3.1)		KOH/g	-	_	-		
NBR 1 ^H elastomers • relative volume change, max. % 7 7 D • relative hardness change mini/maxi IRHD -7/+2 -7/+2 D • change in tensile strength % F F D • elongation at break % F F D • elongation at break % F F D Elastomer compatibility: 100°C/168 h D6546 D6546 FPM 1 ^H , EPDM 1 ^H , NBR 1 ^H elastomers -7/+2 -7/+2 • relative volume change, max. % D D 7 • relative volume change, max. % D D 7 • relative volume change, max. % D D 7 • relative volume change, max. % D D 7 • relative volume change, max. % D D 7 • change in tensile strength % D D 7 • change in tensile strength % D D 1 (ISO 15029-1, VII L Spray ignition characteristics Rating Pass Pass <td< td=""><td></td><td>kg/m³</td><td>F</td><td>۴</td><td>F</td><td></td></td<>		kg/m ³	F	۴	F		
 relative hardness change mini/maxi IRHD -7/+2 -7/+2 D change in tensile strength % F F D elongation at break % F F D D6546 FPM 1^H, SPD M 1^H, NBR 1^H elastomers relative volume change, max. % D D D D D C relative volume change, max. % D D D D D D C relative hardness change, mini/maxi IRHD D D D D T relative hardness change, mini/maxi IRHD D D D D T relative hardness change, mini/maxi IRHD D D D T relative hardness change, mini/maxi IRHD D D D T relative hardness change, mini/maxi IRHD D D D T relative hardness change, mini/maxi IRHD D D T relative hardness change, mini/maxi IRHD D D T relative hardness change, max. % D D D T (ISO 15029-1, VII I 3.1.3, NT FIRE 03: 3.1.3, NT FIRE 03: 3.1.3, NT FIRE 03: Spray ignition characteristics Rating Pass Pass Pass Pass P Acid number increase, max. Mic AD<td>NBR 1^H elastomers</td><td></td><td></td><td></td><td></td><td></td>	NBR 1 ^H elastomers						
 relative hardness change mini/maxi IRHD -7/+2 -7/+2 D change in tensile strength % F F D elongation at break % F F D D6546 FPM 1^H, SPDM 1^H, NBR 1^H elastomers relative volume change, max. % D P P relative volume change, mini/maxi IRHD D D D D D P P relative hardness change, mini/maxi IRHD D D D D P P relative hardness change, mini/maxi IRHD D D D P P relative hardness change, mini/maxi IRHD D D P relative hardness change, mini/maxi IRHD D D D P relative hardness change, mini/maxi IRHD D D D P relative hardness change, mini/maxi IRHD D D D D P relative hardness change, mini/maxi IRHD D D D D D P P	 relative volume change, max. 	%					
elongation at break % F F D elongation at break % F F D Elastomer compatibility: 100°C/168 h D D T FPM 1 ^H , EPDM 1 ^H , NBR 1 ^H elastomers V D D 7 • relative volume change, max. % D D -7/+2 • change in tensile strength % D D F • change in tensile strength % D D F • elongation at break % D D F • change in tensile strength % D D F • elongation at break % D D F • Spray ignition characteristics Rating I I (ISO 15029-1, VII I Spray ignition characteristics Rating Pass Pass Pass ISO 15029-1, VII I Solid lignition test Rating Pass Pass ISO 15029-1, VII I 3.1.3, NT FIRE 03: Oxidation stability (DIN 51373) (DIN 51373) (DIN 51373) (DIN 51373) Acid number increase, max.	 relative hardness change mini/maxi 	IRHD					
Pendigation at break 76 Elastomer compatibility: 100°C/168 h D6546 FPM 1 ^H , FPDM 1 ^H , NBR 1 ^H elastomers 0 7 • relative volume change, max. % 0 0 -7/+2 • relative hardness change, mini/maxi IRHD 0 0 -7/+2 • change in tensile strength % 0 0 F • elongation at break % 0 0 F • elongation at break % 0 0 F • Spray ignition characteristics Rating I I (ISO 15029-1, VII L Strategy ignition characteristics Rating Pass Pass Pass (ISO 15029-1, VII L Vick flame persistence Rating Pass Pass (ISO 15029-1, VII L 3.1.3, NT FIRE 03: Oxidation stability (USO 15029-1, VII L 3.1.3, NT FIRE 03: (ISO 14935) (ISO 14935) Acid number increase, max. mg 0 0 1,5 (DIN 51373) Acid number increase, max. mg 0 0 1,5 (copper) Mass losseses, max. mg 0<	 change in tensile strength 						
FPM 1 ^H , EPDM 1 ^H , NBR 1 ^H elastomers • relative volume change, max. % D D 7 • relative hardness change, mini/maxi IRHD D D -7/+2 • change in tensile strength % D D F • change in tensile strength % D D F • elongation at break % D D F Spray ignition characteristics Rating I I (ISO 15029-1, VII I Stray ignition characteristics Rating I I (ISO 15029-1, VII I Wick flame persistence Rating Pass Pass Pass Validation stability Rating Pass Pass (ISO 14935) Acid number increase, max. mg D D (DIN 51373) Acid number increase, max. mg D 1 (iron), 2 (copper) Mass losses, max. Mg D D 1 (iron), 2 (copper) Ageing properties D 4 D D		%	F	F	D	D6546	
 relative volume change, max. % b relative hardness change, mini/maxi IRHD D D -7/+2 change in tensile strength % D D F elongation at break % D D F Spray ignition characteristics Rating I I ISO 15029-1, VII L 3.1.3, NT FIRE 03: 3.1.3, NT FIRE 03: Manifold ignition test Rating Pass Pass Pass Pass Pass CETOP RP 65 H) Oxidation stability Acid number increase, max. mg Copper) (VII LUX 5.3.1) PH value increase 							
		%			7		
 elongation at break elongation characteristics Pating Rating I I I ISO 15029-1, VII I 3.1.3, NT FIRE 03 3.1.3, NT FIRE 03 Manifold ignition test Rating Pass Pass Pass Pass Pass Pass CETOP RP 65 H) (DIN 51373) Acid number increase, max. Mg Mass losses, max. MoH/g Mageing properties pH value increase P Acid number P Acid number Copper) (VII LUX 5.3.1) 	0						
Spray ignition characteristics Rating I I I (ISO 15029-1, VII L Spray ignition characteristics Rating Pass Pass Pass Pass Iso 15029-1, VII L 3.1.3, NT FIRE 03' Nick flame persistence Rating Pass Pass Pass Pass (ISO 14935) Manifold ignition test Rating Pass Pass Pass (ISO 14935) Oxidation stability 0 D (DIN 51373) (DIN 51373) Acid number increase, max. mg D D 1,5 Mass losses, max. KOH/g D 1 (iron), 2 Ageing properties mg VII LUX 5.3.1) (VII LUX 5.3.1)	5						
Ageing properties Pating Pass Pass Pass Pass Sol 14935) Vick flame persistence Rating Pass Pass Pass (ISO 1502-F), Vit I Manifold ignition test Rating Pass Pass Pass (ISO 14935) Vick flame persistence Rating Pass Pass Pass (ISO 14935) Vick flame persistence Rating Pass Pass (ISO 14935) Oxidation stability (DIN 51373) (DIN 51373) (DIN 51373) Ageing properties mg Copper) (VII LUX 5.3.1) pH value increase P 4 P						//00 / FRGT / / ///	
Manifold ignition test Rating Pass Pass Pass (CETOP RP 65 H) (DIN 51373) Axid number increase, max. mg D D 1,5 Mass losses, max. KOH/g D 1 (iron), 2 (copper) Ageing properties pH value increase D 4 D	Spray ignition characteristics	Rating	I	,	I	(ISO 15029-1, VII LUX 3.1.3, NT FIRE 031)	
Dividation stability mg D D 1,5 Acid number increase, max. mg D D 1,5 Mass losses, max. KOH/g D D 1 (iron), 2 (copper) mg (copper) (VII LUX 5.3.1) Ageing properties D 4 D		Rating	Pass	Pass	Pass		
Acid number increase, max. mg D 1,5 Mass losses, max. KOH/g D D 1 (iron), 2 mg (copper) Ageing properties (VII LUX 5.3.1) pH value increase D 4		Rating	Pass	Pass	Pass	· /	
Action number increase, max. Ing T, S T,			6	0		(DIN 51373)	
Ageing properties pH value increase physical data and the physical							
Ageing properties (VII LUX 5.3.1) pH value increase D 4 D	Mass losses, max.	-	D	D			
pH value increase P 4 P	A	mg			(copper)		
			D	А	D	(VII LUX 5.3.1)	
Insolubles % ^D <4 ^D		0/					

🕼 D7044 – 04a

TABLE 2	2 Continued
---------	-------------

Composition	Type HFC: T (-20°C to +5 Type HFDR: (-20°C to +7 Type HFDU:	50°C, ISO 7745) These are synthetic fluids 0°C/150°C ^A , ISO 7745)	lutions, typically with m	ore than 35 % water conter	
			Specifications		Otom doubling Toot
Characteristic or Test	Unit	Finished Emulsion Category HFB ^B	Finished Solution Category HFC ^B	Category HFD ^B (R-U classes)	 Standard or Test Method
Viscosity grade, ISO VG		46 - 68 - 100	22 - 32 - 46 - 68	15 - 22 - 32 - 46 - 68 - 100	ISO 3448 ^C
Cleanliness		D	D	<18/16 ^J	(ISO 4406)

Hydrolytic stability D D (DIN 51348) Acid number increase, max. mg KOH/a л л Vane pump D2882 mg к к 4-Ball machine mm D2783 D5182^{L,M} ĸ FZG gear test Fail stage

^A The higher temperature indicates the approximate upper temperature limit for short-term operation. This will depend on whether the application is hydrostatic or hydrodynamic and, for HFDU fluids, on the chemical composition of the fluid. Where doubt exists, clarification should be sought from the equipment manufacturer or fluid supplier, or both.

^B These fluids are normally supplied as the finished product.

^c These viscosity grades are determined by measuring the viscosity as described in ISO 3104:1994 and ISO 3105:1994.

^D The test method or requirement is either not applicable or is not relevant to this fluid type.

^E The appearance of the delivered fluid shall be clear and bright and free of any visible particulate matter, under normal visible light at ambient temperature, using a clear glass container of approximately 10 cm diameter.

^F It may be interesting to know the value corresponding to this characteristic and this should be provided by the supplier. Otherwise no limit value is required.

^G For fluids with a viscosity greater than 10 mm²/s at 20°C.

^H EPDM 1 and FPM1 are elastomers normally suitable for HFDR fluids, with the exception of the combination of FPM 1 and alkyl phosphate esters. However, the degree of compatibility is highly dependent on the composition of the base polymer. NBR 1 elastomers are not suitable for use with HFDR fluids.

¹ The methods to be published in the three parts of ISO 15029 (see B.1 in Annex B) measure different fluid characteristics under conditions that are not necessarily comparable. However, performance under one test condition only would normally be required. The method and the limits are, therefore, to be agreed between the end user and the fluid supplier, in accordance with national or other requirements. Where data are reported, reference should be made to the method used.

^JApply the sampling technique prescribed in ISO 5884.

^K Test methods and rating scales or limits are to be negotiated between the supplier and the user.

^L DIN 51777-2 is applied to instances where interference by certain chemicals is to be avoided.

^M For dyed fluids, ISO 6619 should be used.

8. Scope

8.1 Not all fire-resistant fluids are biodegradable, nor do all biodegradable fluids possess the same degree of fire resistance. The purpose of this test method is to define a classification, which distinguishes fire-resistant hydraulic fluids that are also biodegradable. Fire resistance can not be assessed on the basis of one test alone, but as a result of adequate performance in several tests representing the relevant hazards of the application. Fire resistance of a hydraulic fluid is determined by its ability to pass various tests that are specified by the appropriate agency responsible for specifying fire-safety regulations for the industry in which the fluid is being used. Examples of authorities who determine fire-safety testing and regulations include the national government, the industrial insurance industry, and various companies themselves. In this test method various standardized test procedures, although not all, that may be selected to determine fire resistance will be described.

9. Environmental Impact

9.1 Biodegradability and ecotoxicity requirements of a hydraulic fluid are set by national regulations using various standardized test procedures including those cited here.

9.2 *Biodegradability*—Classification D6046 lists test methodologies for evaluation of the biodegradability of hydraulic fluids. This classification covers all unused fully formulated hydraulic fluids in their original form.

9.2.1 In the current version of Classification D6046, the aspects of environmental impact included are environmental persistence, of which biodegradability is one component, and acute ecotoxicity. Although only environmental persistence will be addressed here, this classification does not imply that considerations of environmental persistence should take precedence over concerns for ecotoxicity.

9.2.2 Another important aspect of environmental impact is bioaccumulation. This aspect is not addressed in Classification D6046 because adequate test methods do not yet exist to measure bioaccumulation of hydraulic fluids.

9.2.3 Classification D6046 addresses the fresh water and soil environmental compartments. At this time, marine and anaerobic environmental compartments are not included, although they are pertinent for many uses of hydraulic fluids. Hydraulic fluids are expected to exhibit no significant impact on the atmosphere; therefore that compartment is not addressed. Classification D6046 also addresses releases to the environment that are incidental to the use of a hydraulic fluid. However, this classification is not intended to address environmental impact in situations of major accidental release.

9.3 Basis of Biodegradable Classification—Classification D6046 consists of two groups of tests, one group addressing

🕼 D7044 – 04a

Characteristics of test	Units	Units Requirements				
Viscosity grade		22	32	46	68	or Standard ISO 3448
Density 15°C	kg/m ³	A	A	A	A	ISO 12185
						ISO 3675
Colour ^{<i>B</i>}		A	A	A	A	ISO 2049
Appearance at 25°C ^C		Clbr	Clbr	Clbr	Clbr	
Ash content, max.	% (m/m)		D	D		ISO 6245
Flash point	. ,					
Cleveland open cup, min.	°C	165	175	185	195	ISO 2592
Kinematic viscosity						
at –20°C, max.	mm²/s		D	D	c	
at 0°C, max.	mm²/s	300	420	780	1 400	ISO 3104
at 40°C, min. to max.	mm²/s	19.8 to 24.2	28.8 to 35.2	41.4 to 50.6	61.2 to 74.8	
at 100°C, min.	mm²/s	4.1	5.0	6.1	7.8	
Pour point, max.	°C	-21	-18	-15	-12	ISO 3104
_ow temperature fluidity after 7 days	°C	D	D	D	D	ASTM D2532
Acid number ^E , max	mg KOH/g		D	D	C	ISO 6618
Water content, max.	mg/kg	5 000	5 000	5 000	5 000	ISO 12937
						ISO 6296
Copper corrosion, 100°C, 3 h, max.	rating	2	2	2	2	ISO 2160
Rust prevention, procedure A	-	Pass	Pass	Pass	Pass	ISO 7120
Foam at 24°C, max.	ml	150/0	150/0	150/0	150/0	
at 93°C, max.		75/0	75/0	75/0	75/0	ISO 6247
at 24°C, max.		150/0	150/0	150/0	150/0	
Air release, 50°C, max.	min	7	7	10	10	ISO 9120
Elastomer compatibility ^F after 1 000 h at						ISO 6072
given test temperature						
NBR 1	°C	60	80	_	_	
HNBR	°C	60	80	100	100	
FPM AC 6	°C	60	80	100	100	
Change in Shore-A-Hardness, max.	grade	±10	±10	±10	±10	
Change in volume, max.	%	-3 to +10	-3 to +10	-3 to +10	-3 to +10	
Change in elongation, max.	%	30	30	30	30	
Change in tensile strength, max.	%	30	30	30	30	
Oxidation stability:						
TOST test time to reach						ASTM D943
$\Delta TAN = 2 \text{ mg KOH/g, min.}$	h	1 000	1 000	1 000	1 000	ISO 4263-1
_oad carrying properties,	otogo	G	10	10	10	DIN 51354-2
FZG A/8, 3/90, min.	stage		10	10	10	DIN 51354-2
Vane pump						
Ring, max.	mg	120	120	120	120	IP 281
Vane, max	mg	30	30	30	30	CETOP RP 67H DIN 51389-2

A Report.

^B For purposes of identification, dye may be used by agreement between supplier and end user.

^C Clear and bright is abbreviated as Clbr.

^D Criteria of performance or values of characteristics to be negotiated between supplier and end user.

^E Initial acid number is given by the base fluids and the additives.

^F Other materials or test conditions may be agreed between supplier and end user. Limits are given for the standard reference elastomers.

^G Not applicable to viscosity grade ISO 22.

the environmental persistence of hydraulic fluids (Category P) and one group addressing acute ecotoxicity of hydraulic fluids, which will not be addressed here. Table 4 shows the Category P classifications for aerobic fresh water persistence.

10. Biodegradable and Fire-Resistant Hydraulic Fluid Classification

10.1 This classification proposes that all fire-resistant hydraulic fluids (that is, type HF and HEPG) that meet the minimum criteria for biodegradability according to Classification D6046 (Pw1), and fire resistance, according to either FM Approvals (Factory Mutual Research Corp.) or ISO 12922, shall be designated with the prefix B- and the suffix -0, 1, or 2 according to the FM Approval rating (that is, B-*Fluid Type*-0, 1 or 2).

10.1.1 Tables 1 and 2 summarize the physical property requirements for type HF type hydraulic fluids according to

ISO 12922. Table 3 summarizes the physical property requirements for category HEPG hydraulic fluids according to ISO 15380.

11. Industry Requirements for Fire Resistance

11.1 *Industrial/Mobile Equipment*—For a hydraulic fluid to be classified as both biodegradable and fire resistant, the fluid must meet the requirements of 10.1.

11.2 *Mining Equipment*—For a hydraulic fluid to be classified as both biodegradable and fire resistant, the fluid must meet the requirements of 10.1.

12. Keywords

12.1 biodegradable; ecotoxicity; fire resistance; fluids; FM approvals; hydraulics

D7044 – 04a

TABLE 4 Aerobic Fresh Water Environmental Persistence Classification

	assilication			
Persistence	Ultimate Biodegradation Test Results			
Designation	% Theoretical CO ₂	$\%$ Theoretical $\rm O_2$		
Hydraulic Fluids Containing <10	% 0 ₂			
Pw1	≥60% in 28 days	≥67 % in 28 days		
Pw2	≥60 % in 84 days	≥67 % in 84 days		
Pw3	≥40 % in 84 days	≥45 % in 84 days		
Pw4	<40 % in 84 days	<45 % in 84 days		
Hydraulic Fluids Containing ≥ 10	% O ₂			
Pw1	\geq 60 % CO ₂ or O ₂ in 28 days			
Pw2	\geq 60 % CO ₂ or O ₂ in 84 days			
Pw3	\geq 40 % CO ₂ or O ₂ in 84 days			
Pw4	<40 % CO ₂ or O ₂ in 84 days			
All Hydraulic Fluids				
Persistence	Primary Biodegradation Test Results %			
Designation	Loss of Starting Material			
Pw-C	≥80 % in 21 days			
Pw4	<80% in 21 days			

ASTM International takes no position respecting the validity of any patent rights asserted in connection with any item mentioned in this standard. Users of this standard are expressly advised that determination of the validity of any such patent rights, and the risk of infringement of such rights, are entirely their own responsibility.

This standard is subject to revision at any time by the responsible technical committee and must be reviewed every five years and if not revised, either reapproved or withdrawn. Your comments are invited either for revision of this standard or for additional standards and should be addressed to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend. If you feel that your comments have not received a fair hearing you should make your views known to the ASTM Committee on Standards, at the address shown below.

This standard is copyrighted by ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959, United States. Individual reprints (single or multiple copies) of this standard may be obtained by contacting ASTM at the above address or at 610-832-9585 (phone), 610-832-9555 (fax), or service@astm.org (e-mail); or through the ASTM website (www.astm.org).