



Renewable Lubricants, Inc.

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Bio-Ultimax™ Hydraulic Fluids **AW 1000 & 2000 (ISO 32, 46, 68)**

STABILIZED™
by Renewable Lubricants

"Biobased Lubricants that Perform Like Synthetics"

Bio-Hydraulic Fluids, Bio-Ultimax™ 1000 & 2000, are ultimately biodegradable¹ vegetable based formulas that replace mineral oil based hydraulic fluids. Bio-Ultimax™ Hydraulic Fluids are formulated to perform in hydraulic systems that require Anti-Wear (AW), anti-rust, anti-oxidation, anti-foam, and demulsibility properties. They are highly inhibited against moisture and rusting in both fresh and sea water and pass both A and B Sequences of the ASTM D-665 Turbine Oil Rust Test. Incorporating the super high viscosity index of the Stabilized* High Oleic Base Stocks (HOBS) into the formula, increases the viscosity index past synthetic levels (Energy Conserving Formulas). Zinc-free additive systems have also been developed that are environmentally friendly and meet or exceed pump requirements.

Bio-Ultimax™ Hydraulic Fluids are designed for use in mobile and stationary hydraulic vane, piston, and gear-type pumps and have shown to have exceptional anti-wear performance. **Very little wear was encountered, 0 to 25mg (Pass), in accelerated biobased tests using Denison T-5D, Vickers 20VQ, 35VQ-25 (M-2950-S), and V-104C (ASTM D-2882), Vickers I-286-S, pump stand tests at pressures and temperatures ranging from 2000 to 3000 psi and from 150° to 210° F.** The anti-wear performance exceeds the requirements for US Steel 126 and 127, load stage 10 in the FZG (DIN 51354), DIN 51524, and GM (LS-2). They also meet the requirements for ashless GL-3 gear oils in reduction units and gear sets where they meet the viscosity ranges. Bio-Ultimax™ AW 1000 meets and exceeds Federal Specifications A-A-59354 Superseding MIL-H-46001D.

The super high viscosity index of the HOBS naturally improves the thermal shear stability of the formula and increases load capacity. The HOBS's extremely low volatility increases the flash and fire safety features in the formula. They are formulated to provide seal conditioning for longer seal life and to reduce oil leakage from the system. Bio-Ultimax™ Hydraulic Fluids should be used in hydraulic systems where low toxicity, and BIODEGRADABILITY properties are required. Base oils and additives in these products pass and exceed the acute toxicity (LC-50 >1000 ppm) criteria adopted by the US Fish and Wildlife Service and the US EPA. Bio-Ultimax™ Hydraulic Fluids are ENVIRONMENTALLY RESPONSIBLE lubricants that are formulated from renewable agricultural plant resources. We believe Earth's environmental future rests in the use of renewable materials.

STABILIZED by Renewable Lubricants™* is RLI's trademark on their proprietary and patented anti-oxidant, anti-wear, and cold flow technology. High Oleic Base Stock (HOBS) are agricultural vegetable oils. This Stabilized technology allows the HOBS to perform as a high performance formula in high and low temperature applications, reducing oil thickening and deposits.

¹ Ultimate Biodegradation (Pw1) within 28 days in ASTM D-5864 Aerobic Aquatic Biodegradation of Lubricants

Patented Product: US Patent 6,383,992, US Patent 6,534,454 with additional Pending and Foreign Patents

* Trademark of Renewable Lubricants™, Inc.

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Availability F.O.B. :Hartville, Ohio, USA 1 Gallon 5 Gallon Pail Drum Totes Bulk

Bio-Ultimax™ 1000 Hydraulic Fluids ISO 32, 46, 68

The test data below show that the Bio-Ultimax™ 1000 Hydraulic Fluids provide high performance in a wide variety of stationary and transportation equipment that operate in broad ranges of environmental conditions. In equipment operating outside, wear from poor cold temperature pumpability, surge loads, moisture, and dusty environments are more prominent. Bio-Ultimax™ 1000 Hydraulic Fluids are formulated to improve performance in equipment that requires excellent anti-wear, hydrolytic stability, and cold temperature pumpability as low as -35°C. In addition, the products may be used in machine tool hydraulic systems with the above Denison and Vickers pump requirements and exceeds the requirements of US Steel 126, 127 and DIN 51524 Part 2.

TYPICAL SPECIFICATIONS	METHOD	ISO 32	ISO 46	ISO 68	Spec. Requirements
Specific Gravity @ 15.6°C	ASTM D-287	0.88	0.88	0.88	Report
Viscosity @ 40°C	ASTM D-445	30.87	43.8	64.1	Note 1
Viscosity @ 100°C	ASTM D-445	6.9	9.67	12.5	Note 1
Viscosity @ -15°C, Brookfield	ASTM D-2983	550 cP	1100 cP	3200cP	Note 1
Viscosity @ -25°C, Brookfield	ASTM D-2983	1,200 cP	3,000 cP	4500 cP	Note 1
Viscosity @ -30°C MRV TP1	ASTM D-4684	4,500 cP	8000 cP	15,000 cP	10W= <60,000
Viscosity @ -35°C MRV TP1	ASTM D-4684	7,500 cP	11,000 cP	24,000 cP	5W= <60,000
Viscosity Index	ASTM D-2270	184	199	198	90 (min)
Pour Point	ASTM D-97	-40°C	-40°C	-39°C	Note 1
Flash Point (COC)	ASTM D-92	236°C	243°C	251°C	198°C (min)
Fire Point (COC)	ASTM D-92	260°C	268°C	274°C	218°C (min)
Hydrolytic Stability,	ASTM D-2619				
Copper Wt. Loss (mg)		0.0139	0.0208	0.0208	0.2
Copper Appearance		1B	1B	1B	Report
Change in Acid Number		0.16	0.20	0.21	Report
Water Layer		3.0	3.0	3.0	4
% Insolubles		0.001	0.001	0.001	Report
Foam Sequence I, II, III (10 min)	ASTM D-892	0 Foam	0 Foam	0 Foam	0 Foam
Rust Prevention	ASTM D-665				
Distilled Water		Pass	Pass	Pass	Pass
Syn. Sea Water		Pass	Pass	Pass	Pass
Copper Corrosion Strip 3hr @ 100°C	ASTM D-130	1A	1A	1A	DIN 51524 2(max)
Rotary Bomb Oxidation, (minutes)	ASTM D-2272	360	360	360	USS 120 (min)
Dielectric Strength (KV) (Avg)	ASTM D-877	42	40	40	>35
Oxidation Stability (Pressure Differential Scanning Calorimeter) min	ASTM D-5483 Modified	70.0 (165°C)	70.0 (165°C)	70.0 (165°C)	Note 2
Neutralization Number mg KOH/g	ASTM D-974	<0.4	<0.4	<0.4	1.5 (max)
Swell of Synthetic NBR-L Rubber, % (Avg.)	DIN 53538, Part 1				
Volume Change (%)		6.0	6.0	6.0	0 to 12
Shore A Hardness Change (%)		-4	-4	-4	0 to -7
Filterability	Denison TP 02100				
A-No Water (s) (Avg)	HF-0 Requirement	113	268	335	600 (max)
B-2% Water (s) (Avg)		187	271	449	2xA (max)
Demulsibility, ML Oil/Water/Emulsion	ASTM D-1401	40/ 40/ 0 (10 minutes)	40/ 40/ 0 (10 minutes)	40/ 40/ 0 (10 minutes)	40/37/3 (max) (30 minutes)
4-Ball Wear, 1h, 167°F, 1200 RPM, 40 kg	ASTM D-4172	0.3 – 0.4	0.3 – 0.4	0.3 – 0.4	USS 127 0.5 (max)
FZG Test	DIN 51354	12	12	12	US.Steel 10 (min)
<u>Biodegradation Classification</u>	ASTM D-5864	Ultimate	Ultimate	Ultimate	Ultimate
<u>Environmentally Friendly</u>	ISO 15380	PW1 yes	PW1 yes	PW1 yes	PW1
<u>USDA Biobased Tested</u>	New Carbon	yes	yes	yes	meets/exceeds
<u>Environmental Management System</u>	ISO 14001:1996	yes	yes	yes	over 50%
<i>Note 1 Viscosity Sufficient for Application</i>					
<i>Note 2 Not Required</i>					
RLI Product Item #		81000	81010	81020	

Bio-Ultimax™ 2000 Hydraulic Fluids ISO 32, 46, 68

Bio-Ultimax™ 2000 Hydraulic Fluids are designed to provide high performance in the high temperature/high pressure machine tool environment. In machine tool equipment, the hydraulic pump may work continuously in automatic machines. Machines may run 24 hours and 7 days a week non-stop. Close tolerances (0.00015 in. = 3 micron) and fine system filters (3 to 5 absolute filtration) for hydraulic/electric servo drive systems can work to elevate hydraulic system temperatures rapidly. It is also not unusual for hydraulic system components to be located close to very high temperature areas, i.e., on the side of a plastic mold injection gun. The very high oxidative stability of Bio-Ultimax 2000 Hydraulic Fluids meets these demands. Bio-Ultimax™ 2000 exceeds the requirements for DIN 51524 Part 2.

If oil samples are monitored and if the machine is running under clean conditions, fluid life can be increased with proper lubricant filtration and improved oxidation. Even though the US Steel requirement is a minimum of 125 minutes in the RBOT, the hydraulic system's fluid life can be increased considerably when RBOT exceeds 400 minutes and a proper preventative maintenance sampling program is used. General Electric, GEK 32568A, requires an RBOT minimum of 450 minutes in turbine oil requirements. In RLI's Bio-Ultimax™ 2000 Hydraulic Fluids, a RBOT of over 500 minutes has been met that increases fluid and equipment life.

TYPICAL SPECIFICATIONS	METHOD	ISO 32	ISO 46	ISO 68	Spec. Requirements
Specific Gravity @ 15.6°C	ASTM D-287	0.873	0.88	0.89	Report
API Gravity @ 15.6°C	ASTM D-287	30.6	29.3	27.5	Report
Viscosity @ 40°C	ASTM D-445	29.5	44.31	64.34	Note 1
Viscosity @ 100°C	ASTM D-445	6.54	9.50	12.2	Note 1
Viscosity Index	ASTM D-2270	186	206	191	90 (min)
Pour Point	ASTM D-97	-32°C	-30°C	-25°C	-12°C (max)
Flash Point (COC)	ASTM D-92	240°C	244°C	253°C	198°C (min)
Fire Point (COC)	ASTM D-92	265°C	272°C	275°C	218°C (min)
Hydrolytic Stability,	ASTM D-2619				
Copper Wt. Loss (mg)		0.0417	0.0208	0.0208	0.2
Copper Appearance		1A	1B	1B	Report
Water Layer		3.0	3.0	3.0	4
Foam Sequence I, II, III (10 min)	ASTM D-892	0 Foam	0 Foam	0 Foam	0 Foam
Rust Prevention	ASTM D-665				
Distilled Water		Pass	Pass	Pass	Pass
Syn. Sea Water		Pass	Pass	Pass	Pass
Copper Corrosion Strip 3hr @ 100°C	ASTM D-130	1A	1A	1A	DIN 51524 2(max)
Rotary Bomb Oxidation, (minutes)	ASTM D-2272	550	550	550	USS 120 (min)
Oxidation Stability (Pressure Differential Scanning Calorimeter) min	ASTM D-5483 Modified	90 (165°C)	90 (165°C)	80 (165°C)	Note 2
Neutralization Number mg KOH/g	ASTM D-974	<0.4	<0.4	<0.4	1.5 (max)
Swell of Synthetic NBR-L Rubber, % (Avg.)	DIN 53538, Part 1				
Volume Change (%)		6.0	6.0	6.0	0 to 12
Shore A Hardness Change (%)		-4	-4	-4	0 to -7
Filterability	Denison TP 02100 HF-0 Requirement				
A-No Water (s) (Avg)		113	268	335	600 (max)
B-2% Water (s) (Avg)		187	271	449	2xA (max)
Demulsibility, ML Oil/Water/Emulsion	ASTM D-1401	40/ 40/ 0	40/ 40/ 0	40/ 40/ 0	40/37/3 (max)
4-Ball Wear, 1h, 167°F, 1200 RPM, 40 kg	ASTM D-4172	0.3 – 0.4	0.3 – 0.4	0.3 – 0.4	USS 127 0.5 (max)
FZG Test	DIN 51354	12	12	12	US.Steel 10 (min)
<u>Biodegradation Classification</u>	ASTM D-5864	Ultimate PW1	Ultimate PW1	Ultimate PW1	Ultimate PW1
<u>Environmentally Friendly</u>	ISO 15380	yes	yes	yes	meet/exceeds
<u>USDA Biobased Tested</u>	New Carbon	yes	yes	yes	over 50%
<i>Note 1 Viscosity Sufficient for Application</i>					
<i>Note 2 Not Required</i>					
RLI Product Item #		81100	81110	81120	

Bio-Hydraulic Fluid ISO 46 Tested at DOD, Ft. Belvoir, VA
Technical Report # 13640 "L" March 1995, TARDEC-TACOM (US Army)

TYPICAL SPECIFICATIONS	METHOD	Bio-46 HYD	Mil-H 46001 Reference Mineral Oil	Spec. Requirements
Specific Gravity @ 15.6°C Viscosity @ 40°C Viscosity @ 100°C Viscosity @ -15°C, Brookfield Viscosity @ -25°C, Brookfield Viscosity @ -30°C MRV TP1 Viscosity Index	ASTM D-287 ASTM D-445 ASTM D-445 ASTM D-2983 ASTM D-2983 ASTM D-4684 ASTM D-2270	0.91 *ISO-46 47.5 9.58 1100 cP 3000 cP 15,000 cP 194	0.87 ISO-32 31.43 5.29 1544 Not Complete Not Complete 99	Report Note 1 Note 1 Note 1 Note 1 10W= <60,000(max) 90 (min)
Pour Point Flash Point (COC) Fire Point (COC) Hydrolytic Stability, Copper Wt. Loss (mg) Copper Appearance Water Layer Foam Sequence I, II, III (10 min) Rust Prevention Distilled Water Syn. Sea Water	ASTM D-97 ASTM D-92 ASTM D-92 ASTM D-2619 ASTM D-892 ASTM D-665	-36°C 278°C 335°C 0.01 1B 0.17 0 Foam Pass Pass	-39°C 212°C 234°C Not Complete Not Complete Not Complete (Fail) Pass Pass	-12°C (max) 198°C (min) 218°C (min) 0.2 Report 4 0 Foam Pass Pass
Cincinnati Machine Thermal Stability Procedure A % Vis Change Neutralization Number mg KOH/g Precipitate or sludge, mg/100ml Steel Rod Visual Condition Deposit, mg Metal Removed, mg/200 ml Copper Rod Visual Condition Deposit, mg		4.38 0.15 15.65 slight tarnish 1.5 Nil 2c 7.4	7.45 (Fail) 0.49 8.75 medium tarnish Nil Nil 4B 5.6	+5 max 0.75 25 (max) Report 3.5 (max) 1.0 (max) 5 10 (max)
Accelerated Storage Stability (@ 100° C One Month) Viscosity Changes, % @ 40°C ASTM D445 Acid Number Changes, mg PDSC, Induction Time Changes, % Copper Corrosion Strip 3 Days @ 100°C Galvanic Corrosion Corrosiveness and Oxidation Stability @ 100°C Humidity Cabinet, Hrs. to Fail	Army Method ASTM D-130 FED-STD 7915, #5322 ASTM D-4636 ASTM-D-1748	0.83 0.1 0 1B Pass Pass 230	1.43 0.03 -25.58 1A Pass Pass 48	Note 2 Note 2 Note 2 Note 2 Note 2 Note 2
Oxidation Stability (Pressure Differential Scanning Calorimeter) min Evaporation Loss, % (100°C, 1 hr) Neutralization Number mg KOH/g Swell of Synthetic NBR-L Rubber, % Demulsibility, ML Oil/Water/Emulsion 4-Ball Wear, 1h, 167°F, 1200 RPM, 40 kg Biodegradation Classification	ASTM D-5483 Modified (Thermogravimetric Analysis) ASTM D-664 FED-STD 791, #3603 ASTM D-1401 ASTM D-4172 ASTM D-5864	13.34 (180°C) 0.78 1.35 10.35 40/ 40/ 0 0.40 Yes	24.2 (180°C) 0.75 0.58 7.78 40/ 40/ 0 0.43 No	Note 2 Note 2 1.5 (max) Report 40 (max) USS 127 0.5 (max) Report
<i>Note 1 Viscosity Sufficient for Application</i> <i>Note 2 Not Required</i>				