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Bio-Ultimax™ Hydraulic Fluids In Comparative Oxidation Studies

STABILIZED™ by Renewable Lubricants

"Bio-based Lubricants that Perform Like Synthetics"

The following data shows independent oxidation tests performed on RLI's patented, biodegradable[1] Bio-Ultimax™ 1000 and 2000 Hydraulic Fluids and compared to competitive commercial hydraulic fluids. The data includes comparative results with other bio-based biodegradable hydraulic fluids, mineral based hydraulic fluids, and synthetic ester based hydraulic fluids. The oxidation tests that were performed are summarized below.

ASTM D-2893 Oxidation Characteristics of Extreme-Pressure Fluids
The Standard Test Methods are designed to measure resistance to oxidation by determining the changes in viscosity produced in a lubricant by the oxygen it absorbs from air. To run this test, 300 ml of the lubricant is placed in a large test tube containing a glass inlet tube designed to carry the air well below the surface of the lubricant. The entire assembly is placed in an oil bath at 95°C (Test Method A) or 121°C (Test Method B) and dry air is bubbled through the sample at 10 liters per hour for 312 hours (13 days). The precipitation number and percent viscosity increase are reported at the end of the test. Typical results are from 0 – 50% viscosity increase for mineral oil and synthetic fluids.

This test can further be modified to accelerate oxidation by replacing the air with oxygen and increasing the temperature to 121°C. These modifications allow for reduction of test duration from 312 hours to 50 hours while providing equivalent severity. This modified test method can also be accelerated further by extending the time to 100 hours or for the full 312 hours at 121°C depending on the oxidation stability of the fluid. The time can also extended to 1008 hours (6 weeks) to show how the fluids respond to extremely sever oxidation testing related to increased time and temperature. The Bio-Ultimax™ 1000 and 2000 are compared below with Cargill Bio-based Hydraulic Fluid, Commercial Bio-based A, a blended Bio-based (sunflower)/ 30% Synthetic Polyolester (trimethylol propane oleate), and a full synthetic polyolester based hydraulic fluid which is considered and promoted in the industry as a very stable formulation. The data also shows that the synthetic polyolester based hydraulic fluid decreases in viscosity before it starts to increase in viscosity. This is commonly seen in synthetic polyolester based formulas because of the chemical reactions during high temperature oxidation tests. The tests below shows only fluids with excellent oxidation stability will survive a <20% viscosity increase or decrease and <2.0 total acid number (TAN) change after 312 hours and 1008 hours @ 121°C test. Hydraulic system and pump manufactures have reported acidic attack of internal metal components when hydraulic fluids reach TAN increase of 2.0 in real life hydraulic equipment applications. The independent data below provides additional information why RLI's Bio-Ultimax™ Hydraulic Fluids have not experienced any hydraulic system problems in actual applications and why RLI is the leader in bio-based lubricant technology.

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Comparative Assessment of RLI Ultimax Hydraulic Fluid Technology

Accerlerated Oxidation Testing (ASTM D-2893) 121°C	Ultimax 1000	Ultimax 2000	Quaker Polyolester hydraulic fluid	Cargill Biobased hydraulic fluid	Commercial Biobased A	Commercial Biobased Synthetic
Viscosity change @ 40°C 100 hrs. %	N/A	N/A	N/A	N/A	452	20
Viscosity change @ 40°C 312 hrs, %	10.2	5.6	-5.8	2780	N/A	N/A
Viscosity change @ 100°C 312 hrs, %	7.3	3.7	-6.6	902	N/A	N/A
Viscosity change at 40°C after 1080 hrs, %	16.2	15.6	8.2	N/A	N/A	N/A
Starting TAN	0.28	0.35	2	0.92	0.9	0.9
TAN change after 312 hrs, mgKOH/g	0.43	0.29	1.3	7.4	11	2

ASTM D-2272 Rotary Bomb Oxidation Test

The Rotary Bomb Oxidation Test (RBOT) is a rapid method of comparing the oxidation life of lubricants in similar formulations. It is used to evaluate the oxidation characteristics of turbine, hydraulic, transformer and gear oils. The test apparatus consists of a pressurized bomb axially rotating at an angle of 30° from the horizontal in a bath at 150°C (302°F). Fifty grams of test oil and 5 grams of water are charged to the bomb containing a copper catalyst coil. The bomb is initially pressurized with oxygen to 90 psi at room temperature. The 150°C bath temperature causes this pressure to increase to approximately 200 psi. As oxidation occurs, the pressure drops, and the usual failure point is taken as a 25 psi drop from the maximum pressure attained at 150°C. The results are reported as the number of minutes to a 25 psi loss. The longer the time, in minutes the greater the stability of the fluid. Notice in Chart 1 below the performance of RLI's patented technology and how it out performs all the other hydraulic fluids with a greater amount of time.

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

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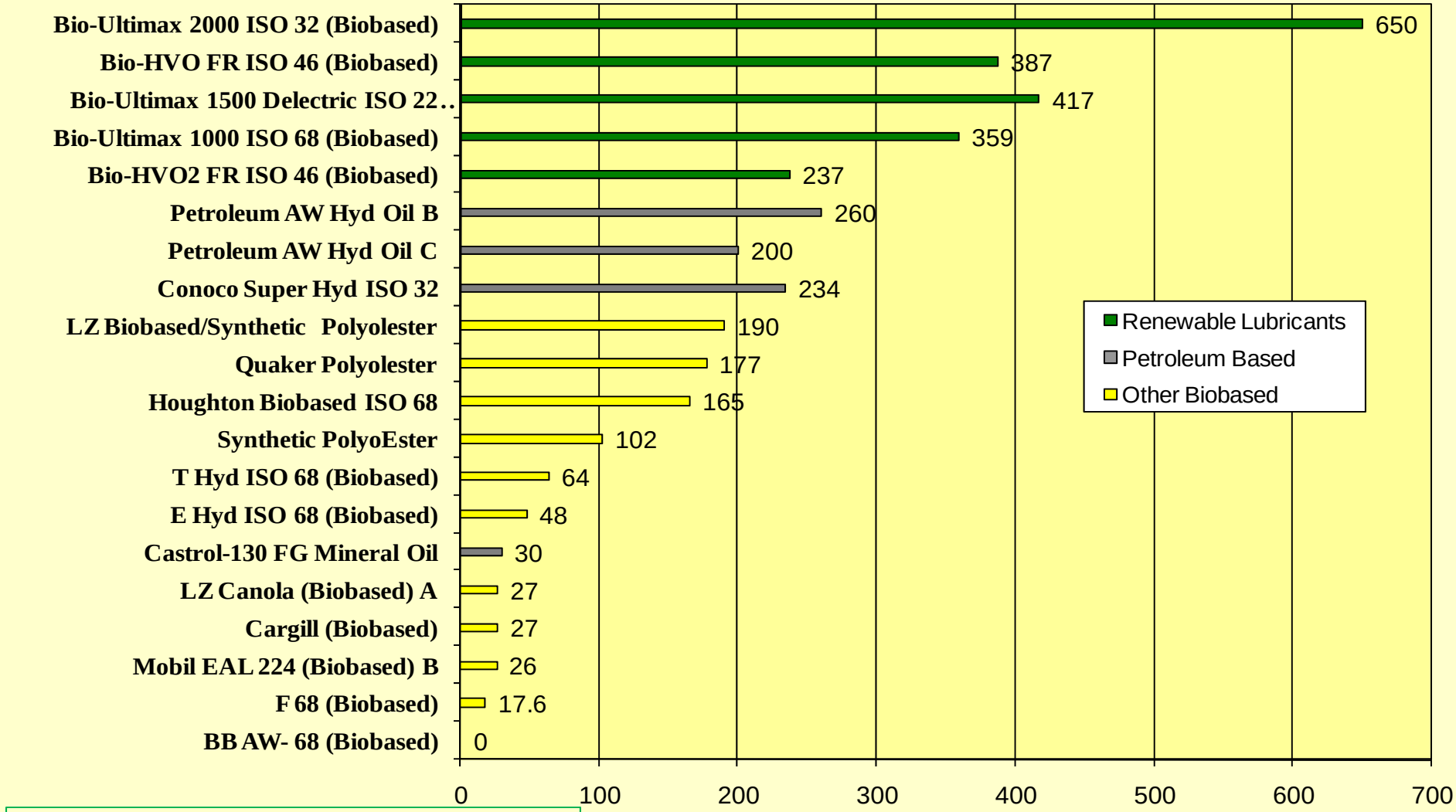
Rotary Bomb Oxidation Test (*RBOT) @ 150°C (ASTM D-2272): A Comparative Study of Hydraulic Fluids Over Time



*RBOT, now called the RPVOT test, is a measure of the fluid's resistance to oxidation.