High Oleic Soy Oil and Estolide-Based Food-Grade Hydraulic Fluid

Snigdha Thummalapalli, Biosynthetic Technologies

Biosynthetic Technologies has developed a fully formulated food-grade hydraulic fluid in ISO grades 46 & 68, utilizing a combination of High Oleic Soy Oil, patented Estolide technology and a blend of additive technologies. These biobased hydraulic fluids are blended using HX-1-approved raw materials, making them NSF H-1 certified (i.e., approved for use in U.S. Department of Agriculture-inspected food processing plants where incidental food contact may occur). Biosynthetic Technologies formulated these biobased food-grade hydraulic fluids to comply with the European EcoLabel and USDA's BioPreferred® Program, recognizing their renewable content.

These food-grade hydraulic fluids serve as a drop-in replacement to conventional mineral-based hydraulic fluids and offer superior lubricity, improved operational performance and lower overall environmental impact. Biosynthetic Technologies formulated these biobased hydraulic fluids to withstand extreme pressure and wear resistance characteristics along with biodegradability. Replacing conventional hydraulic oils with Biosynthetic Technologies' hydraulic fluid will help food companies meet environmental sustainability objectives as well as reduce the bio-hazard risks associated with accidental spills due to non-toxicity (> 100 ppm as per the OECD 201, 202, and 203) & high biodegradability (>75% by the OECD 301B).

Formulation Data

Biosynthetic Technologies developed these food-grade hydraulic fluids using a combination of HOSO and patented sustainable base oils BT4 and BT22. A combination of additive technologies including an off-the-shelf food-grade additive package and additional performance additives was used to meet the ISO 46 and ISO 68 specifications. The finished products were then tested for their performance characteristics such as hydrolytic stability, oxidative stability, 4-ball-wear-and-load, demulsibility, rust, foam, timken, viscometrics, pour point, elastomer compatibility, flash point, and biodegradability. The high viscosity of the HOSO base stock offers superior lubricity and thermal stability while the estolides result in improved oxidative & hydrolytic stability. The finished hydraulic fluids showed excellent performance capabilities for load wear, four ball weld and corrosion, among others. All the blends have high biobased content (>38% by the ASTM 6866), low toxicity (see above) and are ultimately biodegradable (see above). The formulations and the performance data of the food-grade hydraulic fluids is as follows.

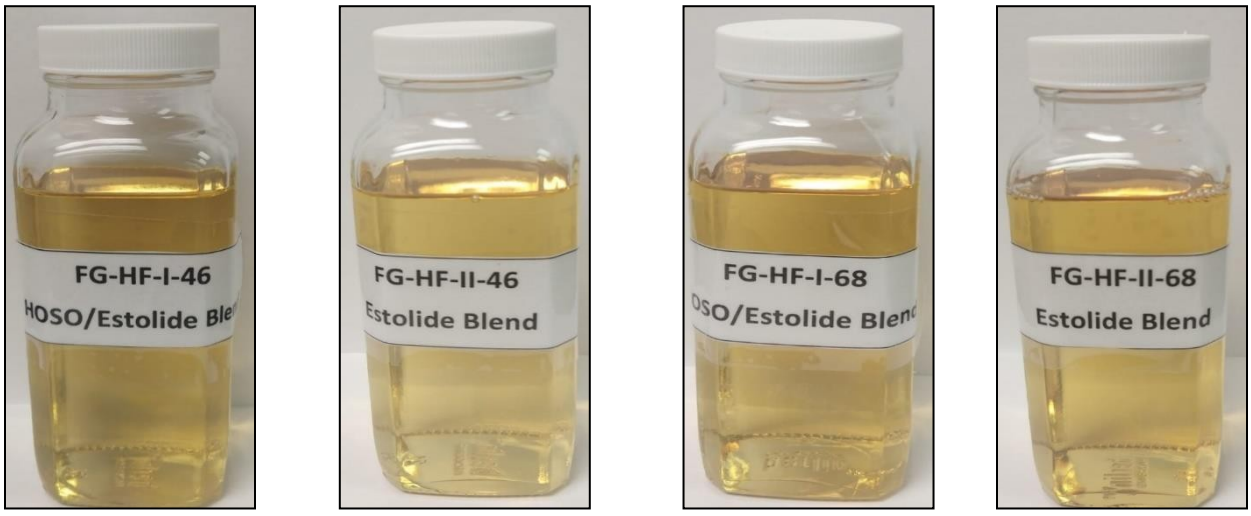
Table 1: Blend data for ISO 46 Prototype Formulation

ISO 46 Formulation		
Type of blend	**HOSO/Estolide Blend**	**Estolide Blend**
High Oleic Soybean Oil (HOSO)	29.85%	**-**
BT4	34.83%	**54.67%**
BT22	30.29%	**35.3%**
AdPac	4.47%	**4.47%**
Anti-foam	0.05%	**0.05%**
SE-6B	-	**4.97%**
PPD	0.5%	**0.5%**
Total	**~ 100%**	**~ 100%**

Table 2: Blend data for ISO 68 Prototype Formulation

ISO 68 Formulation		
Type of blend	**HOSO/Estolide Blend**	**Estolide Blend**
High Oleic Soybean Oil (HOSO)	30%	**-**
BT4	16%	**30.35%**
BT22	49.45%	**59.65%**
AdPac	4.5%	**4.47%**
Anti-foam	0.05%	**0.05%**
SE-6B	-	**4.97%**
PPD	0.5%	**0.5%**
Total	**~ 100%**	**~ 100%**

Figure 1: Sample formulations of Biosynthetic Technologies; food-grade hydraulic fluids – ISO 46 and ISO 68 Grades



Properties	Test Method	Unit	ISO 46 HOSO Blend	ISO 68 HOSO Blend	ISO 46 BT Blend	ISO 68 BT Blend
Viscosity KV 100°C	ASTM D445	cSt	**9.25**	**12.24**	**8.51**	12.25
Viscosity KV 40°C	ASTM D445	cSt	**48.6**	**70.02**	**46.2**	73.9
Viscosity Index	ASTM D2270	-	**176**	**174**	**163**	164
Specific Gravity	ASTM D4052		**0.9134**	**0.9153**	**0.9103**	0.9123
Gardner Color	ASTM D1544	-	**3.2**	**3.7**	**3.3**	3.9
Pour Point	ASTM D97	^{o}C	**-29**	**-26**	**-27**	-24
Flash Point (COC)	ASTM D92	^{o}C	**212**	**210**	**210**	210
Total Acid Number	ASTM D664	mg KOH/g	**0.79**	**0.83**	**0.78**	0.86
Water Content	ASTM D6304	wt%	**0.02**	**<0.02**	**0.02**	0.02
Rust Testing, A -Fresh Water (24h)	ASTM D665	-	**PASS**	**PASS**	**PASS**	PASS
Rust Testing, B - Salt Water (24h)	ASTM D665	-	**PASS**	**FAIL**	**PASS**	PASS
Copper Corrosion	ASTM D130	Rating	**1A**	**1A**	**1A**	1A
Demulsibility	ASTM D1401	-	**40/40/0 (10)**	**40/40/0 (15)**	**40/40/0 (10)**	40/40/0(15)
Foam	ASTM D892	-	**450/90, 75/0, 50/0**	**45/0, 135/0, 100/0**	**30/0, 80/0, 30/0**	390/100, 110/0, 30/0
4-Ball Weld,Weld load	ASTM D2783	kgf	**200**	**200**	**200**	200
4-Ball Weld, Last Non-SeizureLoad	ASTM D2783	kgf	**100**	**100**	**100**	80
4-Ball Weld, Load Wear Index	ASTM D2783	kgf	**40.59**	**40.61**	**40.71**	33.38
Oxidative Stability,RPVOT	ASTM D2272	min	**223**	**220**	**729**	762
Hydrolytic Stability,TAN Increase in oil layer	ASTM D2619	mg KOH/g	**0.46**	**0.47**	**0.29**	0.22
Hydrolytic Stability,TAN Increase in water layer	ASTM D2619	mg KOH/g	**16.9**	**19.0**	**20.7**	20.1
Biodegradability	OECD 301B	-	**76%**	**76%**	**76%**	76%
Eco-toxicity (Green Algae)	OECD 201	100 ppm limit test	Not acutely toxic			
Eco-toxicity (Water Flea)	OECD 202					
Eco-toxicity (Fathead Minnow)	OECD 203					

Performance Features

- Multi-functional biobased hydraulic fluid (Grade 46 and 68)
- Can be classified as ISO-L-HEES (according to ISO 6734-4 classification)
- Similar to Class HV/HM (acc.to ASTM D6158)
- Highly inhibited against moisture and corrosion
- Higher load bearing capacity and reduced wear
- Formulated for applications in incidental food contact in and around food processing equipment
- High-performance lubricants formulated to withstand extreme pressures (high weld load values)
- Energy-conserving formulations due to the high viscosity index of HOSO
- Good oxidative & hydrolytic stability
- Low volatility, increased stability and longer lasting
- Excellent performance that resists wearing
- Maintenance benefits

Applications

Ideal for use in a variety of hydraulic oil applications and suitable for several agricultural, marine, mining, and industrial applications where environmental and safety concerns are high, such as food processing applications, where USDA & FDA require NSF-certified lubricants to ensure food safety. These hydraulic fluids benefit a wide array of processing equipment, including hydraulic systems, hydrostatic drives and motors, drip oilers, bearings, cables etc. Biosynthetic Technologies' food-grader hydraulic fluids allow food and agricultural processors to switch to products to meet regulatory expectations.

OUR SOY CHECKOFF™

About the United Soybean Board:

Through the soybean checkoff, the United Soybean Board provided financial support for the research in addition to Biosynthetic Technologies' investment.

About Biosynthetic® Technologies:

Biosynthetic® Technologies manufactures a revolutionary new class of biobased synthetic compounds called Estolides that are made from organic fatty acids found in various bio-derived oils. These highly functional biosynthetic oils have numerous uses in lubricant, metalworking fluid, automotive, marine, pharma and personal care applications and can be used as the primary base oil of a formulation, a component of a base oil co-blend, or even as an additive. In addition to their high-performance properties, these renewable oils are biodegradable and nontoxic. Biosynthetic Technologies strives to make their mark on the world by delivering innovations for a sustainable future. For more information about Biosynthetic™ Technologies, please visit www.biosynthetic.com and follow us on LinkedIn and Twitter.