SANTOLUBES

UHE SYNTHETIC BASE OILS

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BACKGROUND

SANTOLUBES® UHE synthetic base oils are a new Group V base oil technology recently developed by Santolubes with the lowest shear strength (lowest coefficients of traction) ever reported for a viable base oil technology.

UHE base oils are currently available for blending in viscosity grades from ISO 15 to ISO 680. These new base oils have extremely high Viscosity Indices (VI) and extremely low elastohydrodynamic shear strengths (or coefficients of traction) over a wide range of conditions. These two features make these base oils suitable for blending lubricating fluids with excellent film thickness protection across a wide temperature range and with unprecedented energy efficiency. Additionally, they are completely stable to viscosity shear down in EHD lubrication applications. Thus, UHEs maintain superior lubricating performance throughout their long service life in properly formulated fluids.

FEATURES AND BENEFITS

The Santolubes UHE Series of full-synthetic lubricants is specifically designed to eclipse the performance of mineral, PAO, and PAG lubricants in gear and rotary compression applications. The ultra-low shear strength properties of Santolubes UHE oils, in industrial gears, allows for higher torque throughput through a reducer and a reduction in equilibrium operating temperatures by double digits. These performance features can correlate to longer seal life, gearbox, and oil life. The high solvency properties of Santolubes UHE creates enhanced equipment protection from sludge and varnish.

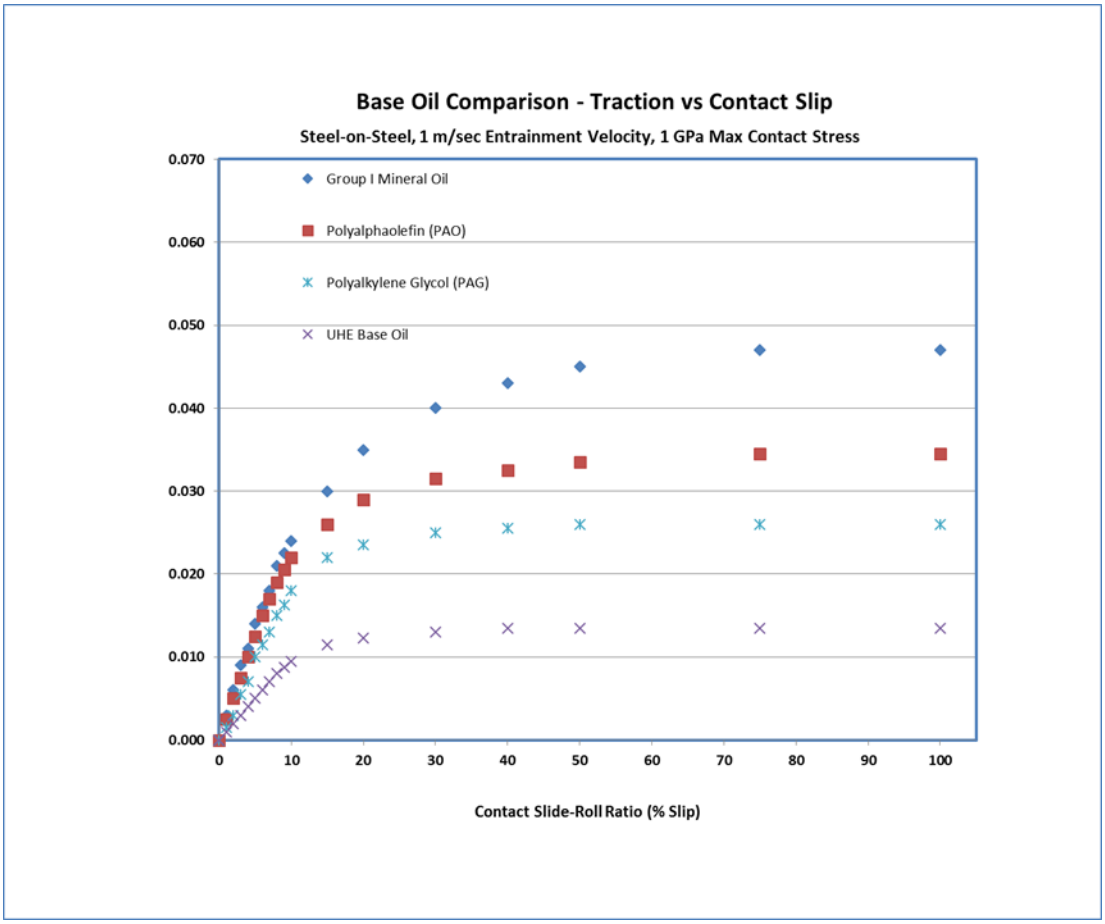
- Extraordinary Film Strength/EP/Antiwear protection for critical equipment components
- High level of micropitting protection for sensitive gear systems
- Safeguards again rust and corrosion in-service
- Superior natural lubricity with unprecedented efficiency well-above current synthetics
- Ultra-Low Shear Strength resulting in both significant energy efficiency gains and reduced operating temperatures
- High solvency to mitigate sludge and varnish formation and deposits

FEATURES COMPARED TO OTHER MINERAL, PAG, PAO, AND OTHER SYNTHETIC LUBRICANTS

There are various types of synthetic base oils. The inherent properties of these oils can differ depending on the raw materials and processes used in their manufacture. Features that can vary among different synthetic oils are the efficiency, from reduced shear strength (traction coefficients), solvency, thermal conduction, and hydrophilic-hydrophobic properties.

HIGH EFFICIENCY

Santolubes researchers have created UHE Base Oils to produce the pinnacle of energy efficiency performance relative to mineral, PAO, PAGs, and other synthetic oils. Coupled with high heat capacities and increased thermal conduction properties of approximately 15% over PAG oils, and even more significant conduction advantages versus PAO and mineral oils, especially in gearboxes that experience considerable slip in the gear mesh cycle, these new base oils possess all of the properties for superior lubrication. These thermal properties along with ultra-low shearing losses lead to lower operating temperatures and superior component and oil longevity.



WIDE TEMPERATURE RANGE

The Santolubes UHE Series of oils have very high VIs that ranging from 209 for the ISO 15 to 205 for the ISO 680. This creates a wide operating temperature ranges, beyond that of mineral oil lubricants, and other synthetic oils and blends.

RUST PROTECTION

The Santolubes UHE Series passes the ASTM D665 Rust test without issue.

FOAM CONTROL

Foam Control is essential, especially in boxes that are “Sealed for Life.” Santolubes UHE Series provides superior results in all three sequences of ASTM D 892 Foam Test.

EP/ANTIWEAR

Having the excellent EP/AW protection is crucial, especially in gearboxes that contain bronze and other less chemically inert metals where traditional EP additives can’t be used. The Santolubes UHE Series of lubricants show excellent EP/Antiwear protection with typical results of 12+ in the DIN5134-2 FZG Scuffing test and excellent bear wear performance in FE8 Bear Wear Test, DIN 51819-3.

Features	Advantages and Potential Benefits
High Thermal Stability and Antiwear Protection	Superior gear and bearing protection under extreme load situations Extended lubricant life reduces scheduled and unscheduled downtime for lubricant changes and increases production output Lower replacement expenditures and maintenance costs
Lowest Friction and Traction Coefficients	High VIs and ultra-low shear strength, improves gear efficiency, lowers the operating temperatures, providing lower power costs and longer seal and oil life
High Thermal Conductivity and Heat Capacity	Significant decreases in operating temps in the gear mesh, and bulk oil sump by lower heat generation and enhanced heat dissipation
Excellent Resistance to Corrosion and Rusting	Superior equipment protections, even when idle, providing longer equipment life and smooth start-up, with materials and labor cost savings

ADDITIONAL UHE PROPERTIES

Compositional and structural characteristics of lubricant base oil molecules govern base stock properties. The following is a summary of those characteristics for UHEs:

Viscosity — UHEs are available in either very low viscosity 15cSt base stock (kinematic viscosity @ 40°C) or high viscosity, 800cSt base stock. Thus, a formulator can blend the optimum viscosity for their application, or we can blend the desired viscosity of base oil for them.

Viscosity Index — UHEs all have a VI above 205. For reference, PAO base oils range typically from 130 for low viscosity PAOs to a maximum of 165 for high viscosity PAO.

Stability — UHE base stocks are thermally, oxidatively, and hydrolytically very stable and have natural solvency to eliminate deposit and varnish formation and are completely shear stable.

Flash Points — UHE base stocks have very high flashpoints. Even the flashpoint of the 15cSt LoVis UHE is +276°C.

Air Release & Foaming — UHEs have excellent Air Release and Non-Foaming characteristics when deploying a proper anti-foaming additive in their product formulation.

Pour Points — 15cSt base stock has a pour point of <-33°C and our 800cSt -36°C.

Scuffing & Micropitting — All gear oil formulations tested, including Food Grade H-1 formulations, show excellent FZG scuffing and micropitting performance with Load Stage Pass of 12+ in FZG Gear Scuffing Tests. In all the FZG tests, the gear pair appeared "Like-New" after testing with only minuscule weight losses.

Wear Protection — All gear oil formulations, including Food Grade H-1 formulation, show excellent wear protection, giving wear scars barely wider than the Hertzian contact width and excellent bearing wear protection.

Compatibility — UHEs are also compatible with both PAOs and PAGs; PAOs up to 50/50 blends and PAGs to ~20%. Thus, a gearbox need only be drained, not flushed, if desired, when replacing another lubricant.

Appearance — UHE base oils are clear, water-white fluids.

Bio-friendly — We will shortly obtain H-1X certification from NSF and complete the panel of marine toxicity studies. We expect to have no issues.

Biodegradability — UHEs are classified as "readily-biodegradable" under the OECD 301B protocol—with biodegradability >90% at normal 28 days test termination.

Intellectual Property — UHEs are patented and registered all over the world—MITI, REACH, CAS, and others.

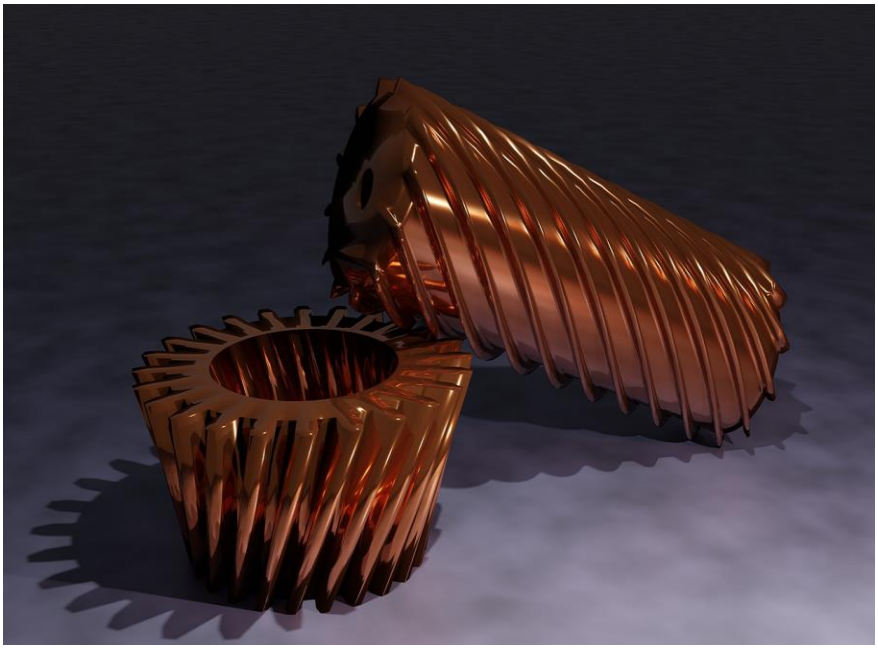
Availability — SantoLubes has enough capacity to satisfy the demand for UHEs for the foreseeable future. Our current capacity is 5+ million per year and is easily upgradable.

Test (typical values)	LoVis Base Oil	HiVis Base Oil
Kinematic Viscosity @ 40°Ç, cSt	21.3	620
Kinematic Viscosity @ 100 °Ç, cSt	5.4	75
Viscosity Index, ASTM D 2270	209	205

Pour Point, ASTM D 97, ℃	-33	-36
Flash Point,ASTM D 92, ℃	276	288
Specific Gravity @ 20 ℃	0.9593	0.9465
Pounds / Gallon	7.898	7.882

APPLICATIONS

Due to its ultra-low shear strength, UHE's offer the best available lubrication protection and efficiency for applications where there is substantial slip within the mating cycle of the contacts, as in worm gears and other types of gearing designs. In addition to this, UHE's food-grade and biodegradability characteristics make it perfect for lubrication applications involving the production of food or where sustainability is paramount.



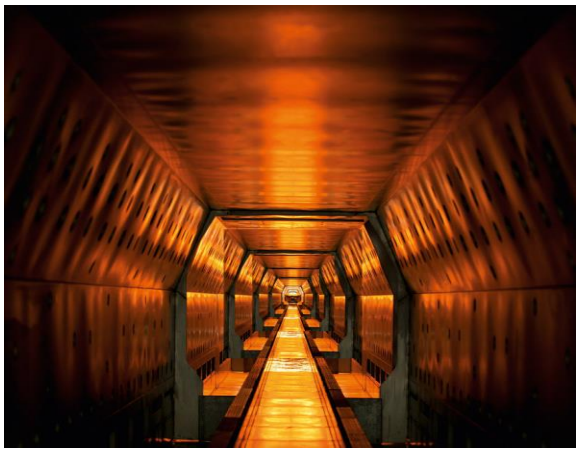
Wind Turbines

With high costs of maintenance, wind turbines are excellent candidates to use UHE. Due to UHE's enhanced lubrication properties compared to other lubricants, less flushing and replenishment needs to be done in a wind turbine's gearbox — reducing the operational costs considerably. In addition to the lowered maintenance costs, UHE's high biodegradability and increased energy efficiency are a natural fit to be used with sustainable energy sources.

Automotive

The increasing prevalence of electric drivetrain vehicles allows for a seamless use case of UHE fluids. With UHE's exceptional lubrication qualities, wear within the drivetrain is minimal which prolongs the life of the drivetrain; reduces maintenance time and costs; reduces drivetrain loses and operating temperature; and, increases efficiency to provide for longer distances between charging cycles.

Oven Chains



Due to the high thermal stability of UHEs, they offer the unique application of serving as lubricants in oven chain settings. This increased stability means that there is the evaporative loss is reduced, leading to lower costs replacing the lubricants.

Aerospace

The average commercial jet engine undergoes a servicing every 3,000-5,000 hours that is incredibly expensive, and the ability to delay them or even reduce the amount of time spent replacing lubricants can save hundreds of thousands of dollars a year. UHEs represent the perfect solution to this, with its wide range of operating temperatures allowing it to effectively handle all of the scenarios that can arise during a flight.

Applications	UHE 22 (Low Vis)	UHE 600 (High Vis)
Gear & Transmission Lubricants	X	X
Hydraulic Fluids	X	—
Compressor Fluids	X	X
Greases (Lithium, Aluminum, Copper Sulfate)	X	X
Food Grade	X	X
As Additives	—	X
Chain Lubricants	X	X
Wind Turbines	X	X