American Chemical Technologies, Inc.

EcoSafe® TF-25

Premium Non-Varnishing Lubricant for Heavy Duty Gas Turbines

Formulated to Reduce or Eliminate Varnish Formation, Valve Sticking, and Resulting Shutdowns and Factored Starts

ucon™ Fluids and Lubricants

Based on synthetic lubricant technology from the UCON™ Fluids & Lubricants business of The Dow Chemical Company

EcoSafe® TF-25

A Premium Lubricant Formulated to Protect Today's Gas Turbines

Varnish build-up in today's smaller, more powerful gas turbines is the root cause behind many turbine shutdowns and resulting lost power generation capacity. A small amount of varnish can cause servo valves to stick and the unit to automatically "trip" or shut down – an event that can cost more than $40,000 for a partial load trip. The cost of a full load turbine trip event can be as high as $150,000 or more!

EcoSafe® TF-25 Turbine Fluid can reduce the potential for varnish formation in gas turbines used in either base load service or high-stress peaking operation. Reduced varnish formation can improve starting reliability, help ensure reliable long-term turbine service, and extend equipment operating life with less maintenance and repair expense.

EcoSafe® TF-25 Turbine Fluid is based on a very high viscosity index (VI), polyalkylene glycol (PAG) base fluid with a high performance additive package. The oil is oxidatively stable and will not degrade to form varnish or sludge, contributing to long-term cleanliness.

Initial field trials in several power generation facilities indicate that EcoSafe® TF-25 can also reduce the potential for microdieseling, electrostatic build-up and other conditions that can contribute to varnish formation, oil breakdown, and resulting wear.

EcoSafe® TF-25 is based on PAG synthetic lubricant technology developed by the UCON™ Fluids & Lubricants business of The Dow Chemical Company.

Performance Advantages

Non-Sludge or Varnish Forming – EcoSafe® TF-25 Turbine Fluid is oxidatively stable and will not degrade to form varnish or sludge. Oxidation by-products are soluble in the base oil and will not fall out of solution to cause varnishing or sludge. The stability of EcoSafe® TF-25 contributes to long-term servo valve cleanliness, reducing the likelihood of sticking and improving starting reliability. Fewer trips due to varnish mean generating revenue is protected and purchases of replacement power are reduced. Unplanned maintenance costs due to forced outages are avoided and intervals between costly scheduled maintenance events are not shortened by increases in the frequency of factored starts.

Less Potential for Microdieseling – Microdieseling occurs when small air bubbles entrained in turbine oil are compressed, explode and burn the oil. The lower foaming tendency of EcoSafe® TF-25 Turbine Fluid suggests minimal air is entrained in the fluid, reducing the potential for small air bubbles to become compressed and explode. This reduces equipment wear and can also reduce a potential source of particle contamination.

Reduced Static Discharge – Low thermal conductivity and resulting hot spots, dielectric breakdown, and the presence of wear metals in the oil are believed to be important contributors to static discharge. With higher thermal conductivity than an ISO 32 Group II mineral oil, EcoSafe® TF-25 can provide better heat transfer, reducing the potential for static discharge produced by hot spots. The dielectric constant of EcoSafe® TF-25 is approximately 5.7 compared to about 1.2 for the mineral oil, which suggests that the insulating capabilities of EcoSafe® TF-25 are more likely to remain intact. The fluid exhibits excellent wear performance, minimizing metal content in the oil.

Hydrolytic Stability – EcoSafe® TF-25 Turbine Fluid will not break down and react with water, minimizing fluid degradation and acid formation that can damage equipment.

High Temperature Stability – EcoSafe® TF-25 Turbine Fluid is very stable at high temperatures and resistant to thermal degradation at temperatures up to 120°C (250°F), resulting in longer oil life and increased reliability.

Reduced Friction – The higher viscosity index of EcoSafe® TF-25 allows use of a lower viscosity grade to achieve the same absolute viscosity as an ISO 32 Group II mineral oil at typical operating temperatures. Using a lower viscosity grade reduces friction and increases overall system efficiency while reducing thermal demand on bearings.

All-Weather Service – With a higher viscosity index than conventional turbine oils, EcoSafe® TF-25 Turbine Fluid retains excellent viscosity characteristics over a wider temperature range than petroleum-based turbine oils. The lubricant has a low pour point for cold weather start-up of peaking units and offline base load units.

Material/Gas Seal Compatibility – EcoSafe® TF-25 Turbine Fluid is compatible with commonly used seals, hoses and metals. The oil is also compatible with common gas turbine seals. Detailed compatibility data is available upon request.

Detergency – EcoSafe® TF-25 is a natural detergent, so systems remain clean – free of staining or sticky residue.

Biodegradable/Low Toxicity – EcoSafe® TF-25 Turbine Fluid is classified as "inherently biodegradable" and environmental impact is low if the product is spilled. EcoSafe® TF-25 also satisfies stringent criteria for toxicity.

Turbine Fluid

Varnish build-up in gas turbines can cause servo valves to stick and turbine units to shut down.

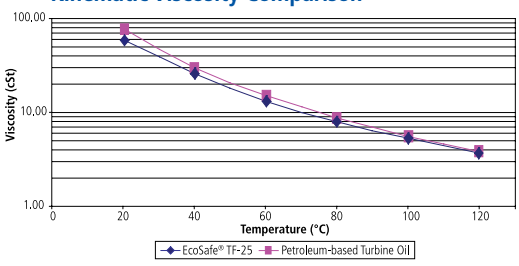
Superior Oxidative Stability
Results of controlled tests show the superior stability of PAG-based fluids such as EcoSafe® TF-25 Turbine Fluid compared to PAOs (synthetic hydrocarbons). After 2,500 hours at 120°C, the PAO produced significant deposits. In contrast, the vial containing the PAG-based fluid was virtually free of deposits.

Typical Performance Properties*	EcoSafe® TF-25	Petroleum-based Turbine Oil
Four Ball Wear, (ASTM D4172), 40 Kg, 1200 RPM, 75°C (167°F), 1 hr., Average wear scar dia., mm	0.63	0.65
Copper Strip (ASTM D130), 3 hrs @ 100°C (212°F)	1A	1A
Hydrolytic Stability (ASTM D2619)		
Weight Change of Copper Panel, mg / cm^2	-0.042	-0.017
Appearance of Copper Panel	Shiny, 1B	Shiny, 1B
% Change in Viscosity	-0.94	+0.77
Change in Acid Number, mg KOH / g	+0.66	-0.02
Total Acidity of Water Layer, mg KOH	3.91	1.07
% Insolubles	0.007	0.001
Thermal Stability (ASTM D2070)		
Copper Rod Weight Change, mg	+0.1	-0.2
Copper Rod Visual	Shiny, #2	Dull, #5
Steel Rod Weight Change, mg	-1.9	0.0
Steel Rod Visual	Shiny, #2	Shiny, #2
Steel Rod Total Sludge, mg / mL	7.3 / 100	8.7 / 100
% Kinematic Viscosity Change	+2.06	+2.60
% Neutralization Number Change	+0.07	+0.13
Foam Tendency (ASTM D892), ml		
5 Minute Blowing		
Seq. I	10	100
Seq. II	0	10
Seq. III	0	50
10 Minute Settling		
Seq. I	0	0
Seq. II	0	0
Seq. III	0	0
Air Release (ASTM D3427) Minutes @ 50°C (122°F)	0.4	4.7
Rust Prevention (ASTM D665) Distilled Water	Pass	Pass
RPVOT, min (ASTM D2272)	420	900

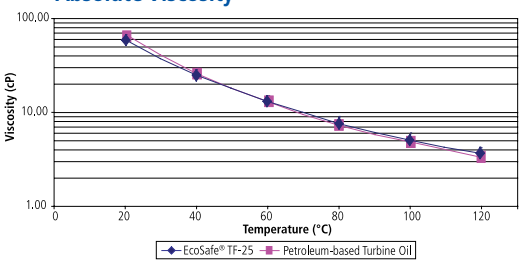
Typical Physical Properties*	EcoSafe® TF-25	Petroleum-based Turbine Oil
ISO Viscosity Grade	25	32
Viscosity @ 40°C cSt (104°F cP)	26.23 (25.84)	32.44 (27.90
Viscosity @ 100°C cSt (212°F cP)	5.19 (5.11)	5.56 (4.78)
Viscosity Index	132	109
Specific Gravity (relative density)	0.985	.86
Pour Point, °C (°F)	-48 (-55)	-30 (-22)
Flash Point, °C (°F)	242 (468)	215 (420)
Specific Heat @ 40°C (104°F), joules / g°K (ASTM E1269)	2.017	2.064
Thermal Conductivity @ 40°C (104°F), watts / m°K (PLTL-73)	0.145	0.1

*Typical properties, not to be construed as specifications.

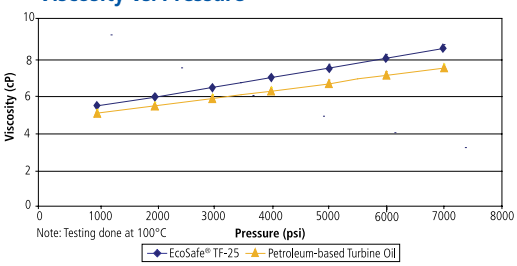
Kinematic Viscosity Comparison



Absolute Viscosity



Viscosity vs. Pressure



EcoSafe® TF-25 Turbine Fluid

Why Varnish Formation is at the Forefront of Gas Turbine Lubrication Issues

A sticking servo valve can cause a gas power generation turbine unit to "trip" or shut down in an instant, taking important power generation capacity off line. Each such forced outage can be an expensive event:

- Lost generating capacity deprives the operator of revenue. While fuel is saved while the unit is down, the difference between operating cost and anticipated revenue, or "spark spread" becomes a net loss.
- To meet customer demand while the unit is down, the operator may be forced to purchase replacement power from others, a significant additional expense.
- Forced outages can mean unplanned maintenance expense for varnish removal.
- An increase in the frequency of factored starts resulting from trip events can decrease the intervals between costly scheduled outages for routine maintenance, called for under OEM guidelines.

Why has varnish formation become such a large issue in the operation of gas turbines? Three factors are often cited:

First, today's gas turbines are smaller, yet capable of producing more power than their predecessors. The smaller equipment works harder, placing greater stress on both the unit itself and the lubricating oil that protects it. If the turbine oil is not oxidatively or thermally stable enough, varnish can form on critical surfaces, leading to shutdowns, and the potential for equipment damage and costly repairs.

The trend toward use of turbines for peaking – versus base load – service places further demands on equipment and oil, increasing stress. Unlike base load units that run continuously, "peaker" turbines operate only during spikes in power demand and remain idle between service periods. Not only is start-and-stop peaker service more stressful on the turbine, but during downtime the turbine oil cools, which can permit oxidation byproducts to fall out of solution and form varnish that can directly impact starting reliability.

Finally, the movement of mineral oil formulations from Group I fluids to higher purity Group II formulations has reduced the solvency of these turbine oils, which increases the potential for varnish formation during operation.

To Learn More Call: 1-800-938-0101
Outside of the U.S. and Canada, please call 1-517-223-0300 (USA)

Europe
Schulze & Partner, PGmbH
Mr. Rudolf M.H. Schulze
Aachener Strabe 79
B-4700 Eupen, Belgium

Phone: +32-87-56 90 20
Fax: +32-87-56 90 17
Mobile: +49-1717778089
E-mail: schulze.partner@skynet.be
Web: www.schulzepartner.com

China
CMC Cometals China
Wei Dong
Floor B-11, Renji Plaza
101 Jingshun Road
Beijing 100102

Phone: +86-10-59540166
Fax: +86-10-59540101
Mobile: +86-13801080752
E-mail: wd@cmc.com

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- EcoSafe® TF-25 Turbine Fluid
- EcoSafe® FR Fire Resistant Hydraulic Fluids
- EcoSafe® EHC Hydraulic Fluids for the Power Generation Industry
- EcoSafe® NCLR Hydraulic Fluids for Nuclear Power Stations
- UCON™ TRIDENT™ AW Anhydrous Hydraulic Fluids
- Neptune® Gear Oils
- EcoGear® Gear Oils

American Chemical Technologies, Inc.

American Chemical Technologies
485 E. Van Riper Road
Fowlerville, MI 48836
Phone: 517-223-0300
Fax: 517-223-1703
www.americanchemtech.com