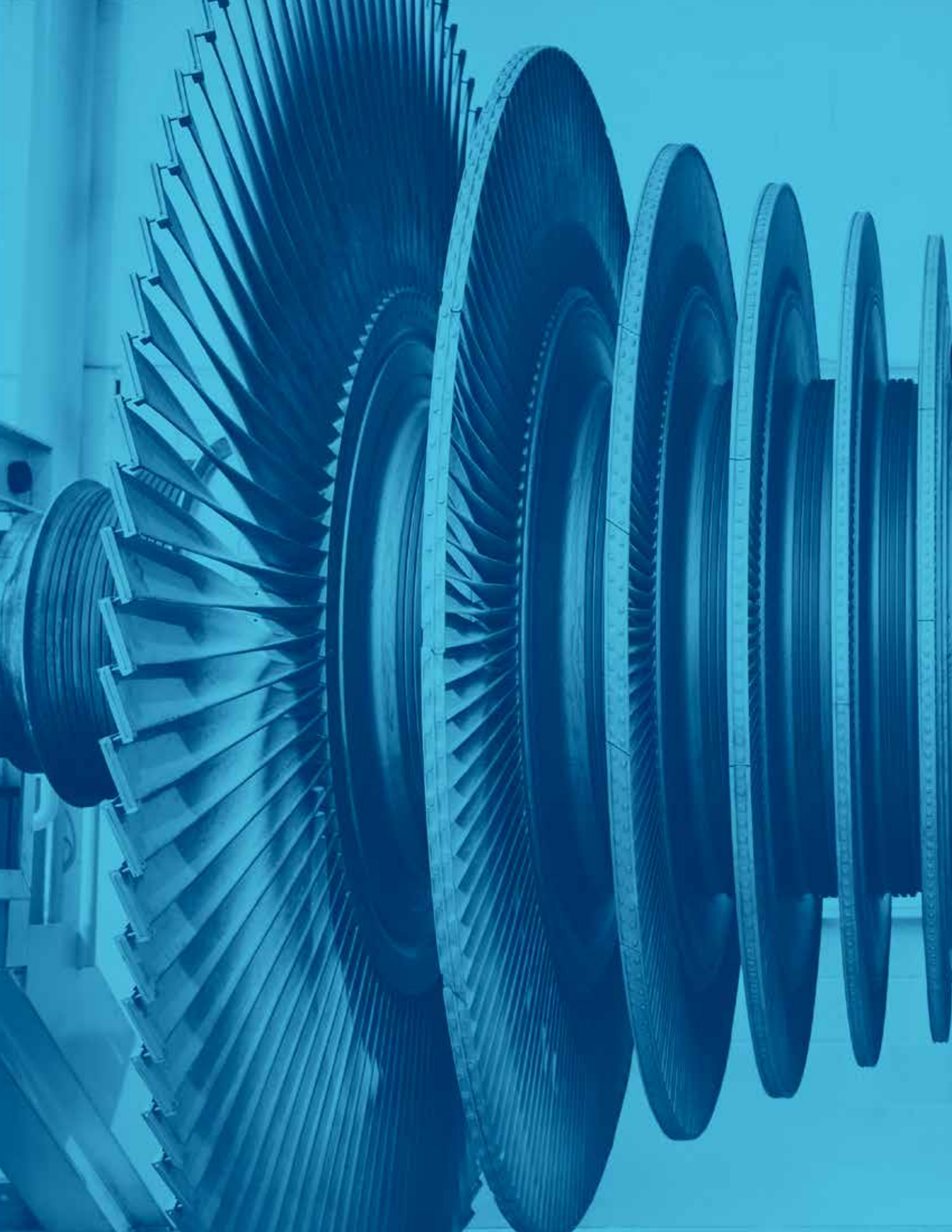




DEFEAT DESTRUCTIVE VARNISH TO OPTIMIZE TURBINE PERFORMANCE

INDUSTRIAL
LUBRICANTS
Run Better Longer

The VARTECH™ Solution



Turbines are at the heart of your operation. If they're attacked by varnish, your production could halt.

Industrial operators have long been aware of the tremendous damage that varnish can do to their operations. Many of them know that varnish can lead to a range of equipment problems, from poor performance to catastrophic failures. They typically consider varnish, and the difficulties that come with it, as inevitable to doing business – something that's beyond their control.

You do not have to accept this.

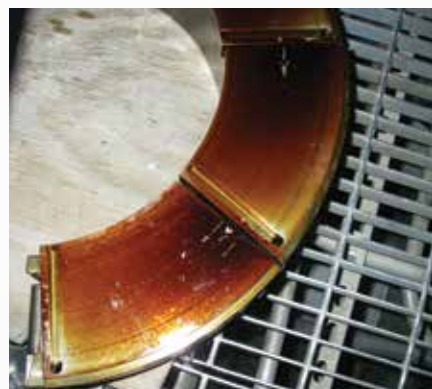
To defeat varnish, you first must understand it

The Culprit

Varnish is a coating that adheres to internal surfaces, wears out equipment components, restricts performance and can ultimately cause failures. It is composed primarily of organic residue mixed with metals, inorganic salts and other contaminants. Varnish can take different forms, from a sticky coating to a hard lacquer, and ranges in color from gray to brown to amber. Varnish is very destructive and hard to remove.

The Causes

Varnish is formed when high operating temperatures deplete protective additives, causing the lubricant to oxidize and break down. Water, chemicals, particles, gasses and other contaminants also act to degrade the oil. Elements of this degradation, known as varnish precursors, precipitate out of the oil and attach themselves to internal surfaces. The tacky nature of these deposits attracts more and more precursors, and varnish builds up layer by layer.



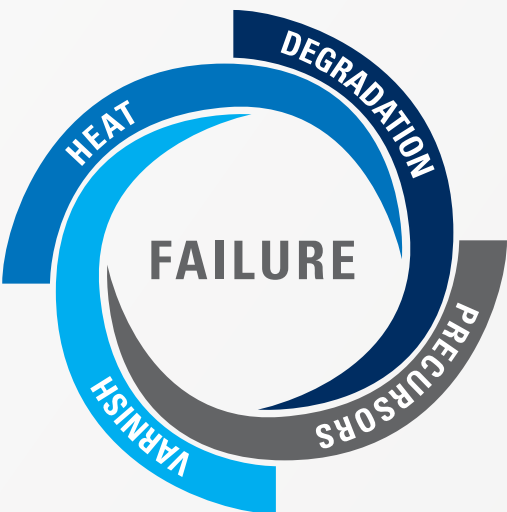
THRUST BEARING TILT PAD



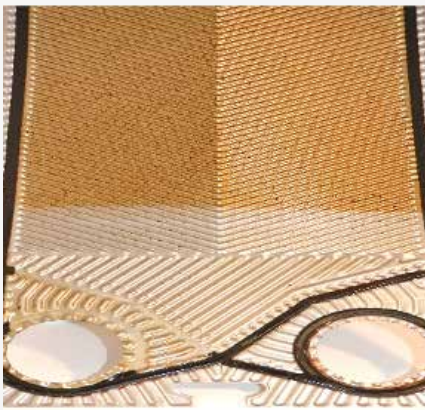
RESERVOIR HATCH COVER

The Cycle of Failure

As varnish worsens, a vicious cycle is often set in motion. The coating insulates metal surfaces which prevents efficient oil cooling which raises the temperature. This causes more more degradation and less effective lubrication. More precursors are created, more varnish layers are formed, and the problem spirals toward equipment failure.



RESERVOIR FLOOR



HEAT EXCHANGER
COOLING PLATE

The Consequences

Even the smallest amount of varnish can result in poor system performance and equipment failures. Valves stick, bearings overheat, components wear out, oil inlets and filters clog, and the internal mechanics of your turbine begin to malfunction. These issues tend to worsen over time as more varnish builds up, leading to shortened oil life, poor equipment performance and premature shutdowns.



**Varnish attacks turbines
from the inside, destroys
performance and threatens
operations**

It's time to fight back

The experts at Caltex Lubricants have developed a two-step, clean-and-control solution to help you protect equipment from varnish and ensure peak productivity in your operation:

The VARTECH™ Solution

STEP 1: CLEAN

VARTECH™ Industrial System Cleaner



Eradicate varnish that has infiltrated your turbine system

VARTECH™ Industrial System Cleaner (ISC) utilizes proprietary technology to do the most thorough and efficient cleaning job without creating operational constraints.

Its triple-action technology:



CUTS
It cuts through the hard varnish layers and removes them as micro-sized particles.



CAPTURES
It captures and stabilizes these varnish particles in a protective barrier so they can be removed from your system without redepositing in other parts of the equipment.



COMPATIBLE
It is compatible with the in-service oil for optimum operational flexibility while maintaining performance during the cleaning cycle that prepares the system for change out to fresh oil.

VARTECH™ ISC helps prepare your equipment for fresh oil. A Caltex lubrication specialist can work with you to recommend an optimized cleaning cycle time to effectively remove sludge and stubborn, baked-on varnish from your system. However, if unexpected delays are encountered, you can feel confident knowing that the cleaner can temporarily remain in your system without damaging internal components.

Clean without compromise



BEFORE
CLEANING



AFTER CLEANING
WITH VARTECH™ ISC



AFTER CLEANING
WITH COMPETITIVE CLEANERS

VARTECH™ ISC	COMPETITIVE CLEANERS
<ul style="list-style-type: none">• Turbines remain online and productive• Varnish micro-particles are gradually removed to avoid overwhelming filters• Compatible with internal equipment components, including seals• Demonstrated compatibility with most turbine and compressor oils• Minimally impacts performance of new oil• Compatibility with the in-service oil can allow longer residence time (if needed) for better removal of stubborn, baked-on varnish• Can temporarily remain in the system, causing no operational constraints• Efficient cleaning process saves time and money	<ul style="list-style-type: none">• Shutdown sometimes required• Large pieces of varnish can break loose and settle in other areas of the system• Harsh chemicals can damage seals and cause leaks• Has the potential to lower lubricant flash point causing higher fire and explosion risk• May accelerate oil degradation, shorten oil life and cause system corrosion• Short cleaning cycle doesn't effectively clean• Repeated filter plugging and shorter filter life• Shorter equipment life and higher maintenance costs

Maximize operational efficiency



The VARTECH™ Industrial System Cleaner (ISC) cleaning process is simple, streamlined and economic. Conventional system cleaners are more complex and require additional steps, external filtration and multiple rinses and compatibility tests.

Turbine operation temperatures kept below alarm levels

SPAR FLOATING PLATFORM, TAHITI FIELD, GULF OF MEXICO

Cleaning with VARTECH™ Industrial System Cleaner helped save \$80K+ in annual maintenance costs.*

STEEL PLATES FROM OIL COOLER



BEFORE CLEANING: Varnish film



AFTER CLEANING: Varnish film cleaned using VARTECH™ ISC

The Equipment

Two Solar Titan 130 gas turbines are configured in generator sets that deliver 15,000 kW of electricity to the platform. Power loss would halt production.

The Problem

Varnish in the oil coolers was causing the unit to run hot, triggering high-temperature alarms. The operator tried a conventional cleaner, which created operational challenges during the cleaning process and only temporarily lowered the temperatures. The operation had to resort to costly mitigation measures, sending the coolers onshore every 4 months to clean the varnish, costing the operation \$80,000+ per year.*

The Solution

VARTECH™ Industrial System Cleaner (ISC) was added to the in-service oil, and temperatures quickly dropped below alarm levels. There were no filter clogging problems, and the operator no longer had to live with the varnish problem.

*Actual savings can vary.





Turbine operation maintained at full design capacity

SAN JOAQUIN VALLEY BUSINESS UNIT, CALIFORNIA

Cleaning with VARTECH™ Industrial System Cleaner helped achieve \$350K in annual revenue gain.*

The Equipment

Solar Taurus 60 gas turbine is used in a steam/ electricity co-generation configuration. The steam facilitates oil recovery and the electricity is sold to a power utility.

The Problem

Varnish in the turbine oil coolers was causing the unit to run too hot to operate at full design capacity, and the operation was losing \$350,000 annually from lost electricity sales.

The Solution

VARTECH™ Industrial System Cleaner (ISC) was added to the in-service oil, cleaning the varnish from the oil coolers. Operating temperatures quickly dropped and the turbine returned to full design capacity, recapturing the lost \$350,000.*

SJV WAS ABLE TO OPERATE THE GAS TURBINE AT FULL CAPACITY WITH NO TEMPERATURE ALARMS

	BEFORE VARTECH™ ISC	AFTER VARTECH ISC	IMPACT
Header temp.	159	154	-5°F / -3°C
Bearing temp.	206	194	-12°F / -7°C
Unit output (MW)	3.3	5.5	+2.2

*Results may vary depending on equipment type, operating conditions and utility costs.

STEP 2: CONTROL

Lubricants Formulated with VARTECH™ Technology

Prevent the formation of new varnish

After existing varnish has been cleaned from your system, it is important to refill your equipment with a lubricant that helps prevent the formation of new varnish. Caltex has developed advanced lubrication chemistry which inhibits the precursors that can form in your oil stream, deposit on internal surfaces and eventually become varnish.

Caltex lubrication experts have formulated select GST® Advantage turbine oils with VARTECH™ Technology. The advanced lubrication chemistry used in VARTECH™ Technology inhibits the formation of varnish precursors, products of oil degradation that can deposit on internal surfaces and build up over time. You get exceptional oxidation stability, less degradation and long oil life – a breakthrough approach to varnish control



The VARTECH Solution for varnish control leads to full-on protection for your equipment, so you can achieve peak performance, reliability and productivity.



Detect varnish, then defeat it

The best way to prevent varnish from attacking your equipment is to detect it early and take decisive action. Fluid monitoring and oil analysis are excellent methods for tracking the health of your lubricating system, but while they can detect varnish precursors in your oil stream, they can't detect varnish that has already formed. Look for changes in oil color, spiking temperatures or visible varnish deposits during routine maintenance.

You can also run a number of tests to monitor the health of your lubricating system. Ruler-voltammetry testing can measure oxidation trends in your oil. Membrane patch colorimetry (MPC), RPVOT and particle count testing can help you measure oil degradation and determine lubricant condemning limits.

Run Better Longer

Caltex Lubricants has developed advanced expertise, premium lubricants and targeted programs for a broad array of industries, to help our customers' equipment and operations Run Better Longer. Find out more at chevronlubricants.com

Contact the experts at Caltex industrial lubricants to help you tackle precisely the right lubrication program to protect equipment performance.

GST Advantage RO with VARTECH Technology

GST Advantage RO are premium performance turbine oils meeting critical demands of non-g geared gas, steam and hydroelectric turbine bearing lubrication requirements. Formulated with Chevron’s premium Group II base oils and proprietary ashless additive package with Vartech Technology, helps improve oxidation stability, reduce oil degradation and extend oil life by limiting harmful varnish precursors that can lead to varnish formation.

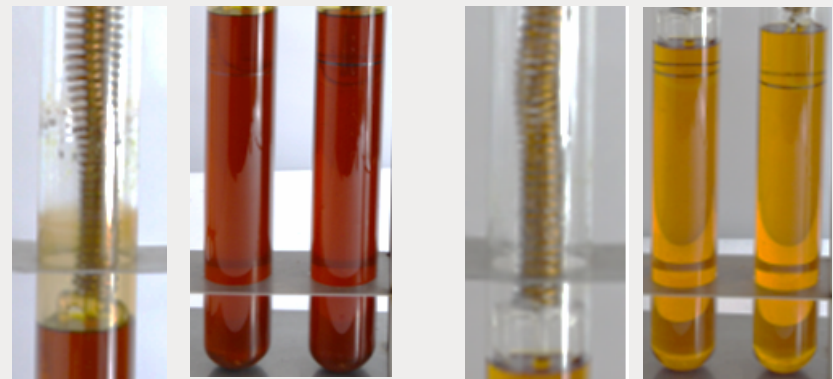
GST Advantage RO is additionally suitable for severe service industrial applications that require a rust and oxidation inhibited (R&O) circulating oil with extended service capability.

Performance Attributes

- Exceptional oxidation and thermal stability
- Low varnish potential
- Minimal deposit formation
- Rapid water separation



DRY TOST (ASTM D7873) 500 HOURS @ 120°C (248°F)



Conventional Turbine Oil

GST Advantage™ RO with
VARTECH™ Technology

GST Advantage™ RO with VARTECH™ Technology turbine oil has a clearer and lighter appearance relative to the conventional oil after 500 hours of aging at a high temperature. The color indicates the turbine oil has the ability to withstand the effects of oxidation and sludge formation.

Conducted at Chevron Richmond Technical Center

Major Turbine Manufacturer Specifications for Approval

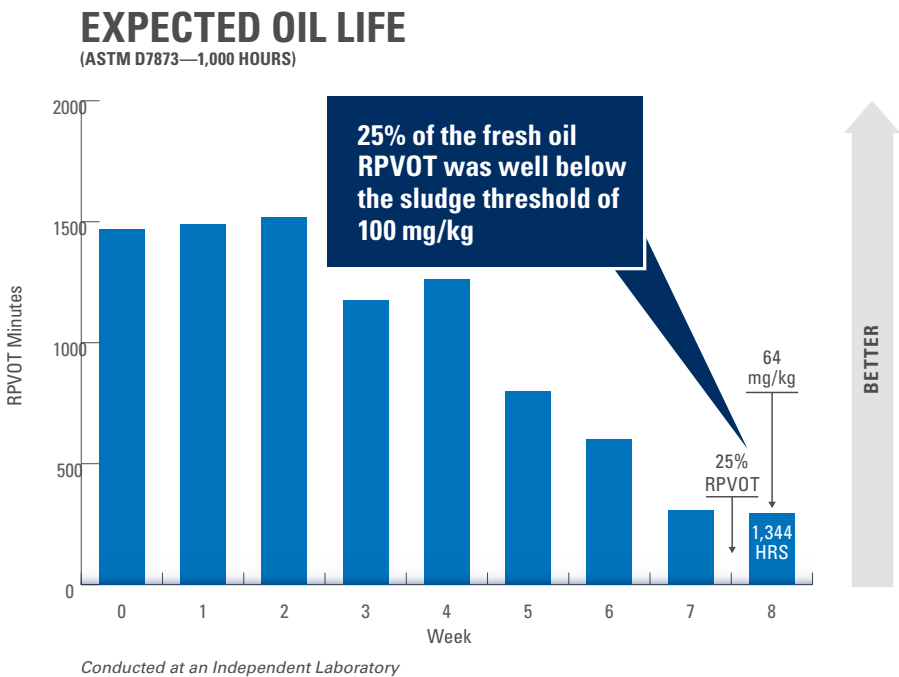
A major turbine OEM has developed some of the most stringent turbine oil specifications in the industry. At the core of the specification is an internally developed oxidation test which has demonstrated a strong correlation between a turbine oil’s ability to meet the specification requirements to low varnish potential in the field. This test has been adapted as an industry standard within ASTM. It is called the ASTM D7873 Standard Test Method for Determination of Oxidation Stability and Insolubles Formation of Inhibited Turbine Oils at 120°C Without the Inclusion of Water (Dry TOST Method).

The Dry TOST test is viewed by most subject matter experts in the industry to be one of the best indicators of sludge and varnish forming tendencies of a turbine oil.

The key properties used to measure the performance of the turbine oil are remaining oxidation life based on RPVOT and the amount of sludge per kg of oil.

Dry TOST test for GST Advantage™ RO with VARTECH™ Technology showed the turbine oil’s ability to extend to 1,344 hours before reaching the end of the test: 25% of the fresh oil RPVOT was well below the sludge threshold of 100 mg/kg.

The test requires reaching 500 hours while staying below 100 mg/kg and >25% RPVOT. The graph below shows that GST Advantage RO performance far exceeds the 500-hour limit reaching >1,000 hours before the RPVOT drops below 25 percent and the sludge values are below the limit, even at reduced oxidation life.



GST Advantage EP with VARTECH Technology

GST Advantage EP turbine oils have exceptional thermal and oxidative stability. They are suitable for use in geared and non-geared gas and steam turbines where extreme temperatures are experienced and require circulation systems with exceptional high temperature stability.

GST Advantage EP turbine oil combines Chevron’s premium Group II base oils and unique additive package minimizing the formation of deposits in reservoirs, high temperature bearings and other hot areas of the turbine.

Meeting the most challenging test requirements of major turbine manufacturers like Siemens, GE, Solar, Ansaldo Energia, etc GST Advantage EP provides exceptional oxidation and thermal Stability for long service life at severe temperatures with minimal deposit formation.

Performance Attributes

- Balanced formulation provides high deposit control without sacrificing EP properties
- Exceptional oxidation and thermal stability
- Low varnish potential
- Minimal deposit formation

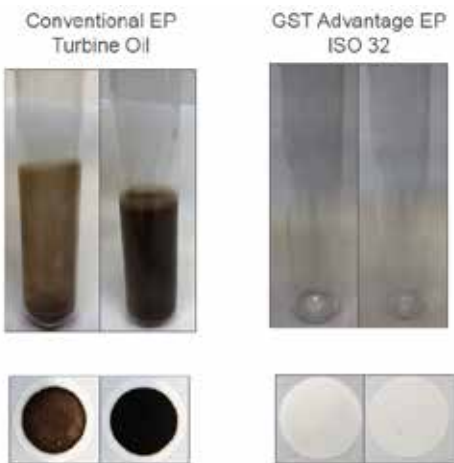


Exceptional High Temperature Thermal Stability

Fluids for use in turbomachinery and compressors supporting a variety of industrial applications need to handle high temperature operating zones. Key OEMs in these applications develop various high temperature testing methods to replicate operating conditions and one of those tests is a High Temperature Fluid Aging Test.

The turbine oils are subject to a set of temperatures at fixed durations to determine their thermal stability and tendency to oxidize and form deposits. Conventional R&O fluids with EP properties are at a higher risk of forming these deposits at even lower temperatures due to lower thermal stability of most EP additives used in the industry

GST Advantage EP with VARTECH Technology provides long oil life and varnish and deposit control. The product formulated with VARTECH Technology shows dramatic improvement over the Conventional EP Turbine Oil. EP performance was not sacrificed with high deposit control but is due to the balanced formulation using VARTECH Technology. A strong level of EP and varnish and deposit control is maintained with this formulation.



High Temperature Aging Test: 150°C, 1-week and 3-week aging

Case Study

BAKERSFIELD, CALIFORNIA

Chevron Lubricants Field Trial at the Chevron Sycamore Cogeneration Plant



GST Advantage™ RO was developed in 2011 to meet customers’ needs for an effective product to help manage sludge and varnish build-up in their gas and steam turbines. It is currently in-service without operational issues in a GE 7EA gas turbine that operates approximately 8,000 hours annually at the Chevron Sycamore Cogeneration Plant in Bakersfield, California. In the spring of 2018, a Rotating Pressure Vessel Oxidation Test (RPVOT) was conducted on the oil after six years of continuous service to help in determining the remaining life of the lubricant’s oxidation inhibitor. It was determined that the oil could remain in service until the next planned major shutdown.

GST Advantage with VARTECH Technology				
Product	ISO Viscosity Grade	Application	Benefits	Claims & Approvals
GST Advantage RO with VARTECH Technology	32, 46	Non geared industrial steam, gas and combined cycle turbines including rotating machinery and turbo-compressors	Exceptional oxidation and thermal stability for long service life at severe temperatures with minimal deposit formation	Siemens TLV 901304 and TLV 901305 MAN Energy Solutions 10000494596 rev 2 GE Specification HTGD 90 117 Alsthom G-HTCT689029 Ansaldo Energia TG02-0171-E00000 Mitsubishi Hitachi Power Systems MS04-MA-CL002 / MS04-MA-CL001 General Electric GEK 32568k, GEK 28143b, GEK 46506e, GEK 27070, GEK 107395 including GE Frame 9HA.01 Gas turbines , GEK 121608 Solar Turbine ES9-224 Class II ANSI/ AGMA 9005-E02-R&O ASTM D4304-Type I / Type III British Standard BS 489:1999 DIN 51515-1 and 51515-2 ISO 8068-L-TSA and L-TGA Chinese Specification GB1120-2011 L-TGA and L-TSA (Type A and Type B)
GST Advantage EP with VARTECH Technology	32, 46, 68, 100	Geared industrial steam, gas and combined cycle turbines including rotating machinery and turbo-compressors	Low varnish potential ensures varnish formulation is minimized to protect the equipment	Ansaldo EnergiaTG02-0171-E00000/C, AE64.3A GEC Alstom NBA P50001 A, NBA P50003 A General Electric GEK 107395 including GE Frame 9HA.01 Gas turbines , GEK 27070, GEK 28143b, GEK 32568e/ f/ h/ i/ j, GEK 32568k, GEK 46506d MAN Energy Solutions 10000494596 Siemens MAT 812101 812102; MAT 812106 812108; MAT 812109 Siemens TLV 9013 04 and TLV 9013 05 Siemens -Westinghouse M SPEC 55125Z3 Solar Turbine ES9-224 Class II Toshiba LST-GMH-XUTW2-0005 ANSI/ AGMA 9005-E02-R&O ASTM D4304-Type I / Type II British Standard BS 489:1999 Chinese Specification GB1120-2011 L-TSA, L-TSE; L-TGA, L-TGE DIN 51515-1 and 51515-2 ISO 8068-L-TSA, L-TSE, L-TGA, L-TGE JIS K-2213 Type II

*Always refer the product data sheet for the most updated approvals and claims



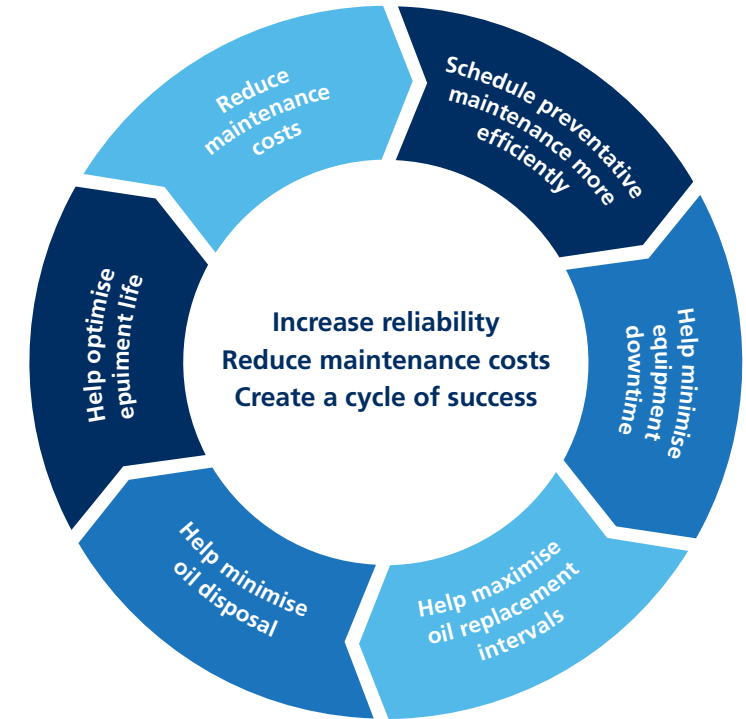
LubeWatch[®] Oil Analysis Program

LubeWatch used oil analysis

LubeWatch oil analysis enables you to track the performance of equipment that is the lifeblood of your business. By analyzing oil samples on a regular basis, you can help optimize equipment life and oil replacement intervals, identify lubricant-related needs and understand the changing environment within a piece of equipment. This knowledge helps in the precise scheduling of maintenance work that can reduce downtime or even eliminate the risk of catastrophic failure.

The LubeWatch oil analysis programme provides:

- > Accurate results on five basic test packages and aa wide variety of specialized testing procedures
- > Reliable interpretation of test results and actionable recommendations based on the data
- > 48-hour turnaround of tests and analyses indicating abnormal or critical steps, provided by email or accessible online
- > Advanced technical services including component failure and/or wear particle analysis
- > Expert training and in-field advice and support
- > Added assurance of oil and system integrity when running on an extended oil drain interval programme.



For more information visit:
me.caltexlubricants.com/lubewatch

Learn more at
me.caltexlubricants.com



Always follow OEM recommendations.

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