

Shell Aviation



AEROSHELL OILS FOR TURBINE ENGINE AIRCRAFT



AEROSHELL TURBINE ENGINE OILS

Shell has been supporting aviation's pioneers for over a century and has been involved in jet-powered flight since helping Sir Frank Whittle to develop the first jet engine. We continue to provide high-quality fuels, lubricants and associated services to the aviation community. We remain committed to working with turbine engine manufacturers and airlines to create innovative high-performance oils for increasingly demanding engines.



UNDERSTANDING YOUR NEEDS

Reduced operating costs

Are your operating costs unnecessarily high? Poorly performing turbine engine oils (TEO) can lead to high oil consumption associated with elastomeric seal degradation and reduced engine efficiency.

AeroShell TEOs are designed to cut your operating costs by helping to reduce oil consumption and maintenance costs, and to enhance engine efficiency.

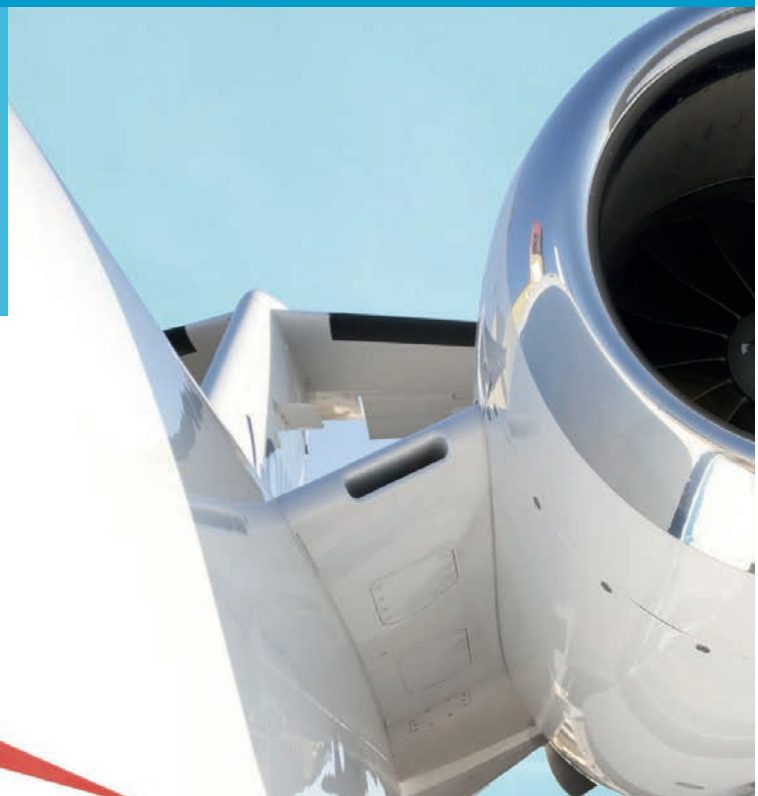
Lower maintenance burden

Do you spend too much time and money on maintenance? Oils that form coke at high temperatures or cause seal-incompatibility issues can lead to an excessive maintenance burden. For example, some oils require a full change of gearbox seals during engine maintenance.

Using low-coking, elastomer-friendly oils such as AeroShell Ascender can result in cleaner engines for easier boroscope inspections and problem identification, and lower maintenance costs.

"IN 2012, WE CONVERTED OUR ENTIRE FLEET TO ASTO 500. IT HAS BEEN A GOOD DECISION FROM THE TECHNICAL, LOGISTICS AND COST-SAVING PERSPECTIVES."

Fermin Tirado Gallego, Director, Technical Area
(Maintenance and Engineering), Air Nostrum, Spain



WIDE DISTRIBUTION NETWORK

Do you have the right lubricants where and when you need them? Do you have local support in aircraft-on-ground situations? Are your logistics and inventory costs too high?

Shell Aviation has a global distributor network to match your operational footprint.

CAN YOUR OIL COPE WITH EXTREME CONDITIONS?

To improve thermodynamic efficiency, turbine temperatures continue to increase; today's engines operate at significantly higher temperatures than those designed in the 1960s. Increasing propulsion efficiency has been achieved by using bigger fans with larger shaft loads, so oils also need greater load-carrying capacities. A desire to reduce the oil system size means that a smaller oil volume needs to work harder and have a higher heat capacity to remove heat from the bearings. Modern engines are also more reliable and operators are striving to extend the time on wing and reduce the need for oil top-up, so the oil must protect the engine for longer.

All of these trends in engine design put increasingly severe demands on TEOs.

To meet the needs of current and next-generation engine technologies, we have developed a range of AeroShell Turbine Oils (ASTO), including

- **AeroShell Ascender** fourth-generation, high-performance-capability (HPC) oil for the latest engines
- **ASTO 560** third-generation, high-thermal-stability (HTS) oil for modern engines
- **ASTO 555** high load-carrying capacity oil for helicopter turbine engines and transmissions
- **ASTO 500** second-generation, standard class (STD) oil for legacy engines
- **ASTO 390** for auxiliary power units
- **ASTO 750** for older turbo prop applications.



"THE COMPLETE CONVERSION OF SAUDI ARABIAN AIRLINES TO ASTO 560 AND ASTO 500 HAS BEEN VERY SATISFACTORY AND WITHOUT ANY OIL-RELATED ISSUES. WE ARE DELIGHTED WITH THE LEVEL OF SERVICE AND TECHNICAL SUPPORT FROM SHELL AVIATION AND ITS DISTRIBUTOR SOOM OIL."

Ghassan Al-sadeg, Director, Aircraft Engineering, Saudia Aerospace Engineering Industries, Saudi Arabia

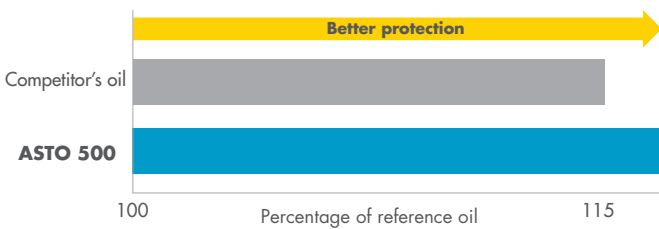
CUTTING COSTS BY EXTENDING COMPONENT LIFE

If an oil film fails, it cannot maintain the boundary lubrication that holds the bearings and gears apart. The consequent metal-to-metal contact can result in damaging wear. This can lead to excessive part replacement costs.

AeroShell TEOs are designed to give you high load-carrying capacities for extended bearing life under conditions of marginal lubrication, which can help to reduce maintenance costs.

For example, in Ryder gear tests,¹ ASTO 500 has a better load-carrying capacity than its main competitor in the same oil class.

¹Ryder gear tests measure the load required to produce a wear scar of a certain diameter compared with the load required to create the same wear scar diameter when using a reference oil.



LONGER COMPONENT LIFE. ASTO 500 has a better load-carrying capacity than competitors' oils in the same class, which can help to extend bearing life.

Many helicopter manufacturers have turned to the high load-carrying capacity of ASTO 555 to protect their engines and transmissions. This oil was developed for demanding jet engine applications, including those used to power Concorde, the world's first supersonic passenger aircraft. ASTO 555 meets the DOD-PRF-85734A helicopter turbine oil specification.

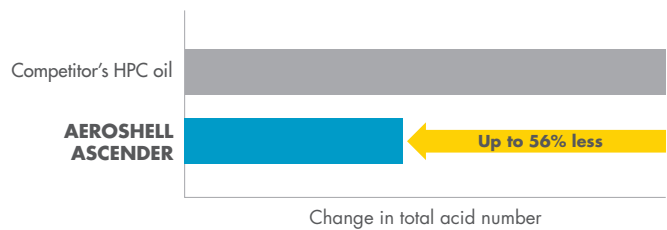
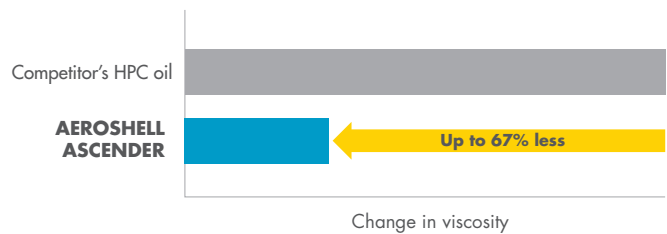
REDUCING THE NEED FOR UNSCHEDULED OIL DRAINS

If an oil breaks down prematurely through oxidation or thermal degradation, it may increase in viscosity and form acids and sludge. The degraded oil may need changing, as the acids produced can corrode gears and bearings.

AeroShell TEOs are designed to resist oxidation, so they stay in shape to perform as intended in your engines.

For example, AeroShell Ascender can go on performing in modern engines when other oils may fall out of specification. In tests comparing it with a competitor's HPC oil, it had **up to 67% less** change in viscosity² and **up to 56% less** change in acid number.²

²Def Stan 05-50 Part 61 Method 9, 25 hours at 220°C



STAYING IN SHAPE. In industry-standard oxidation tests, AeroShell Ascender had less viscosity change and acid formation than a competitor's HPC oil.



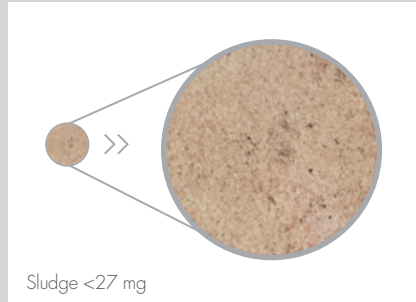


AEROSHELL ASCENDER



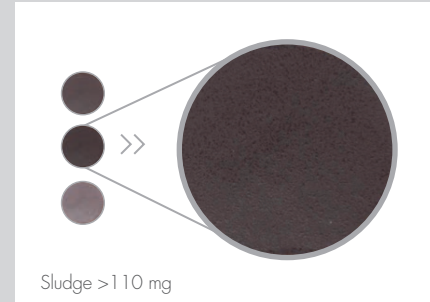
Sludge <2 mg

ASTO 560



Sludge <27 mg

COMPETITOR'S STD OIL



Sludge >110 mg

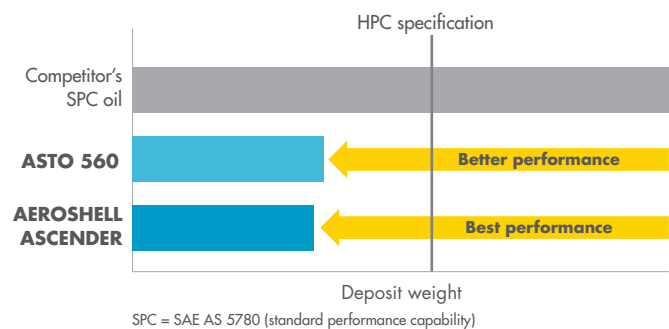
PROTECTING AGAINST SLUDGE. In industry-standard oxidation tests,¹ ASTO 560 formed far less potentially harmful sludge (<27 mg) after 72 hours of testing at 218°C than a competitor's STD-grade oil (>110 mg). The competitor's oil required three filters to capture the sludge. AeroShell Ascender takes sludge protection to the next level for cleaner, better-performing engines (<2 mg). ASTO 560 and AeroShell Ascender also produced less sludge in the vapour phase than the competitor's oil, which demonstrates their superior high-temperature stability.

¹FTM-791C Method 5308 (modified), 72 hours at 218°C

LOWER COSTS AND ENHANCED SAFETY

Oil at high temperatures can form coke, which may block oil filters and oil-feed, scavenge and vent pipes, thereby requiring possible filter replacements and causing bearing failures due to oil starvation and, ultimately, engine failure.

AeroShell TEOs are designed to resist high-temperature coke formation for lower maintenance costs and enhanced safety.



CLEAN, SAFE ENGINES. AeroShell Ascender produced far less coke in HPLS standard 20-hour tests compared with a competitor's STD-grade oil. Coking propensity is not specified by the MIL-PRF-23699G HTS standard. Nevertheless, ASTO 560 also falls well below the maximum coking limit of the tougher SAE AS 5780 HPC specification.

"THIS IS THE CLEANEST BOROSCOPE I HAVE SEEN FOR THIS AGE OF ENGINE."

Engineer commenting during an engine examination for Corendon Airlines that revealed negligible levels of coke in the oil scavenge tubes



LESS TIME SPENT CLEANING. With ASTO 560 (left), the No. 5 bearing housing in a CFM56-7 engine is much cleaner than the same component after a similar operating time with a competitor's oil. The engine had over 23,500 flight hours with ASTO 560 since its last overhaul and 52,200 flight hours total life.





THE COST OF COKING

The following theoretical example demonstrates the potential benefits switching to a HTS oil such as ASTO 560. If an operator of 20 Airbus A320 aircraft with V2500 engines uses a standard oil and has a history of No. 5 bearing problems, inspection and cleaning (at \$85/hour) would cost approximately \$40,000 per 6,000 hours.¹ If 20% of the engines need new parts, this could cost an additional \$32,000.

Switching to a low-coking oil could save the operator \$72,000 per 6,000 hours flight time.

¹Standard oils in V2500 engines can lead to coking around the No. 5 bearing. Service bulletin V2500-ENG-72-0461 requires about nine hours' inspection every 6,000 hours of operation. If cleaning is needed, an extra 12 work hours per engine is required. If the components cannot be cleaned, replacement costs are about \$4,000 per engine. Values are estimated and dependent on prevalent rates.

LOWER OIL CONSUMPTION

Elastomer seal degradation can cause leaks, which lead to high overhaul costs, carbon deposit levels and oil consumption. AeroShell TEOs are compatible with competitors' oils. They provide a similar amount of elastomer seal swell, which makes changing to AeroShell TEOs trouble-free. In tests, elastomer seals kept their integrity for longer with AeroShell Ascender compared with a competitor's HPC oil, which may help to lower oil consumption.

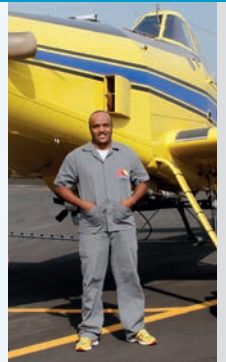
"SINCE USING ASTO 560, WE HAVE OBSERVED A DOWNWARD OIL CONSUMPTION TREND FOR SOME OF OUR ENGINES."

Oguzhan Horasanli, Deputy Engineering Manager, Powerplant Systems, Corendon Airlines



"ASTO 500 CAME IN THE ENGINE FROM THE FACTORY AND WE HAVE BEEN USING IT EVER SINCE. WE DRAIN THE ENGINE AND THE OIL IS CLEAN. WE HAVE NEVER HAD ANY OIL-RELATED PROBLEMS."

Estácio Palhares de Oliveira Junior, Aircraft Mechanic, Precisão Aero Agrícola, Brazil





“WE STARTED USING AEROSHELL ASCENDER IN 2010. THE CHANGEOVER WAS SMOOTH AND WE HAVE NOT EXPERIENCED LEAKAGE OR PERFORMANCE DEGRADATION FROM THE ENGINES.”

Paulo Meneghel, Power Plant Engineering Manager, TAM Airlines, Brazil

AEROSHELL ASCENDER

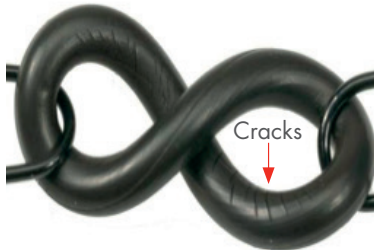


Fluorocarbon (Viton A) O-rings



Fluorocarbon (Viton GLC) O-rings

COMPETITOR'S HPC OIL



Fluorocarbon (Viton A) O-rings



Fluorocarbon (Viton GLC) O-rings

LOWER OIL CONSUMPTION. After eight days of embrittlement testing, elastomer seals are twisted into figures of eight and submerged at 200°C in a test oil. O-rings in AeroShell Ascender remained intact, whereas those manipulated and submerged in a competitor's oil cracked and failed. Seals that fail or swell too much or too little can lead to high oil consumption.

FOCUSED ON THE FUTURE

Just as engine manufacturers continuously strive for new performance levels, Shell too works relentlessly on creating tomorrow's TEO technology. Over the last decade, we have invested more than \$25 million in TEO research and development, and continue to invest over \$4 million every year. Scientists at our dedicated AeroShell research and development facility in Westhollow, Houston, USA, perform much of this work.

We also work closely with aircraft and engine manufacturers to evaluate our innovative technologies, including AeroShell Ascender.



BENEFITS AND SPECIFICATIONS

Product	Benefits	Specifications and approvals (Full approval details can be obtained from your AeroShell representative.)
Fourth-generation, HPC TEO for the latest engine technologies		
AeroShell Ascender	<ul style="list-style-type: none"> ■ Shell's ultimate TEO ■ Maintenance-saving formula ■ Low coking propensity and high thermal stability ■ Excellent seal compatibility 	<ul style="list-style-type: none"> ■ SAE AS5780B HPC grade ■ MIL-PRF-23699G HTS grade ■ Rolls-Royce Trent 1000 ■ IAE V2500 Series* ■ Other approvals and flight evaluations pending
Third-generation, HTS TEO for modern engines		
ASTO 560	<ul style="list-style-type: none"> ■ Maintenance saving ■ Longer engine life ■ Lower oil consumption 	<ul style="list-style-type: none"> ■ MIL-PRF-23699G grade HTS ■ SAE AS5780B grade SPC ■ CFM56, V2500, GE90, GEnx and others
Second-generation, STD grade TEO		
ASTO 500	<ul style="list-style-type: none"> ■ Reduced operational costs 	<ul style="list-style-type: none"> ■ MIL-PRF-23699G grade STD ■ SAE AS 5780 SPC ■ DEF STAN 91-101 Grade OX-27
Auxiliary power unit TEO		
ASTO 390	<ul style="list-style-type: none"> ■ Reliable cold-soak starting ■ Approved by auxiliary power unit manufacturers 	<ul style="list-style-type: none"> ■ DEF STAN 91-94 (British) ■ IPM-10, VNII NP 50-1 4f and 4u, and 36Ku-A (Russian analogue) ■ Joint Service Designation OX-7
High load-carrying-capacity TEO for turbine engines and transmissions, especially helicopters		
ASTO 555	<ul style="list-style-type: none"> ■ High load-carrying capacity ■ Reduced maintenance costs ■ Approved by leading helicopter engine manufacturers 	<ul style="list-style-type: none"> ■ DOD-PRF-85734A ■ Approved by Agusta, Bell Helicopter Textron, Boeing Vertol, Eurocopter, McDonnell Douglas, MBB, Sikorsky, Westland Helicopters and others
Other AeroShell TEOs		
ASTO 308	<ul style="list-style-type: none"> ■ Military use only 	<ul style="list-style-type: none"> ■ MIL-PRF-7808L grade 3
ASTO 750	<ul style="list-style-type: none"> ■ High load-carrying capacity 	<ul style="list-style-type: none"> ■ DEF STAN 91-98 (DERD 2487)

*Approved FAR 33

A COMPREHENSIVE AND PROVEN RANGE

AeroShell is the most comprehensive and proven product range available; all new products undergo many hours of testing. Our experts can also offer helpful and problem-solving technical support. Whatever you fly, we can provide a full range of AeroShell products to meet your needs, including

- **AeroShell Grease 33**, the universal airframe grease used as a first-fill product by both Boeing and Airbus
- **AeroShell Grease 22** for wheel bearings
- **AeroShell Fluid 41** "super-clean", mineral hydraulic oil.
- **AeroShell Landing Gear Fluid** and **AeroShell Shock Strut Fluid**
- **AeroShell Calibrating Fluid 2**, for fuel-system calibration
- **ASTO 2 and ASTO 3**, for protection against corrosion during storage.



CONTACT US

For more information, please contact your AeroShell representative or visit www.shell.com/aviation.