



# THE SHELL ECOSAFE RANGE

LOW-VARNISHING, POLYALKYLENE GLYCOL (PAG) BASED  
FLUIDS FOR TURBINES

**SHELL  
LUBRICANT  
SOLUTIONS**



**EVEN A SMALL AMOUNT OF VARNISH CAN CAUSE SOPHISTICATED SERVO VALVES TO STICK, WHICH RESULTS IN TURBINE TRIPS, SIGNIFICANT MAINTENANCE AND REPAIR EXPENDITURE, AND FINANCIAL PENALTIES FOR MISSING GENERATING COMMITMENTS.**



The move from Group I to Group III base stocks has produced more environmentally and worker-friendly oils, but it has reduced the oils' polarity and solubility. As these oils age, insoluble oxidation products precipitate out to form damaging varnish.

Removing varnish can become an ongoing and expensive contest. Varnish skids require downtime for piping installation and additional filter and system maintenance, and may not work, as there are many types of varnish. And they do not clean varnished surfaces.

The solution is to match the solubility of the base fluid and the oxidation products.

### **SHELL ECOSAFE POLYALKYLENE GLYCOL BASED FLUIDS**

The PAG-based synthetic fluids for turbines in the Shell EcoSafe family contain polar molecules that can only break down to form polar by-products. As these products are similar in chemistry to the base fluid, they are soluble and remain within the base fluid (Figure 1). Without insoluble by-products, little or no varnish can form. This helps to reduce your maintenance and downtime, increase your generating capacity and reduce your total cost of ownership.

In addition to being low-varnishing, Shell EcoSafe fluids provide exceptional equipment protection. They are designed for high-output gas and steam turbines and are specifically formulated to provide better oxidation and thermal stability compared with mineral-oil-based turbine oils. PAG-based fluids can also support more profitable and sustainable operations by helping to protect workers and the environment through their favorable health, safety and environmental profiles.

### **THE SHELL ECOSAFE RANGE**

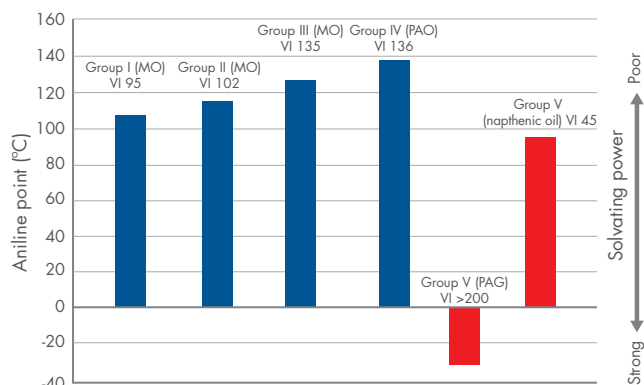
Shell offers a portfolio of fluids for turbines designed to meet diverse customer needs. These fluids include gas-to-liquids turbine oils such as Shell Turbo S4 X and Shell Turbo S4 GX, which are formulated to meet the demands of the latest high-efficiency systems, and oils for special applications, including Shell Turbo N for ammonia turbocompressors.

The PAG-based Shell EcoSafe range expands this portfolio to offer you high-performing, low-varnishing, long-life fluids, including

- **Shell EcoSafe Turbine Fluid S5 X 25** low-varnishing, top-tier gas and combined-cycle turbine fluid, formerly EcoSafe TF-25
- **Shell EcoSafe Turbine Fluid S5 GX 25** low-varnishing, top-tier gas and combined-cycle turbine fluid for geared turbines, formerly EcoSafe TF-25M
- **Shell EcoSafe Revive** solvency enhancer for cleaning varnish from rotating equipment, formerly EcoSafe Revive
- **Shell EcoSafe EHC S3 DU** fire-resistant and readily biodegradable hydraulic fluid for electrohydraulic control systems, formerly EcoSafe EHC.

### **EXTENDING SERVICE LIFE**

Shell EcoSafe Turbine Oil S5 X 25 can help to extend service life and reduce maintenance costs through its exceptional protection against fluid breakdown, even under conditions of high oxidation and thermal stress.

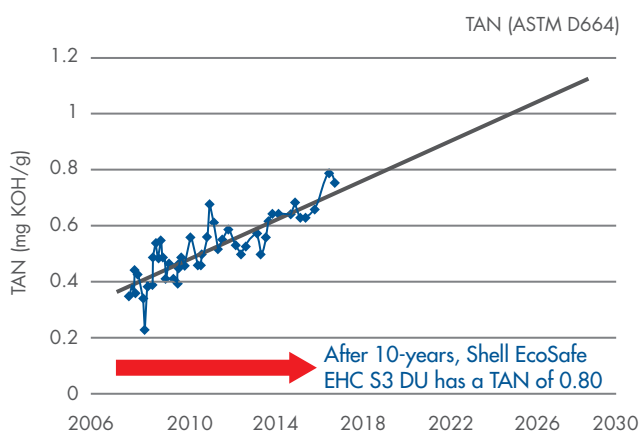


**Figure 1. Like dissolves like:** PAG-based fluids have low aniline point compared with mineral oil based oils. They have greater solvency and can dissolve oxidation products, thereby preventing them from precipitating out and forming damaging varnish.

- In 2007, a customer in Oklahoma, USA, had 50 trips and 18 servo-valve failures in its two “must-run” GE 7F units. It eliminated these failures and extended major servo maintenance to 3–5 years by converting to Shell EcoSafe Turbine Fluid S5 X 25. After 10 years, the antioxidant content of the fluid was 75.7% of the original value. The General Electric GEK 32568 specification expects fluids to operate trouble-free until 25% of the new value is reached. Consequently, the Shell EcoSafe Turbine Fluid S5 X 25 at this site has a life expectancy of decades.

Shell EcoSafe EHC S3 DU helps to extend the service and equipment life of steam and gas turbines with electrohydraulic control (EHC) valves, including high-pressure systems and systems with servo valves.

- The total acid number (TAN) of Shell EcoSafe EHC S3 DU has been tracked for a customer in Nebraska, USA. The fluid started with a TAN of about 0.35 mg KOH/g. Caution is advised when the TAN reaches 2.0 mg KOH/g and change-out is recommended at 5.0 mg KOH/g. After 10 years, the EHC S3 DU has a TAN of only 0.8 mg KOH/g (Figure 2).



**Figure 2. Long life expectancy:** TAN monitoring shows that Shell EcoSafe EHC S3 DU is likely to last for decades.

## REMOVING VARNISH WHILE MAKING MEGAWATTS

Shell EcoSafe Revive is a varnish solvency enhancer that is added to the existing turbine oil during normal unit operation, 6–12 months ahead of a scheduled change-out.

The addition of Shell EcoSafe Revive increases the existing oil’s ability to dissolve and hold in solution previously deposited varnish and oxidation by-products as well as any additional degradation products that are formed in the oil.

These components are then removed from the system completely once the oil is changed. Unlike alternatives such as chemical treatments, it does not require additional maintenance or an outage to install equipment.

Utilization of Shell EcoSafe Revive often eliminates the need for high velocity flushing between fluid change-outs, and is compatible with most turbine oils, although compatibility confirmation testing is advised.

- Eliminating outages. A customer’s power plant in Deweyville, Texas, USA, had 18 servo-related trips and/or false starts in one year across four GE 7F gas turbines. The last-chance filters were plugging and causing the servo valves to malfunction. In 2014, 10% Shell EcoSafe Revive was added to each reservoir. The varnish skids were removed and the company had no further servo-related trips or false starts.
- Extending service life. Another power generator’s oil had a TAN of 0.52 mg KOH/g, which was approaching the condemning limit. In 2014, 10% Shell EcoSafe Revive was added to the reservoir and the TAN fell to 0.07 mg KOH/g, thereby enabling the company to keep its turbines operating.

## AS THESE OILS AGE, INSOLUBLE OXIDATION PRODUCTS PRECIPITATE OUT TO FORM DAMAGING VARNISH.

## PREVENTING OUTAGES AND REDUCING MAINTENANCE

Shell EcoSafe fluids do not degrade to form varnish or sludge and have excellent resistance to oxidative and thermal degradation. These properties help to prevent unplanned outages resulting from valve sticking (Figures 3 and 4).



**Figure 3. Outstanding cleanliness:** A reservoir after 11 years with Shell EcoSafe Turbine Fluid S5 X 25.



**Figure 4. Low maintenance:** Shell EcoSafe EHC S3 DU will not break down to form acids. It leaves tanks clean and with minimal maintenance requirements.



## SPECIFICATIONS, APPROVALS AND RECOMMENDATIONS

General Electric specifies (GE GEK 32568) the use of PAG-based fluids for its large-frame gas turbines owing to their exceptional performance in preventing varnish.

PRODUCT	FORMER NAME	TECHNOLOGY	VISCOSITY GRADE	APPLICATION AND BENEFITS
Shell EcoSafe Turbine Fluid S5 X 25	EcoSafe TF-25	Synthetic, PAG	25	Low-varnishing, long-life, top-tier gas and combined-cycle turbine fluid
Shell EcoSafe Turbine Fluid S5 GX 25	EcoSafe TF-25M	Synthetic, PAG	25	Low-varnishing, long-life, top-tier gas and combined-cycle turbine fluid for geared turbines
Shell EcoSafe Revive	EcoSafe Revive	Synthetic, PAG	32	Solvency enhancer for cleaning varnish from rotating equipment
Shell EcoSafe EHC S3 DU	EcoSafe EHC	Synthetic, PAG	46, 68	Fire-resistant and readily biodegradable hydraulic fluid for cleaner systems and longer service life

## CONTACT US

For more information, please contact your Shell Lubricant Solutions representative or visit [shell.us/ecosafe](https://shell.us/ecosafe).

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