

# DRIVING AUTO PERFORMANCE THROUGH LUBRICANT SELECTION

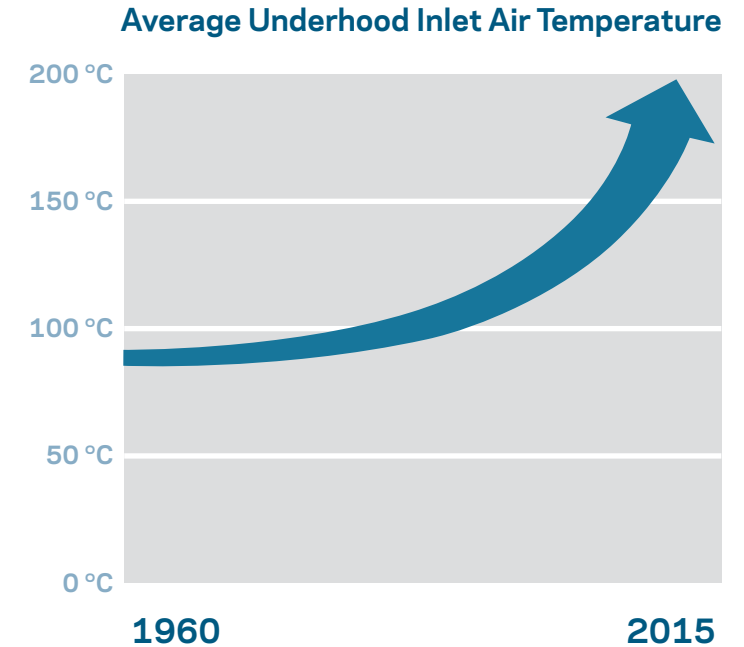
How Lubricants Can Reduce Component Failures and Extend Vehicle Life

# Driving Auto Performance Through Lubricant Selection

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In the 1960s the average underhood inlet air temperature to the alternator was below 100 °C (210 °F). By the early 2000s that jumped to more than 120 °C (250 °F)<sup>1</sup>, and today, underhood operating temperatures can approach 200 °C (392 °F). Finding a lubricant that can withstand the rising temperatures and harsh conditions over an extended period is critical to optimal vehicle performance.

High performance lubricants, such as perfluoropolyethers (PFPEs), excel in these conditions, creating a ripple effect of value: reducing component failures, extending vehicle life, reducing warranty claims, improving quality and customer loyalty, and increasing profitability.



<sup>1</sup> Mike Bradfield, "Thermal Design Challenges in Automotive Alternator Power Electronics," Electronics Cooling, May 2002 (<http://www.electronics-cooling.com/2002/05/thermal-design-challenges-in-automotive-alternator-power-electronics/>).

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## Understanding the Challenges of Temperature and Performance

Automotive interior and underhood **temperatures** vary significantly—from below -50 °C (-58 °F) to nearly 200 °C (392 °F), and many applications generate additional heat above the ambient temperature. Over time, these temperature extremes can cause lubricants to degrade, resulting in component failures.

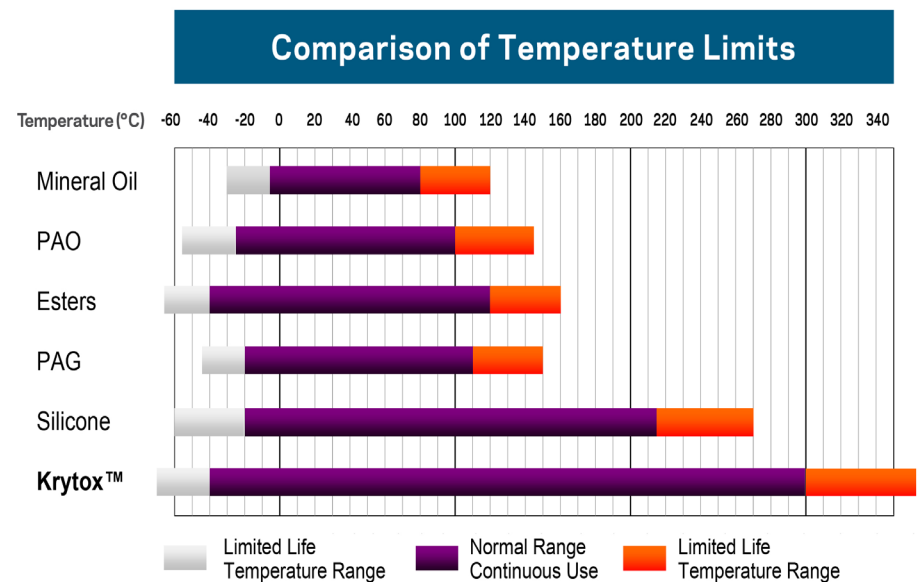
For example, most standard petroleum-based greases begin to oxidize and degrade above 100 °C (212 °F). Synthetic lubricants (e.g., esters, polyalkylene glycols, and polyalphaolefins) can survive at higher temperatures, but the PFPE lubricants provide the highest performance, withstanding temperatures above 300 °C (572 °F).

Lubricant **performance** also varies significantly based on loads, speeds, and environmental conditions—including exposure to corrosive road deicers, fuel, and other materials.

During a standard bearing endurance test (ASTM D-3336) at 10,000 revolutions per minute, petroleum-based greases last only a few hundred hours, while one PFPE grease lasted more than 25,000 hours.

Given the unique performance capabilities of each lubricant, understanding the strengths and weaknesses of each lubricant class can help maximize performance.

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Sources: 1) Chemours Engineering Standard L3A: Synthetic Lubricants / 2) Engineering Science Data Unit – Tribology Series – ESDU 94020: Selection of Synthetic Lubricants

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## The Automotive Lubricant Landscape

Here's a capability overview of common automotive lubricant classifications:

### **Perfluoropolyethers**

PFPEs are a class of synthetic lubricants used in demanding applications due to their combination of physical and chemical properties. PFPEs offer excellent thermal and chemical stability, low volatility, and unmatched lubricity at extreme temperatures. PFPEs are the ideal lubricant when high performance is needed in an extreme environment, and can also be the lubricant of choice for applications requiring other properties, such as chemical inertness and extreme pressure capability. Vehicle warranties can typically be extended due to the long-lasting performance of these lubricants.

### **Mineral**

Mineral lubricants offer excellent hydrolytic stability and good seal material compatibility, lubricating ability, and toxicity. However, mineral lubricants provide poor fire resistance and only moderate thermal and oxidation stability.

### **Polyalphaolefins (PAOs)**

PAO lubricants boast excellent hydrolytic stability and toxicity, along with above average oxidation stability, volatility, seal compatibility, and lubricating ability. Yet, the lubricant has limited capabilities across temperature extremes, with only moderate thermal stability and poor fire resistance.

### **Diester**

Diester lubricants provide good thermal, oxidation, and hydrolytic stability, as well as above average lubricating ability, toxicity, and volatility. However, the lubricant has only moderate fire resistance and poor seal material compatibility.

### **Polyol Ester**

Polyol ester lubricants have similar performance capabilities to diesters, but with improved hydrolytic stability, slightly stronger thermal stability, and overall lubricating ability.

### **Silicones**

Silicone lubricants have good chemical inertness, thermal stability, and low volatility, making them a good lubricant choice for certain applications. However, their lubricating film-forming capability is low; and, consequently, silicone lubricants cannot support high loads. Silicones are also known to migrate easily, which can cause serious concerns in a vehicle assembly plant, particularly around paint lines.

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## Lubricant Capability Comparison

	THERMAL STABILITY	OXIDATION STABILITY	HYDROLYTIC STABILITY	VOLATILITY	FIRE RESISTANCE	SEAL MATERIAL COMPATIBILITY	LUBRICATING ABILITY	TOXICITY
PFPE	●	●	●	●	●	●	●	●
MINERAL	○	○	●	○	○	●	●	●
PAO	○	●	●	●	○	●	●	●
DIESTER	●	●	○	●	○	○	●	●
POLYOL ESTER	●	●	●	●	●	○	●	●
SILICONES	●	●	●	●	●	●	○	●

○ POOR    ○ MODERATE    ● GOOD    ● EXCELLENT

# Driving Auto Performance Through Lubricant Selection

## A Deeper Look at the Unique Properties of PFPEs

### Wide temperature range

PFPEs have proven they perform well at [extreme temperatures](#), from -75 °C to greater than 400 °C (-103 °F to 752 °F). This is a broader temperature range than any other class of lubricants. The volatility of PFPEs at elevated temperatures is very low, so the lubricant stays in place and does not dry out in service.



**Hydrocarbon**



**PFPE  
(Krytox™ GPL 227)**

*In an oven at 232 °C (448 °F) for 40 hours, hydrocarbon (left) lost 40% of weight and developed tar and significant hardening. PFPE (right) remained unchanged, retaining all lubrication properties, and still meeting new product specifications.*

### Chemical compatibility

Given the harsh automotive environment, the chemical inertness of PFPEs provides a significant advantage. Compatible with a wide range of materials—including all automotive plastics, elastomers, metals, fabrics, paint, clear coat, fuel, and even other lubricants—PFPEs outlast and outperform all alternatives in [compatibility tests](#).

### Excellent oxidative stability

Generally, high temperatures, water, acids, and catalysts increase the rate of oxidation, creating a corresponding decrease in the life of the lubricant, and, as a result, component life. In contrast, PFPEs do not oxidize and do not thermally degrade, even at service temperatures well above 400 °C (752 °F)—helping [PFPEs outlast](#) other lubricants.

### Long lubrication life across wide viscosity range

The ability of a lubricant to support a load depends significantly on viscosity. If viscosity is too low, the load will overcome the lubricating film and failure will occur. Conversely, if viscosity is too high, excessive heat can be generated in the shearing of the lubricant, particularly in high-speed applications. While hydrocarbon lubricants displayed signs of wear and early failure in [extreme pressure testing](#), PFPEs reached the maximum test loads without failure.

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## Where to Use PFPEs

The many automotive applications of PFPEs generally fall into two categories:



### Under the Hood

Underhood temperatures are gradually rising as aerodynamics dictate tighter packaging and large engines are being replaced by smaller turbocharged and supercharged engines for improved fuel efficiency. With ambient temperatures under the hood exceeding 120 °C (248 °F), PFPEs have a growing list of automotive applications, including:

- Overrunning decouplers for alternator drive pulleys
- Front end accessory drive (FEAD) tensioners and idlers
- Throttle body bearings
- EGR valves
- Variable-geometry intake manifold valves
- Fuel system emission control valves
- Electric cooling system pumps and valves
- Ignition system boots



### Vehicle Interior and Noise, Vibration, and Harshness

PFPEs are particularly effective at eliminating squeaks and associated noises on and inside vehicles without any concern over material compatibility. PFPEs significantly reduce friction and energy buildup between surfaces that can lead to noises when the parts rub against each other. Application categories include:

- Interior plastics
  - Instrument panels
  - Door trim
  - Center and overhead consoles
- Leather seats and seat latches
- Electric switches
- Weatherstrips and seals

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## About Krytox™ PFPE Lubricants

Krytox™ lubricants are Chemours' line of high quality PFPE oils and greases first developed by DuPont. Krytox™ lubricants have been proven to offer long-term performance and superior value. These lubricants are PFPEs, resulting in exceptional chemical stability. Therefore, they are thermally stable, nonflammable, and insoluble in water, acids, bases, and most organic and all non-fluorinated solvents.

Chemours is ISO 9001 and ISO 14001 certified and NSF H-1 for selected grades of Krytox™ lubricants.

For more products and information, visit [Krytox.com/AutoLube](http://Krytox.com/AutoLube), or call a Krytox™ lube technical expert:

**In the U.S. and Canada** ..... 1-800-424-7502

**Outside the U.S.** ..... 1-302-773-1000



### The attributes of Krytox™ lubricants include:

#### Performance over a wide temperature range

Extreme heat or cold have no effect on the lubricity of these lubricants, effective from -75 °C to greater than 400 °C (-103 °F to 752 °F), depending upon operating conditions and product grade.

#### Resistant to chemical attack

Krytox™ lubricants withstand fuel, coolant, brake fluid, engine oil, washer solvent, and even battery acid.

#### Low evaporation

Krytox™ lubricants—within the recommended temperature ranges—experience almost zero evaporation or chemical changes over the many years of a vehicle's service life.

#### Compatibility

Krytox™ lubricants won't harm painted surfaces, plastics, or elastomers. They are compatible with almost every material they may contact.

#### Outstanding dielectric properties

Krytox™ lubricants are good insulators and have become the lubricant of choice for electrical applications.



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