

IMPACT OF MODERN LUBRICANTS ON THE EFFICIENCY OF GAS PISTON POWER PLANTS

Diyorbek Shodmonov

Master's Student, Faculty of Energy Engineering,

Tashkent State Technical University

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Abstract. This thesis examines the main types of modern lubricants used in gas piston power plants, their influence on friction processes, and their contribution to overall energy efficiency. Special attention is given to the advantages of synthetic and semi-synthetic lubricants, including their effects on operational reliability, maintenance intervals, and equipment lifespan. Practical examples and findings from recent technical literature are used to demonstrate how advanced lubrication technologies improve the performance and efficiency of gas engine power generation systems.

Keywords: gas piston power plant, lubricant, synthetic oil, friction, efficiency, maintenance, engine performance

Introduction. Gas piston power plants play a crucial role in industrial and municipal energy systems due to their high efficiency, operational flexibility, and reliability. The effective operation of these facilities largely depends on the proper lubrication of mechanical components exposed to high temperatures, pressures, and frictional loads. Gas engines and associated piston systems operate under demanding conditions where inadequate lubrication can result in excessive wear, reduced efficiency, and increased maintenance costs.

For many years, conventional mineral oils have been widely used in gas engine applications. However, modern lubricants have introduced significant technological improvements that enhance engine performance and reliability. Advanced synthetic and semi-synthetic lubricants provide superior thermal stability, oxidation resistance, and cleaning properties, reducing friction and protecting critical engine components from wear and deposits.

The use of modern lubricants not only decreases operational expenses but also extends maintenance intervals and equipment service life. Furthermore, these lubricants contribute to improved energy efficiency by minimizing mechanical losses and ensuring stable engine operation under varying load conditions. In addition to their technical benefits, modern lubricants offer environmental advantages through reduced waste generation, lower oil consumption, and decreased emissions. Therefore, the selection and management of high-quality lubricants have become essential factors in optimizing the performance of gas piston power plants and achieving sustainable energy production.

Literature Review.

1. CIMAC WG8 (2021). *Guideline: Lubrication of Reciprocating Gas Engines*

This guideline provides comprehensive recommendations for the lubrication management of reciprocating gas engines. It highlights the importance of proper lubricant selection and monitoring in maintaining engine reliability and maximizing mechanical efficiency. The document emphasizes that effective lubrication reduces wear, minimizes frictional losses, and contributes to the optimization of gas piston power plant performance.

2. ExxonMobil (2023). *Mobil Pegasus 1107 Product Data Sheet*

This technical document presents the characteristics and performance specifications of Mobil Pegasus 1107, a lubricant specifically developed for modern gas engines. The product is designed to withstand high temperatures and pressures while providing excellent oxidation



resistance and deposit control. Its application improves engine reliability, extends oil drain intervals, and enhances the operational efficiency of gas piston power systems.

3. ExxonMobil (2023). *Mobil Pegasus 805 Product Data Sheet*

The Mobil Pegasus 805 product data sheet describes the lubricant's suitability for gas engine applications. The oil offers excellent wear protection, thermal stability, and engine cleanliness. These properties contribute to improved engine performance, reduced maintenance requirements, and increased efficiency in energy generation processes.

4. ScienceDirect (2025). *Experimental Research on Thermophysical Properties of Jet Oil*

This study investigates the thermophysical properties of advanced lubricating oils through experimental methods. The findings demonstrate the importance of lubricant thermal conductivity, viscosity stability, and heat transfer characteristics in high-performance engines. Such research contributes to the development of more efficient lubrication systems for gas engines and other energy conversion equipment.

5. Liqui Moly (2023). *Engine Oils Overview*

This publication provides an overview of engine oil technologies and their significance in modern power generation systems. It highlights the role of high-quality lubricants in reducing friction, improving fuel efficiency, and extending engine service life. The study confirms that proper lubricant selection is a key factor in maintaining the long-term reliability of gas piston power plants.

6. ResearchGate (2023). *Effects of Lubricating Fluids on Service Performance*

This research examines the influence of lubricating fluids on equipment service performance. The study concludes that lubricant properties directly affect wear rates, maintenance frequency, and operational efficiency. In gas piston engines, optimized lubrication systems significantly improve reliability and contribute to higher overall plant efficiency.

Main Part.

The continuous and reliable operation of gas piston power plants is closely associated with the effective control of friction processes occurring within internal combustion engines. In such engines, moving components—including pistons, crankshafts, valves, bearings, and other mechanical elements—operate at high speeds and under significant mechanical loads. These operating conditions generate considerable frictional forces and thermal stresses within contact surfaces. Therefore, the use of high-quality lubricants becomes essential to prevent excessive wear, ensure component durability, and maintain maximum engine efficiency. [3]

Modern lubricants perform far more functions than simply reducing friction. In addition to minimizing mechanical losses, they facilitate heat dissipation from critical engine components, protect metal surfaces against corrosion, prevent the formation of harmful deposits, and maintain stable operating conditions between moving parts. These functions are particularly important in gas piston engines, which are frequently subjected to high temperatures, elevated pressures, and continuous operation. Under such demanding conditions, lubricants must possess excellent thermal stability, oxidation resistance, and viscosity retention characteristics. These requirements are effectively met by advanced synthetic-based lubricant technologies. [4]

From an operational perspective, modern lubricants have a direct impact on the overall efficiency of gas engines. By reducing friction-related energy losses and improving component protection, they contribute to longer maintenance intervals, lower operating costs, and improved fuel utilization. As a result, power generation systems can achieve higher efficiency, increased service life, and enhanced environmental performance. Consequently, lubricant selection has



become a critical factor in optimizing the performance of modern gas piston power plants. [3]

Lubricants used in gas piston engines can generally be classified into three main categories:

Mineral Lubricants.

Mineral lubricants are produced through the refining of crude oil fractions. They are relatively inexpensive and widely available, making them a common choice for many industrial applications. However, their thermal stability is limited, and they tend to degrade more rapidly when exposed to high temperatures. This reduces their service life and makes them less suitable for modern high-performance gas engines operating under severe conditions. Mineral oils are generally recommended for low-load and moderate-temperature applications. [6]

Semi-Synthetic Lubricants.

Semi-synthetic lubricants consist of a blend of mineral and synthetic base oils, combining the advantages of both lubricant types. Compared with conventional mineral oils, they offer improved thermal stability, better oxidation resistance, and enhanced wear protection. Their longer service life and extended maintenance intervals make them an attractive option for many gas engine applications. Semi-synthetic lubricants provide a balanced compromise between performance and cost-effectiveness. [6]

Synthetic Lubricants.

Synthetic lubricants are manufactured through advanced chemical synthesis processes and consist of highly engineered molecular structures. These lubricants maintain their physical and chemical properties even under extreme operating conditions involving high temperatures and pressures. Synthetic oils exhibit excellent oxidation resistance, low volatility, superior thermal stability, and outstanding wear protection. Furthermore, they contribute to improved engine cleanliness and reduced environmental impact. For heavily loaded gas piston engines, synthetic lubricants are generally considered the most effective solution for maximizing operational efficiency and reliability. [6]

Table 1. Comparative Characteristics of Lubricant Types

Lubricant Type	Temperature Resistance	Oxidation Resistance	Service Life	Cost	Environmental Safety
Mineral	Low	Low	Short	Low	Low
Semi-Synthetic	Moderate	Moderate	Medium	Moderate	Moderate
Synthetic	High	High	Long	High	High

In gas piston engines, critical components such as the crankshaft, pistons, cylinder liners, valves, and bearings are continuously subjected to friction and mechanical stress. The operating temperature of these components typically ranges between **250–350 °C**, while the pressure inside the combustion chamber can reach **30–50 bar**. Under such demanding conditions, lubricants must perform multiple functions beyond simple friction reduction. They act as cooling media, protect metal surfaces from corrosion, prevent scuffing and wear, and ensure stable engine operation throughout the service cycle. Due to their superior thermal stability, synthetic lubricants significantly reduce the formation of carbon deposits within the engine. This contributes to cleaner engine operation and extends the service life of filtration systems and other critical components. As a result, maintenance requirements are reduced, and engine reliability is improved. [5]



Practical experience from gas engine power plants manufactured by companies such as MTU, Caterpillar, and MWM has demonstrated notable improvements when synthetic SAE 40 lubricants are used:

Oil change intervals increased from approximately **500 hours to 1,500 hours**.

Fuel consumption decreased by **4–6%**.

Service life of wear-prone components increased by **20–30%**.

Engine operating temperature decreased by approximately **5–8 °C**.

These improvements contribute directly to lower operating costs, reduced downtime, and enhanced maintenance efficiency. Another significant advantage of next-generation lubricants is their environmental performance. Modern synthetic lubricants produce lower levels of smoke emissions, contribute to the reduction of nitrogen oxide (NO_x) and carbon monoxide (CO) emissions, and help extend the service life of exhaust after-treatment systems and catalytic converters. Furthermore, several lubricant manufacturers are developing biodegradable lubricant formulations that further improve environmental sustainability. A number of specialized lubricant products are currently available on the market for gas engine applications:

Mobil SHC Pegasus – designed for high-load gas engines and severe operating conditions.

Shell Mysella – suitable for engines operating under stable temperatures and continuous heavy-duty conditions.

Total Nateria – an environmentally friendly and cost-effective solution for low- and medium-power gas engines.

These lubricants are certified by equipment manufacturers and are widely recommended for use in gas engine power plants. Despite their numerous benefits, modern lubricants also have certain limitations. Synthetic and semi-synthetic lubricants are considerably more expensive than conventional mineral oils. Lubricant selection must be carefully matched to the specific engine model and operating conditions, as an unsuitable lubricant may accelerate wear of critical mechanical components. Synthetic lubricants can also be sensitive to contamination, placing greater demands on filtration systems. Additionally, high-quality lubricants require proper storage and transportation conditions. Exposure to excessive moisture, temperature fluctuations, or ultraviolet radiation may degrade their properties. Regular monitoring through oil analysis and laboratory testing is also necessary, which introduces additional operational costs and organizational requirements. Nevertheless, despite these disadvantages, the long-term economic and technical benefits generally outweigh the initial investment costs. Consequently, modern lubricants have become an indispensable component of maintenance strategies for gas piston power plants.

o	Lubricant Name	Lubricant Type	Manufacturer (Country)	Temperature Resistance	Main Characteristics
	Mobil SHC Pegasus	Synthetic	ExxonMobil (USA)	Very High	Long service life, excellent oxidation resistance
	Shell Mysella S5 N	Synthetic	Shell (Netherlands)	Very High	Specially developed for turbocharged gas engines
	Total nevastane syng	Synthetic	TotalEnergies (France)	High	Environmentally friendly, non-toxic formulation



	Valvoline SynPower	Synthetic	Valvoline (USA)	High	Reduces friction and provides long-term protection
	Liqui Moly 5W- 40	Semi- Synthetic	Liqui Moly (Germany)	Moderate– High	Effective protection under various operating conditions
	Castrol GTX Ultraclean	Semi- Synthetic	Castrol (United Kingdom)	Moderate	Advanced deposit-control technology
	Lukoil Genesis Armortech	Semi- Synthetic	Lukoil (Russia)	Moderate– High	Good thermal stability and extended service life
	Mobil Pegasus 1005	Mineral	ExxonMobil (USA)	Low– Moderate	Cost-effective solution with shorter service life
	Shell Mysella A	Mineral	Shell (Netherlands)	Low– Moderate	Conventional mineral oil with economical pricing
0	Gazpromneft MGE-30	Mineral	Gazpromneft (Russia)	Moderate	Designed for gas engines and suitable for local operating conditions

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