Performance Enhancement of Petrol Engine Using Lubricants Mixed with Nano-Particles

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ABSTRACT

The performance and durability of petrol engines are strongly influenced by frictional losses and wear between moving components. Conventional engine lubricants provide adequate lubrication, but their effectiveness decreases under high temperature and load conditions. This study investigates the improvement of lubricant properties by mixing nano-particles with base engine oil. A stable nano-lubricant was prepared by dispersing nano-particles in controlled concentration using proper mixing techniques. The prepared lubricant was evaluated through friction test, wear test, flash point test, and fire point test to analyze thermal characteristics. The results were compared with those of conventional engine oil. Experimental findings indicate an increase in flash point and fire point values was observed, indicating improved thermal stability and safety at elevated temperatures. The study concludes that nano-particle blended lubricants can effectively enhance lubrication characteristics and support better engine reliability without requiring major mechanical modifications.

KEYWORDS: Nano-lubricants, Petrol Engine, Friction Reduction, Wear Analysis, Flash Point, Fire Point, Tribology.

INTRODUCTION

1.1 Background of Internal Combustion Engines

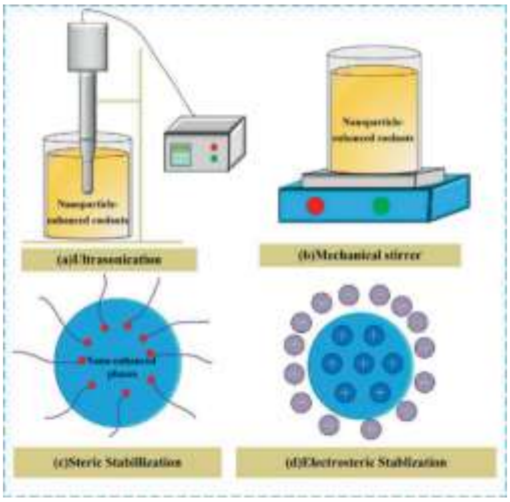
Internal Combustion (IC) engines have remained one of the most influential technological inventions in the field of mechanical engineering. Since their development in the late nineteenth century, IC engines have continuously evolved to meet the increasing demands of transportation, agriculture, industrial machinery, and power generation. These engines operate by converting the chemical energy stored in fuel into mechanical energy through combustion within a confined space called the combustion chamber. The rapid expansion of high-temperature and high-pressure gases produced during combustion drives a piston, which in turn rotates the crankshaft and produces useful mechanical work. The compact design, high power-to-weight ratio, operational flexibility, and relatively low manufacturing cost of IC engines have made them indispensable in modern society.

Among the various classifications of IC engines, petrol engines, also known as spark ignition engines, are widely used in light motor vehicles, two-wheelers, small generators, and portable machinery. Despite significant improvements in design, materials, and control systems, petrol engines still face challenges related to frictional losses, wear of moving components, and thermal degradation of lubricating oil. These issues directly affect engine efficiency, durability, fuel economy, and maintenance cost. Therefore, research efforts are continuously directed toward enhancing engine performance through innovative lubrication techniques and advanced materials.

1.2 Preparation and Stability of Nano-Lubricants

The preparation of nano-lubricants involves dispersing nano-particles uniformly into base oil at controlled concentrations. Proper dispersion is essential to prevent agglomeration, which may negatively affect lubrication performance. Techniques such as mechanical stirring and ultrasonication are commonly used to achieve stable suspension. The concentration of nano-particles must be optimized, as excessive concentration may increase viscosity and lead to sedimentation.

Ensuring long-term stability of nano-lubricants is a critical challenge. Stable dispersion ensures consistent performance during operation and accurate experimental evaluation.



LITERATURE REVIEW

Ali A and Wail A (2016) studied how two different octane numbers affect a spark ignition engine. They checked engine performance, exhaust gases, and noise levels. The results showed that higher octane fuel improved combustion and reduced knocking, which helped the engine run more smoothly and lowered some emissions.**Zhang W et al. (2017)** tested a new alcohol-based gasoline fuel in a spark ignition engine. Their work focused on emission characteristics. They found that adding alcohol helped reduce harmful exhaust gases and improved combustion efficiency under certain operating conditions.**Iodice P and Senatore A (2016)** examined how different engine operating conditions influence emissions in a 4-stroke motorcycle engine. The study showed that speed and load strongly affect emission levels, and careful tuning can help reduce pollutants.**Iodice P et al. (2017)** investigated ethanol–gasoline blends in modern spark ignition engines. The results indicated that ethanol blends can reduce carbon monoxide and hydrocarbon emissions while maintaining good engine performance.

Liu Z et al. (2018) developed an artificial neural network model to predict engine performance and emissions when using butanol–gasoline blends. The model successfully estimated engine behavior and showed that butanol blends can improve combustion and lower some emissions.**Li Y et al. (2017)** studied butanol as an oxygen-rich fuel in a spark ignition engine. They observed better combustion efficiency and reduced exhaust emissions compared to pure gasoline, especially at moderate loads.**Usman M and Hayat N (2020)** compared LPG and petrol in a motorbike engine. The study looked at lubrication, emissions, and performance. LPG showed cleaner exhaust emissions, while petrol gave slightly better power output in some conditions.**Semin et al. (2009)** reviewed the development of engines using compressed natural gas (CNG). The paper explained that CNG is a cleaner alternative fuel and can reduce harmful exhaust emissions compared to gasoline.**Evans RL and Blaszczyk J (1997)** compared natural gas and gasoline in a spark ignition engine. Natural gas produced lower emissions, but gasoline provided higher power output under certain conditions.

Das L et al. (2000) evaluated hydrogen and CNG as alternative fuels. Hydrogen showed high combustion efficiency and lower emissions, but practical issues such as storage and safety were noted.**Usman M and Hayat N (2019)** compared CNG and high-octane gasoline in terms of performance, emissions, and lubrication oil condition. The study showed that CNG reduced exhaust emissions but affected lubrication oil properties differently than gasoline.**Duc KN et al. (2019)** examined a spark ignition engine fueled with CNG using port fuel injection. The results showed stable engine operation and lower emissions compared to conventional gasoline operation.**Geok HH et al. (2009)** tested a CNG-converted engine with sequential port injection. Their findings showed improved combustion stability and reduced emissions compared to carbureted systems.**Jahirul MI et al. (2010)** compared CNG and gasoline in a modified car engine. CNG provided cleaner exhaust gases, while gasoline offered slightly better acceleration performance.**Mohamed ES (2016)** studied the effect of active thermal management in a bi-fuel engine. Proper temperature control improved fuel efficiency, combustion quality, and reduced exhaust emissions.**Liu Z et al. (2022)** discussed nanotechnology-based viscosity modifiers for engine oils. The study showed that nano-additives can improve oil stability, reduce friction, and enhance engine protection at high temperatures.**Sharma R et al. (2020)** compared synthetic and mineral oils in terms of thermal stability. Lubricating oils performed better at high temperatures and maintained their properties for a longer time.**Kumar R and Li J (2021)** explained how nanoparticles improve engine oil performance. They found that nano-additives reduce wear, improve lubrication, and enhance thermal properties of engine oils. **American Petroleum Institute (2021)** provided updated engine oil performance standards. These standards help ensure that engine oils meet required quality and protection levels for modern engines. **SAE International (2021)** presented recent developments in automotive lubricants. The report highlighted improvements in fuel efficiency, emission control, and advanced additive technologies used in modern engine oils.

Methodology for Preparation Nano-Lubricants

Selection of Base Lubricant

The first step in the preparation of nano-lubricants involves the careful selection of a suitable base oil. In the present study, commercially available engine oil was selected as the base lubricant due to its wide use in automotive engines and its favourable viscosity–temperature characteristics. Base oils possess superior oxidation stability, enhanced film-forming capability, and improved thermal resistance when compared to conventional mineral oils. These characteristics make them an ideal candidate for evaluating the effect of nanoparticle additives.

The viscosity grade ensures adequate lubrication under both low-temperature starting conditions and high-temperature operating environments. Moreover, the compatibility of this lubricant with nanomaterials has been reported in several Thermal investigations. The base oil was used without any further chemical modification to maintain the original physicochemical properties.

Prior to the preparation process, the lubricant was filtered to remove any unwanted impurities and then stored in sealed laboratory containers to avoid contamination from atmospheric moisture or particulate matter.

Selection of Nanoparticles

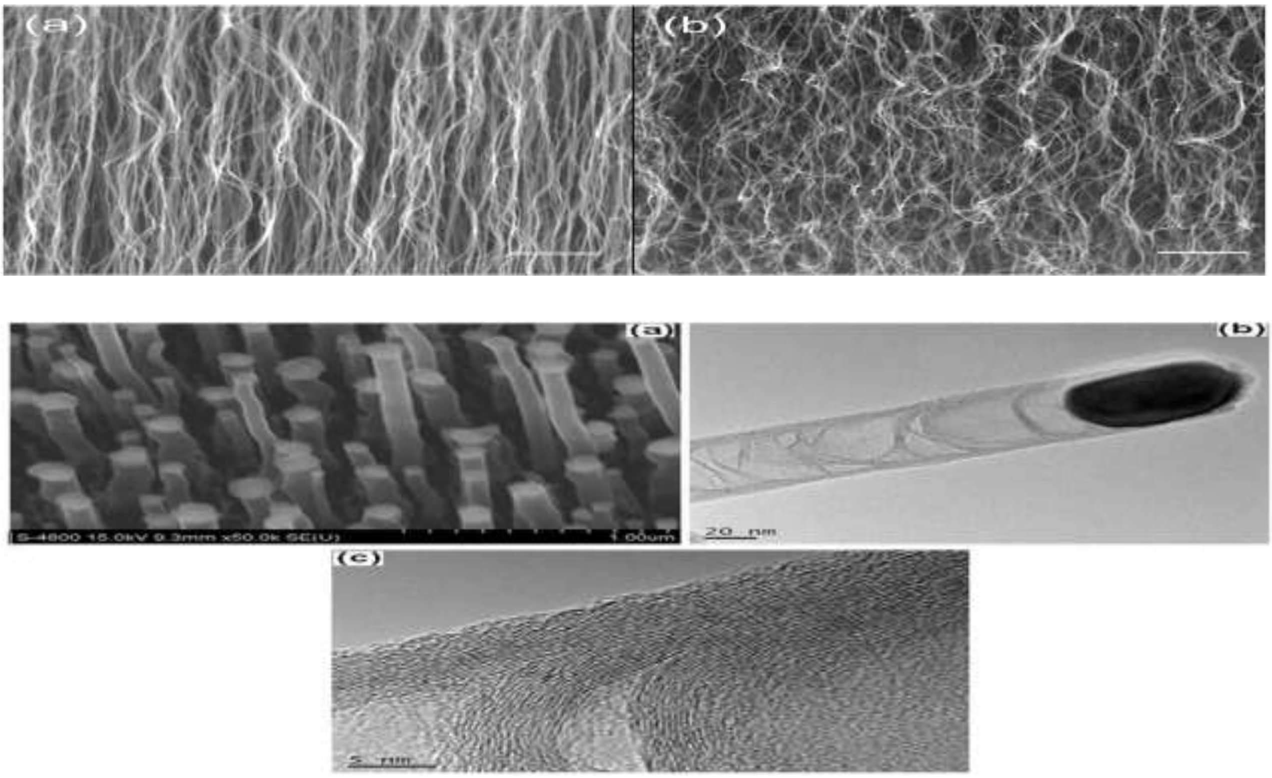


Fig.14- Microscopic View of Various Nano Particles

RESULTS AND DISCUSSION

Dispersion Stability of the Prepared Nano-Lubricants

The stability of nanoparticle dispersion within the base lubricant plays a crucial role in determining the effectiveness of nano-lubricants. In the present study, the prepared nano-lubricant samples were subjected to a sedimentation stability test for a period of one week after the mixing and sonication processes. During this period, the samples were stored under undisturbed laboratory conditions and visually examined to observe any particle settlement or phase separation.

The experimental observations indicated that the dispersion method employed in this study resulted in relatively stable nano-lubricant suspensions. The combined effect of magnetic stirring and ultrasonic probe sonication significantly

improved the distribution of nanoparticles throughout the lubricant. Ultrasonic cavitation generated during probe sonication helped break down nanoparticle agglomerates and promoted uniform dispersion within the oil matrix.
The use of surfactants such as Span-80 also played an important role in maintaining suspension stability. These surfactants reduce the interfacial tension between nanoparticles and the lubricant medium and form a thin protective layer around the particles. As a result, particle clustering and agglomeration were minimized. Although a slight tendency of sediment formation was observed in samples with higher nanoparticle concentrations after extended resting periods, the overall stability remained acceptable for thermal characteristics testing.

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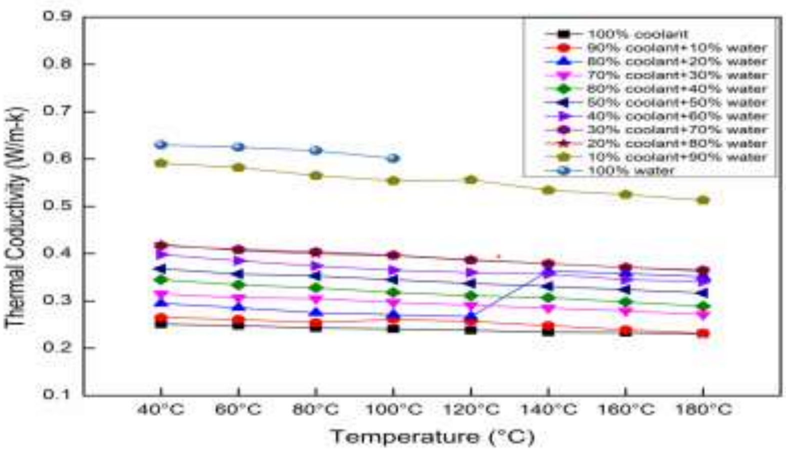

CONCLUSION

- The experimental work involved preparing nano-lubricant samples by dispersing nano-scale particles into a base lubricant in order to study their influence on lubrication behavior under operating conditions.
- Engine oil was selected as the base lubricant because it is commonly used in automotive lubrication systems and performs reliably across a wide range of temperatures and loads.
- Nanoparticles were used as additives due to their mechanical strength and their known ability to reduce friction and improve surface protection in lubricated contacts.

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