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Optimisation of Lubricants by Nano Metal Powder

[1]Tirmare Sankalp, [2]Pankaj Awate
[1,2]PVPIT, BUDHGAV(Sangli), MAH., India.

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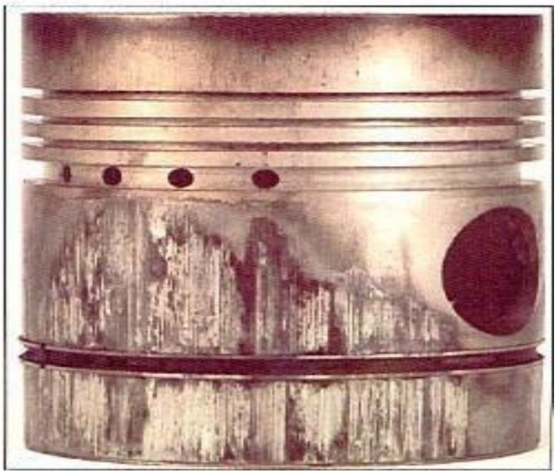
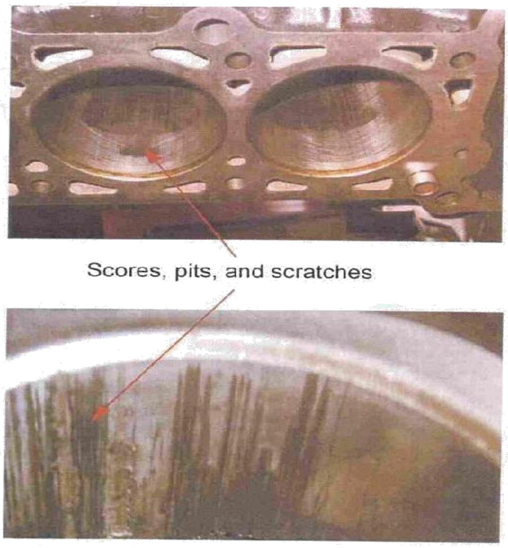
Abstract

Lubricants play a vital role in machine performance, machine life, reducing wear and friction and preventing component from failure. Poor performance of lubricant can cause significant energy and material losses. To improve the lubricating properties of bearing oil, nanoparticles can be added in bearing oils. In this research Aluminium Oxide (Al2O3) nanoparticles were added into the SN-500 base oil and tribological properties were examined. The concentrations of Al2O3 nanoparticles prepared in SN-500 base oil are 0.1 wt. %, 0.5 wt. %, 0.75 wt. % and 1 wt. %. The trials of friction and wear were carried out on a pin on disc tribotester, with varying the concentration of nanoparticle and by varying load (10N, 30N & 50N). The obtained results were compared between Al2O3 nano oil and SN-500 base oil. The results showed that 0.5wt% for Al2O3 nano fluid concentration was an optimum concentration for wear. For the friction reduction test, when Al2O3 nanoparticles were added into a base oil, the coefficient of friction reduced by 19%, 35% & 52% at 0.5 wt.% concentration as compared to oil without nanoparticles.

Introduction

Large global demand for lubricants, frequent engine oil replacement, higher-cost and lower-performing additives, and piston wear failure due to inadequate lubrication, oil starvation, and abrasion.



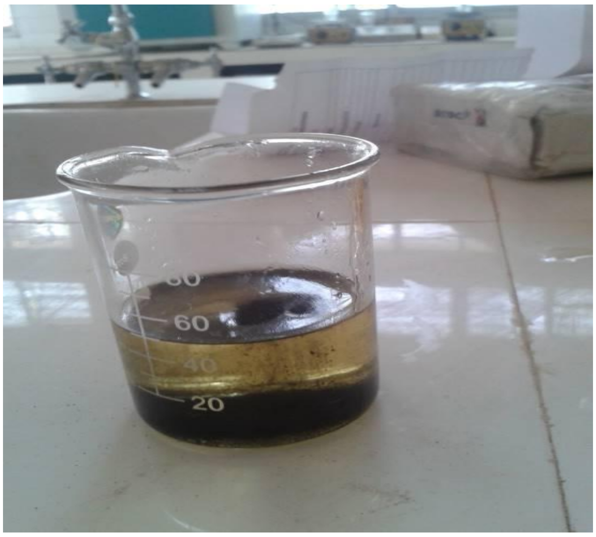


This research work analyzes the tribological behaviour of Al_2O_3 nanoparticles as additives in SN-500 base oil. It compares wear performance of the base oil with and without nanoparticles and determines the optimum nanoparticle concentration for minimum wear. Specimens are tested using a pin-on-disc tribometer to evaluate wear behaviour. The future scope focuses on reducing friction and wear, meeting stricter lubrication requirements, withstanding high temperatures and extreme pressure (EP) conditions, and improving the tribological properties of the base lubricant oil through the addition of Al_2O_3 nanoparticles.

Literature Survey

Y. Y. Wu examined the tribological properties of lubricating oils, including API-SF engine oil and base oil, using CuO, Al_2O_3, and nano-diamond nanoparticles as additives. D. X. Peng investigated the tribological properties of diamond and CuO nanoparticles added to liquid paraffin. Experimental studies using SEM showed that the optimal concentration for minimizing wear scar diameter was 0.2–0.5 wt% for diamond and 0.1–1 wt% for CuO nanoparticles. Thus, both nanoparticles, even at low concentrations, demonstrated better anti-wear and anti-friction properties than pure paraffin oil.

Ming Zhan examined the tribological properties of blank PAO and PAO containing $CaCO_3$ nanoparticles. The results showed that $CaCO_3$ nanoparticles can significantly improve load-carrying capacity as well as anti-wear and friction-reduction properties. Total frictional losses in an I.C. engine are approximately 13–17% and include direct friction losses, pumping losses, blow losses, and valve throttling losses. These losses are influenced by the stroke-to-bore ratio, cylinder size and number of cylinders, compression ratio, engine speed, engine load, cooling-water temperature, oil viscosity, and number of piston rings.



Al_2O_3 is used because of its good lubrication and thermal conductivity properties. Oleic acid is used as a surfactant for stabilization of the nanoparticles. The weight of a 500 ml SN-500 sample is 432 g. For preparation, 0.432 g (1 wt%) of Al_2O_3 nanoparticles is added to 50 ml of oleic acid.

Mix 0.432 gram nano powder into oleic acid. Keep it on Magnetic stirrer for 20 min. Taking SN-500 Base oil with 450ml Quantity. Mix Oleic Acid into Base Oil .Magnetic Stirrer for 45 min

Experimentation: Disk mounted on Motor .Pin mounted between holder socket. Sample oil spread on disk. One test taken for 10 minute time period. Also Speed of disk was constant at 1000 rpm. Sliding speed – 5 m/s. Data acquisition system. Changing different samples and different loads i.e. 10N, 30N and 50N respectively. In order to confirm the repeatability of experimental data, the friction coefficient was measured in triplicate using the pin on disk tribotester under 10N, 30N and 50N load conditions at 10 minute with concentration of particles constant for respective tests. The friction coefficients of SN-500 base oil without nanoparticles are displayed .A similar trend for different experimental results, and a maximum standard deviation of 0.198, 0.120 and 0.100 with respect to 10N, 30N and 50N load conditions among all sets of test data.

Table 1: Results

Observation	**0.5% Percentage of Al2O3 nano particles by weight**		
Load applied	10N	30N	50N
Coeff. of Friction	0.097	0.094	0.09
Wear (microns)	7	9	18
Wear in microns in Base oil only	11	26	38

Conclusion

As a lubricant, friction-reduction properties of base oil can be enhanced by the addition of Al2O3 nanoparticles to particular concentration. Dispersing nanoparticles inside base oil, due to the base oil's high viscosity, is a very difficult work. The nanoparticles modified by oleic acid exhibited good dispensability and stability in base oil. The deposition of nanoparticles on the worn rubbing surface can decrease the shearing stress, and hence reduce friction and wear. Adhesion between the contact surfaces was reduced with the presence of nanoparticles. Rolling ability of nanoparticles could significantly restrict the increase in the friction force, especially under higher loading conditions. As a result especially, wear between components remains reduced.0.5wt% for Al2O3 nano fluid concentration was an optimum concentration for wear. The wear in microns of SN-500 base oil without nanoparticles are 10 µ, 26 µ and 38 µ with respect to load conditions 10N, 30N and 50N respectively among all sets of test data. The anti-wear property at
0.5 wt. % Al2O3 concentration of the base oil sample drastically improved the wear reduction at 10N, 30N and 50N loading conditions and the values are 7µ, 9 µ and 18 respectively. For the friction reduction test, when Al2O3 nanoparticles were added into base oil, the coefficient of friction reduced by 19%, 35% & 52% at 1wt% concentration as compared to SN-500 base oil without nanoparticles.

References

Bharat Bhushan, "Principle and application of tribology", A Wiley-Interscience Publication (1999), ISBN 0-471-59407-5, pp. 98–415.

Ramsey Gohar, Homer Rahnejat, "Fundamentals of Tribology", 2nd ed., Imperial College Press, UK, 2012, pp. 1–4.

http://www.razorinnovation.com/razor/tech-nano-energizer-works.htm

Y.Y. Wu & W.C. Tsui, "Experimental analysis of tribological properties of lubricating oils with nanoparticles additives", Wear 262 (2007), pp. 819–825.

R. Chou, "Tribological behaviour of polyalphaolefin with the addition of nickel nanoparticles", Tribology International, vol. 43, 2010, pp. 2327–2332.

Ashkan Moosavian, G. Najafi, Barat Ghobadian, Mostafa Mirsalim, Seyed Mohammad Jafari, Peyman Sharghi, "Piston scuffing fault and its identification in an IC engine by vibration analysis", Applied Acoustics 102, 2016, pp. 40–48.

P.C. Mishra, "A Review of Piston Compression Ring Tribology", Tribology in Industry, Vol. 36, No. 3, 2014, pp. 269–280.

Sudeep Ingole, Archana Charanpahari, Amol Kakade, S.S. Umare, D.V. Bhatt, Jyoti Menghani, "Tribological behavior of nano TiO_2 as an additive in base oil", Wear 301, 2013, pp. 776–785.

Ming Zhang, Xiaobo Wang, Yanqiu, "Performance and anti-wear mechanism of $CaCO_3$ nanoparticles as a green additive in poly-alpha-olefin", Tribology International 42 (2009), pp. 1029–1039.

J.C. Sanchez-Lopez, M.D. Abad, L. Kolodziejczyk, "Surface-modified Pd and Au nanoparticles for anti-wear applications", Tribology International 44 (2011), pp. 720–726.

Pankaj P. Awate, Shivprakash B. Barve, "Enhanced microstructure and mechanical properties of Al6061 alloy via graphene nanoplates reinforcement fabricated by stir casting", Functional Composites and Structures, 2022.

Pankaj P. Awate, Shivprakash B. Barve, "Microstructural observation and mechanical properties behavior of Al_2O_3/Al6061 nanocomposite fabricated by stir casting process", Engineering Research Express, 2022.

Pankaj P. Awate, Shivprakash B. Barve, "Graphene/Al6061 nanocomposite selection using TOPSIS and EXPROM2 multi-criteria decision-making methods", Materials Today: Proceedings, 2022.

Pankaj P. Awate, Shivprakash B. Barve, "TOPSIS & EXPROM2 multicriteria decision methods for Al_2O_3/Al6061 nanocomposite selection", Materials Today: Proceedings, 2021.

Pankaj P. Awate, Shivprakash B. Barve, "Graphene/Al6061 nanocomposite for aerospace and automobile application", Materials Today: Proceedings, 2023.

Pankaj P. Awate, Shivprakash B. Barve, "Al_2O_3/Al6061 nanocomposite for aviation and automobile components", Materials Today: Proceedings, 2024.

Pankaj P. Awate, S.D. Admuthe, "Investigation of mechanical behavior of CNT reinforced A356 nanocomposites", Journal of Propulsion Technology, 2024.

Pankaj P. Awate, Shivprakash B. Barve, "Formation and characterization of aluminum metal matrix nanocomposites", Int.

J. Mech. Prod. Eng. Res. Dev., 2019.

Pankaj P. Awate, "Study on fabrication and characterization of aluminum metal matrix composites and nanocomposites", Journal of Applied Science and Computations, 2019.

Pankaj Awate, Vijay Chavan, "Characteristics enhancement of MWCNT/AA7075 nanocomposites for automotive and aerospace application", Journal of Xidian University.

Pankaj P. Awate, "Review on CNT reinforced A356 nanocomposites", International Research Journal of Engineering and Technology, 2024.

Pankaj P. Awate, R.B. Sonawane, "Investigation of mechanical behaviour of CNT reinforced Al6061 nanocomposites", International Journal of Engineering Research & Technology, 2026.

Pankaj Awate, Vijay Chavan, "Review on CNT reinforced Al7075 aluminium alloy nanocomposites", IRJET, 2025.