Enhancement of Kinematic viscosity of coconut oil

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Abstract - The use of vegetable oils for lubrication purposes has been in practice for many years. In this study the CaO nanoparticles are prepared by sol-gel method and are homogeneously dispersed into the commercially available coconut oil at room temperature. The kinematic viscosity results of coconut oil containing different concentrations of CaO nanoparticles are discussed. The results show that the kinematic viscosity increase with respect to increasing nanoparticle concentration.

Keywords: vegetable oils, kinematic viscosity, nanoparticles, lubrication, coconut oil

1. Introduction

Lubrication is the action of applying a solid/semi-solid/liquid/gas substance to an engine/component so as to minimize friction and allow smooth movement. It may also have the function of transmitting forces, reduces the heat generated when the surfaces interacts, transporting foreign particles and heating/cooling the interacting surfaces in relative motion. Generally liquid lubricants contain 90% base oil like petroleum fractions/mineral oils and less than 10% additives for enhancing the functional properties. Vegetable oils or synthetic liquids such as hydrogenated silicones, polyolefins, fluorocarbons, esters and many others are also used as base oils in which dispersed additives deliver increased viscosity, reduced friction and wear, resistance to corrosion and oxidation, etc. [1].

The use of vegetable oils for lubrication purposes has been in practice for many years due to the depletion of fossil fuels. The use of vegetable/bio-lubricant oils for lubrication purposes has been in practice for many years due to the environmental impact of commercial fossil fuels [2]. Bio-lubricants are extracted from vegetable oils which have good lubricity and viscosity index and have poor oxidation stability [3]. The thermo-physical properties of the bio-lubricants can be improved by dispersing the nano-scale materials which has high thermal conductivity and effective viscosity compared to conventional base liquid like water [1]. The nano additives containing base fluids are called as nanofluids/nanolubricants. The thermo-physical properties of nanofluids/nanolubricants such as thermal conductivity and viscosity are endure direct impact nano-additives

Kedzierski measured the kinematic viscosity and density of polyolester based copper oxide nanoparticle (30 nm diameter, spherical) suspension at atmospheric pressure for a temperature range from 288 K to 318 K with differing nanoparticle mass concentration (2.9%, 5.6% and 39.2%). The results show that viscosity and the density increase with respect to increasing nanoparticle mass concentration and decrease with respect to increasing temperature [4]. Maheswaran et al. experimentally studied the effect of garnet dispersion on the kinematic viscosity of SN500 grade gear lubricant oil and reported that the kinematic viscosity and the density increase with respect to increasing nanoparticle mass concentration and decrease with respect to increasing temperature [5-8]. Redhwan et al. was investigated the viscosity and thermal conductivity of the SiO_2 nanoparticles homogeneously dispersed in Polyalkylene glycol lubricants for the volume concentrations of 0.2–1.5% and working temperatures of 303 K–353 K and compared the results with Al_2O_3 nanolubricants at different concentrations. The results show that the kinematic viscosity and the density increase with respect to increasing nanoparticle mass concentration and decrease with respect to increasing temperature [9].

Further, nanofluids and nanolubricants exhibits notable tribological and anti-wear properties under normal and extreme pressure conditions compared to conventional lubricating oils. Rende Liu et al. [10] prepared surface-modified mixed rare earth nanoparticles and their tribological performances as lubrication additives are evaluated using a four-ball friction and wear tester. The analytical results show that the average size of the particles is less than 30nm and they exhibit excellent anti-wear, load carrying and good friction-reducing capacities in base stock. Auger electron spectroscopy and Xray photoelectron spectrometry are performed to investigate their tribochemical mechanism and the results indicate that there is a boundary film composed with ferrous oxides, organic acid, rare earth oxides and complex of rare earth metals formed on the rubbed surface. Kenneth C. Ludema [11] reviewed various theories focused on adhesion as the cause of scuffing and they usually do not take account of the changing surface roughness during sliding. W. Piekoszewski et al. [12] presented a new method for research of scuffing. It is realized on the four-ball tester and considers scuffing as a process leading to seizure, i.e. the stopping of the relative movement of a tribo-system. For extreme pressure lubrications they concluded that due to chemical reactions and diffusion probably inorganic compounds with their good anti-seizure properties mitigate the scuffing propagation and reduce wear intensity. Mukesh Kumar et al. [13] described a methodology for preparing nano-and micro-PTFE (Polytetrafluoroethylene) particles that were blended into 150N API Group II base oil. The particle sizes were 50 nm, 150 nm, 400 nm and 12 mm, and the particle concentrations were 4, 8 and 12%. The formulations were characterized for physical properties and tribological behavior. Physical properties included density, viscosity, pour point, and flash point. Results from tribological testing of the experimental oil sand bearing steel test specimens showed that PTFE particles can significantly improve the weld load, as well as anti-wear and friction reduction properties. The smaller the size of PTFE particles and the higher their concentration, the greater was the performance improvement.

In this study the CaO nanoparticles are prepared by sol-gel method and are homogeneously dispersed into the commercially available coconut oil at room temperature. The viscosity of coconut oil containing different nanoparticle concentration is investigated using rotary viscometer test method. The kinematic viscosity results of coconut oil containing different concentrations of CaO nanoparticles are discussed in this paper.

2. Materials

In this study coconut oil is used as the base fluid for preparing the nanofluid. It is rare to find coconut trees in dry regions which are mostly found in tropical regions. Its fruits are rich in saturated fatty acids (91%) and it does not oxidize easily. The antioxidant properties of coconut oil come from its saturated fats like caprylic acid, capric acid, myristic acid and caproic acid. Coconut oil is used in many natural beauty products. It is also naturally antibacterial and antifungal, coconut oil for skin is an excellent moisturizer. Moreover, coconut oil has been widely used as a lubricating agent in rickshaws and scooters in India.

The CaO nanoparticles are used as a lubricant additive. It is prepared by sol-gel method. The CaO based nanolubricants are prepared by dispersing CaO nanoparticles into coconut oil using ultrasonication process.

3. Results and discussion

The SEM images of CaO nanoparticles are shown in Figure 1 which is directly obtained from sol-gel method. It shows that the surfaces of CaO nanoparticle having the morphology of irregular flake-shape.

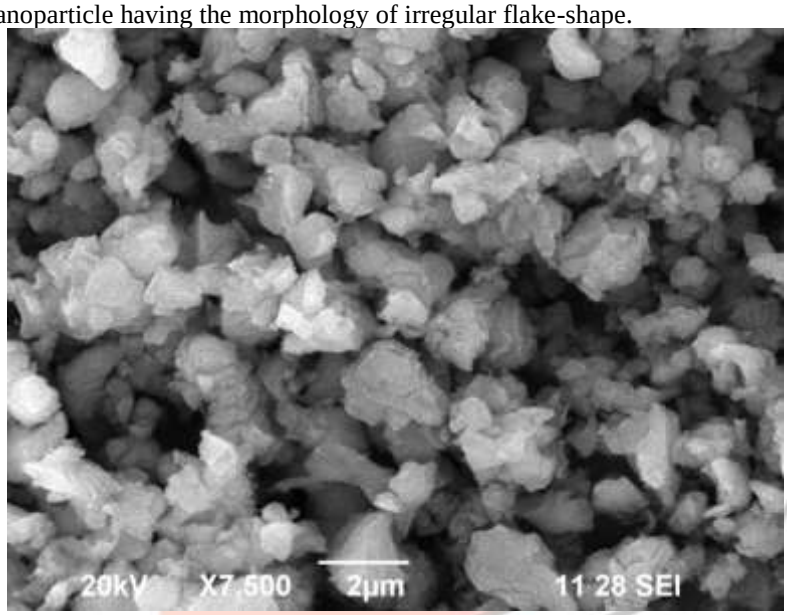

Figure 1 SEM images of CaO nanoparticles

In this study, coconut oil is used as the base fluid for preparing the nanofluid. The CaO nanoparticles are used as a lubricant additive. The CaO based nanolubricants are prepared by dispersing CaO nanoparticles into coconut oil using ultrasonication process. The viscosity of lubricating oil is typically measured and defined in two ways, either based on the kinematic viscosity or its dynamic viscosity. The kinematic viscosity is defined as the resistance to flow and shear due to gravity.

In this study the viscosity of coconut oil containing different nanoparticle concentration is investigated using rotary viscometer test method. In this method, a metal spindle is rotated in the oil at a constant rpm, and the torque required to rotate the spindle immersed in the test fluid is measured. The absolute viscosity can be determined based on the internal resistance to rotation provided by the shear stress of the test oil.

The 0.1 wt%, 0.2 wt%,0.3 wt%,0.4 wt%,0.5 wt% and 0.6 wt% of CaO nanofluids are prepared by using ultrasonication process. The viscosity of additive free coconut oil and different concentrations of CaO nanofluids are estimated using rotary viscometer test method.

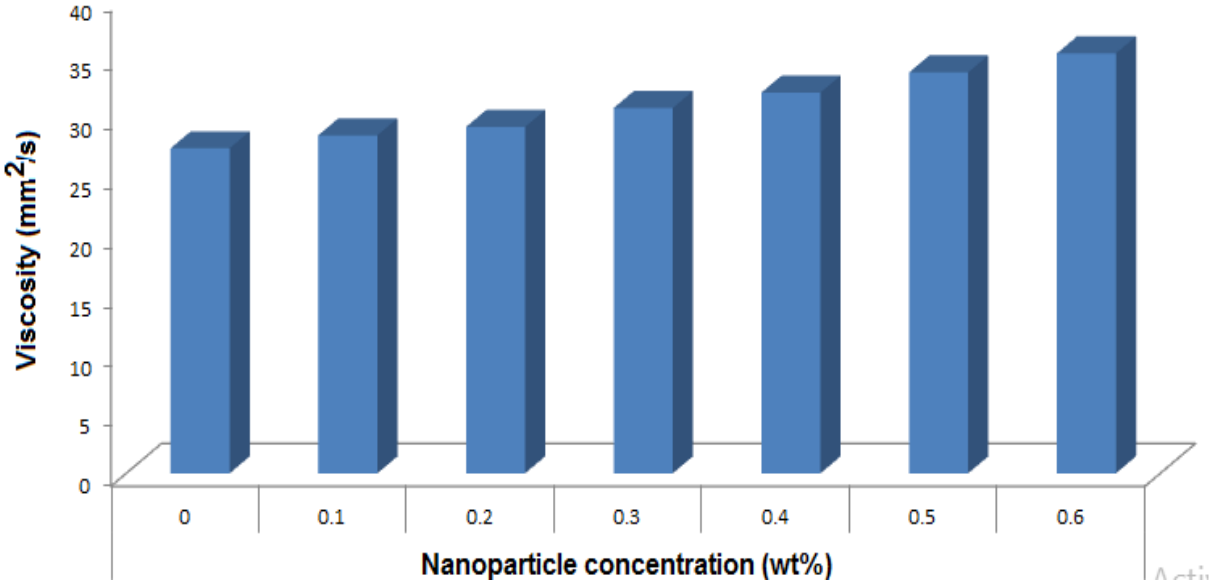

Figure 2 Viscosity of coconut oil

The Figure 2 shows the effect of nanoparticle dispersion on the viscosity of coconut oil. The viscosity of additive free coconut oil at 40◦C is 27.4 mm^2/s which increases to 28.5 mm^2/s, 29.2 mm^2/s, 30.8 mm^2/s, 32.1 mm^2/s, 33.8 mm^2/s and 35.4 mm^2/s when it is disersed with CaO nanoparticle concentration of 0.1 wt%, 0.2 wt%,0.3 wt%,0.4 wt%,0.5 wt% and 0.6 wt%, respectively. This viscosity enhancement is due to the change of internal viscous of shear stress due to the impact of lower temperature on liquid viscosity does not weakens the intermolecular forces and the forces between molecules of the measured range of nanofluids.

Conclusions

The present work focuses on the estimation of the kinematic viscosity of CaO nanoparticles dispersed in coconut oil nanolubricants. The viscosity of coconut oil containing different nanoparticle concentration is investigated using rotary viscometer test method. The results show that the kinematic viscosity increase with respect to increasing nanoparticle concentration due to the change of internal viscous of shear stress due to the impact of lower temperature on liquid viscosity does not weakens the intermolecular forces. However, further investigations need to be done on the performance of coconut oil nanolubricants to extend the present work.

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