Development of Vegetable Oil-based Nano-lubricants using MMT Nanoparticles as Lubricant Additives

MD Mashfiqur Rahman, Md Abu Sayeed Biswas, and Javier A. Ortega
Department of Mechanical Engineering
The University of Texas Rio Grande Valley
Edinburg, TX 78539, USA
mdmashfiqur.rahman01@utrgv.edu, mdabusayeed.biswas01@utrgv.edu,
javier.ortega@utrgv.edu

Laura Peña-Parás and Demófilo Maldonado-Cortés
Engineering Department
Universidad de Monterrey
San Pedro Garza García, N. L. 66238, México laura.pena@udem.edu,
demofilo.maldonado@udem.edu

Abstract

Because of the environmental impact and price volatility, there has been a growing concern on the use of petroleumbased lubricants. This issue has stimulated research into the development of biodegradable lubricants like vegetable oils. In this study, the tribological and rheological behavior of sunflower, peanut, and corn oils modified with montmorillonite nanoclay (MMT) as lubricant additives were evaluated at various concentrations. A custom-made block on ring tribotester was used to evaluate the wear and friction characteristics of the nano-lubricants, following the ASTM G-077-05 standard. The effects of concentration and shear rate on shear viscosity were studied using a parallel plate rheometer, and the experimental data was compared with conventional models. Analytical methods, including scanning electron microscopy (SEM), X-Ray diffraction (XRD), thermogravimetric analysis (TGA), and profilometry, were used to characterize the morphology and structure of the MMT nanoclay, as well as the worn surfaces. The experimental results showed that the volumetric wear and coefficient of friction decreased with the addition of MMT nanoparticles, at different concentrations, compared to the base vegetable oils. In conclusion, the newly developed vegetable oil-based nano-lubricants with the addition of MMT nanoclay, look like a promising environmentally friendly solution to compete with petroleum-based lubricants.

Keywords
Vegetable oils, nano-lubricant, montmorillonite nanoclay, rheological behavior, tribology