Available online at www.sciencedirect.com

ScienceDirect

Procedia Engineering 149 (2016) 431 – 437

Procedia Engineering

www.elsevier.com/locate/procedia

International Conference on Manufacturing Engineering and Materials, ICMEM 2016, 6-10 June 2016, Nový Smokovec, Slovakia

On the tribological performance of vegetal lubricants: experimental investigation on Jatropha Curcas L. oil

Ruggiero A.[a]*, D'Amato R.[b], Merola M.[a], Valášek P.[c], Müller M.[c]

[a]*Università di Salerno, Department of Industrial Engineering, Salerno, Italy*
[b]*Universidad Politecnica de Madrid, Departamento de Ingeniería Mecánica, Química y Diseño Industrial, Madrid, Spain*
[a]*Czech University of Life Sciences Prague, Faculty of Engineering, Department of Material Science and Manufacturing Technology, Prague, Czech Republic*

Abstract

The limited resources of petroleum-based lubricants and increased environmental contamination, that they produce, lead to increased demand for bio-lubricants. Due to several factors such as biodegradability, good lubricating properties and low production costs, the plant oils represent a good alternative as reference to replace the petroleum-based oils. Obviously, the need to ensure the use of vegetable oils as a source of food makes non-edible vegetable oils a formidable source for plant oil lubricants. Thus, the toxicity of Jatropha Curcas L. oil makes it a very attractive and alternative lubricant source. Therefore, the aim of this work is to investigate on tribological performance of Jatropha Curcas L. oil in the lubricating contact pair AISI 52100 steel sliding against X210Cr12 steel. The experimental tests were carried out using ball-on-flat reciprocatory tribometer for several frequencies and with normal load of 12N. The Jatropha Curcas L. oil was analyzed for its chemical and physical properties such as viscosity, density and flash point. The results were interpreted on the basis of the evolution of the friction coefficient. The evolution of the friction coefficient was monitored for 40 min in all tests. The results show that the friction coefficient decreases with the increase of the frequency, and the final value stays in the range of 0.04-0.122.

© 2016 The Authors. Published by Elsevier Ltd. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).
Peer-review under responsibility of the organizing committee of ICMEM 2016

Keywords: Jatropha Curcas L., natural-based oil, tribological performance, AISI52100 steel, X210Cr12 steel.

1. Introduction

The quick exhaustion of fossil reserves, the rise in prices of products made from petroleum and the high levels of environmental pollutants lead to explore alternative and no contaminant lubricants [1]. Unfortunately, due to their low biodegradability and high toxicity, the mineral oils are not a viable alternative. The lubricants do not create many problems with respect to a set of other products released into the environment, although it a large portion of lubricants, during or after their use, can pollute the environment [2]. Several advantages and properties are offered by the use of vegetable oils: biodegradability [3, 4], low production costs [5], good lubricating properties, low toxicity, high viscosity and high flash points [6]. The plant oils are employed in various industrial applications as for the automotive lubricants. In this case the lubricants are derived from rapeseed, and soy oils that are finding good use in European countries [7].

Jatropha Curcas L. is a perennial shrub, poisonous, with a maximum height of approximately 5 m, which belongs to the Euphorbiaceae family. Areas where Jatropha Curcas L. grows are subtropical and tropical regions in Africa, Central and South America and South Asia as well. Seeds of Jatropha Curcas L. plants are pressed and the obtained oil is used in many industrial

* Corresponding author. Tel.:+39 089964312; fax: ++39089964037.
E-mail address: ruggiero@unisa.it

1877-7058 © 2016 The Authors. Published by Elsevier Ltd. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).
Peer-review under responsibility of the organizing committee of ICMEM 2016
doi:10.1016/j.proeng.2016.06.689

branches from health services to a production of biodiesel [8, 9]. Conditions for pressing of seeds and an optimization of the pressing process are described by many authors [8]. Being Oil Jatropha Curcas L. a cheap natural-based lubricant, it is important to assess its characteristics to extend the application conditions. Experimental investigation describes important oil characteristics as viscosity, density and flash point. The authors performed tests, to know its chemical and physical properties, according to the standard ASTM D445 - Standard Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and Calculation of Dynamic Viscosity).

Therefore, the aim of this work is to investigate on tribological performance of Jatropha Curcas L. oil in the lubricating contact pair AISI E52100 steel sliding against X210Cr12 steel. The test was carried out using a ball-on-flat reciprocatory tribometer for several frequencies and with normal load of 12N. The results were interpreted on the basis of the evolution of the friction coefficient.

2. Methods

Jatropha Curcas L. seeds from Indonesia were pressed by Labor Tech MP Test 5.050 machine, and the pressure of 5 kN was applied. Deformation speed corresponded to 10 $mm \cdot min^{-1}$. According to the standard ASTM D445 the density, viscosity and flash point of the Oil Jatropha Curcas L. were investigated. All tests were performed in the ETSIDI laboratory of chemical engineering of the Polytechnic University of Madrid. For the density a pycnometer of 10 ml was used and the result was obtained at a temperature of 15ºC. For the viscosity, the temperature was of 40ºC under ASTM D445-65 recommendation and Afora Cannon-Fenske viscometer (Series 300) was employed (**Figure 1**).

Figure 1: Afora Cannon-Fenske viscometer (Series 300)

For the flash point a Flash Point Tester was used, according to Pensky-Martens ASTN D93 IP 34 Semi-Automatic DIN 51758. The flash point measures the tendency of the sample to form an ignitable mixture with air. The sample is heated slowly (5ºC/min) and at constant speed with continuous stirring. At regular intervals a small flame in the glass has been introduced by stopping, simultaneously, the agitation. The flash point is defined as the lowest temperature at which ignition of the vapor above the sample occurs. The test was performed at an atmospheric pressure of 703 mmHg. For this reason, according to the standard ASTM D445, this result should be corrected, using the formula reported below, at a pressure of 760 mmHg.

$$T = T_{obs}(^{o}C) + 0.333 \times [760 - P_{obs}] \quad (1)$$

Friction tests were carried out using a ball-on-flat testing apparatus on a TR-BIO 282 Reciprocatory Friction Monitor (Ducom Instruments, Bangalore, India), following a consolidate procedure [10,11]. In **Figure 2** the schematic apparatus is represented. An AISI E52100 steel pin – circular section, 6 mm diameter – was hold in contact against a flat specimen of X210Cr12 steel.

Download English Version:

https://daneshyari.com/en/article/853226

Download Persian Version:

https://daneshyari.com/article/853226

Daneshyari.com