International Journal of Mechanical Sciences 53 (2011) 549–555

Contents lists available at ScienceDirect

International Journal of Mechanical Sciences

journal homepage: www.elsevier.com/locate/ijmecsci

Experimental evaluation of palm oil as lubricant in cold forward extrusion process

S. Syahrullail*, B.M. Zubil, C.S.N. Azwadi, M.J.M. Ridzuan

Faculty of Mechanical Engineering, Universiti Teknologi Malaysia, 81310 UTM Skudai, Johor, Malaysia

ARTICLE INFO

Article history:
Received 17 May 2010
Received in revised form
24 February 2011
Accepted 8 May 2011
Available online 23 May 2011

Keywords:
Aluminum
Palm stearin
Visioplasticity
Mineral oil
Extrusion

ABSTRACT

Today, vegetable oil is much desired for its application as a lubricant in metal forming processes, because it is a renewable resource and has high biodegradability compared to mineral oil. According to the Organization for Economic Cooperation and Development for the European Union 301C (OECD) testing method, the biodegradability levels of vegetable oils are better compared to petroleum-based lubricants. Palm oil is used more often than other vegetable oils. Therefore, palm oil has the potential to fulfill the demand for vegetable-based lubricants. The purpose of this paper is to evaluate the viability of palm oil when used as a lubricant in cold work such as the forward plane strain extrusion process. The performances of palm oil were compared with additive-free paraffinic mineral oil. Experimental work with a plane strain extrusion apparatus with a symmetrical workpiece was carried out at room temperature. The material of the workpiece is annealed pure aluminum A1100. The visioplasticity method was used to calculate the velocities and effective strain in the deformation zone of the workpiece. The results obtained from the experimental work showed that palm oil has satisfactory lubrication performances, as compared to paraffinic mineral oil, and has advantages in reducing the extrusion load.

1. Introduction

Ecological factors are gaining importance in our society. Bearing in mind that our environment is being increasingly contaminated with all kinds of pollutants, any reduction is welcome. From an environmental point of view, and compared to a number of other chemical products, lubricants are not particularly problematic. A large proportion of lubricants pollute the environment either during or after use. It has been stated that 5–10 million tons of petroleum-based oleochemicals enter the biosphere every year. About 40% comes from spills, industrial and municipal waste, urban runoff, refinery processes, and condensation from marine engine exhaust [1]. These oleochemical pollutants are derived from the food industry, petroleum products, and byproducts such as lubricating, hydraulic, and cutting oils.

The terminology used in connection with environmental compatibility can be split into two criteria, i.e., subjective and objective. The non-measurable or subjective criteria are environmentally friendly and environmentally compatible. The objective criteria, among others, include biodegradability, water solubility, ecological toxicity, efficiency improvements, etc. Normally a biodegradability of at least 60%, according to OECD 301, is considered the main objective criterion for bio-lubricants. One of the possible lubricants that can satisfy this need is vegetable oil, which can offer significant environmental advantages with respect to resource renewability, biodegradability, and adequate performance in a variety of applications [2].

Natural fatty acid oils such as castor oil, palm oil, rapeseed oil, soybean oil, sunflower oil, and tallow oil have been used in lubricants for years. They are the so-called triglycerides of more or less unsaturated fatty esters. This type of base is biodegradable and, compared to mineral oils, will show excellent tribological qualities such as low friction coefficients and good wear protection. Their range of use is limited by lower stability against thermal oxidative and hydrolytic stress and partly inferior cold flow properties. These limits can be improved gradually with additives.

In Malaysia, palm oil has the possibility to be used as an industrial lubricating oil. Palm oil is vegetable oil, which is biodegradable, and also has a high production rate, which could fulfill the demand for vegetable-based lubricating oil in the future. One hectare of palm trees can produce almost 10 times as much oil compared to other sources of vegetable oil [3]. Therefore, palm oil has the potential to fulfill the supply volume in the demand for vegetable-based lubricants.

In this research, we examine RBD palm stearin (a type of refined palm oil) used as a lubricant in a cold work forward plane strain extrusion process. The extrusion load from the experimental work

* Corresponding author.
E-mail address: syahruls@fkm.utm.my (S. Syahrullail).

0020-7403/$ - see front matter © 2011 Elsevier Ltd. All rights reserved.
doi:10.1016/j.ijmecsci.2011.05.002