Contents lists available at SciVerse ScienceDirect

Chemical Engineering Research and Design

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

Effect of process conditions on the removal of phospholipids from *Jatropha curcas* oil during the degumming process

Kuan-Ting Liu[a], *Shun Gao*[a], *Tsair-Wang Chung*[a,*], *Char-ming Huang*[b], *Yung-Sen Lin*[c]

[a] *Department of Chemical Engineering/R&D Center for Membrane Technology, Chung Yuan Christian University, Chungli, Taoyuan 320, Taiwan*
[b] *Department of Environmental Engineering, Kun Shan University, Tainan 710, Taiwan*
[c] *Department of Chemical Engineering, Feng Chia University, Taichung 407, Taiwan*

ABSTRACT

This work aims to study the removal of phospholipids from *Jatropha* oil through a conventional degumming process combined with ultrafiltration membrane separation in a small-scale batch system. The effect of temperature, amount of acid solution added, and speed of centrifugation during the conventional degumming process were analyzed using response surface methodology (RSM). The optimum operating condition was determined to be at 65 °C, with 4 wt% acid solution added and a centrifugation speed of 1600 rpm. After the degumming process, the phospholipid content of *Jatropha* oil was reduced from 1200 ppm to 60 ppm. This was further reduced to less than 20 ppm by subjecting the oil to ultrafiltration membrane separation. It was found that the entire process not only decreased the phospholipid content of the oil but also improved its fuel properties, especially its kinematic viscosity and carbon residue. The kinematic viscosity was decreased from 30.02 cSt (mm^2/s) to 27.20 cSt, while the carbon residue was decreased from 7.8% to 4.0%. Aside from the phospholipid content, the other two properties mentioned above were also considered to be important in the use of pure plant oil as a fuel in diesel engines. Future research could investigate the integration and optimization of the conventional degumming process combined with a membrane separation process.

Keywords: Oil degumming; Ultrafiltration membrane; Phospholipids; *Jatropha curcas*; Response surface methodology

1. Introduction

Biofuels are renewable, biodegradable, and clean energy sources. Producing enough biofuels to replace fossil fuels will reduce air pollution and other environmental concerns that fossil fuels cause. As found in the literature, biodiesel fuel has been used in most diesel engines without any modification. The use of the transesterification process to convert plant oils with methanol into fatty acid methyl esters (biodiesel fuel) can reduce the viscosity and density of plant oils (Shweta et al., 2004; Lu et al., 2009). Because the price of methanol and the cost of manufacturing biodiesel fuel are increasing, the use of pure (degummed) plant oil as biofuel will become as important as its conversion to biodiesel fuel (Forson et al., 2004; Leung and Guo, 2006; Kumar et al., 2003).

Several plant oils can be used to make biofuel for diesel engines. However, some of them are edible, which may cause competition with respect to their use in the food market (Ramadhas et al., 2008; Sahoo et al., 2009; Banapurmath et al., 2008). *Jatropha* oil is inedible and is a high-quality oil that performs well at low temperatures. *Jatropha curcas* is a drought-resistance shrub and can easily survive in barren soil with less fertilizer and moisture (Haldar et al., 2009). Its bark, fruit, leaves, and roots contain two toxins, toxalbumin and curcin, making them unfit for human consumption. However, its seeds are abundant in oil, which can be used to make candles, soap, and biofuel. *Jatropha* seeds are harvested almost three times a year in tropical areas (Keith, 2000).

In recent years, a great amount of work has been accomplished by several researchers to determine the compatibility of plant oils in diesel engines using *Jatropha* oil, soybean oil, rapeseed oil, sunflower oil, and palm oil, among others (Karaosmanoğlu et al., 2000; Silvio et al., 2002; Lertsathapornsuk et al., 2008). *Jatropha* oil has the potential

* Corresponding author. Tel.: +886 3 2654125; fax: +886 3 2654199.
E-mail address: twchung@cycu.edu.tw (T.-W. Chung).
Received 13 June 2011; Received in revised form 28 October 2011; Accepted 5 January 2012
0263-8762/$ – see front matter
doi:10.1016/j.cherd.2012.01.002