Energy 115 (2016) 791–799

Contents lists available at ScienceDirect

Energy

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

Recovery of diesel-like fuel from waste palm oil by pyrolysis using a microwave heated bed of activated carbon

Su Shiung Lam [a, e, *], Wan Adibah Wan Mahari [a], Chin Kui Cheng [b], Rozita Omar [c], Cheng Tung Chong [d], Howard A. Chase [e]

[a] Eastern Corridor Renewable Energy Group (ECRE), School of Ocean Engineering, University Malaysia Terengganu, 21030 Kuala Terengganu, Malaysia
[b] Faculty of Chemical and Natural Resources Engineering, University Malaysia Pahang, Lebuhraya Tun Razak, 26300 Gambang, Pahang, Malaysia
[c] Department of Chemical and Environmental Engineering, Universiti Putra Malaysia, 43400 Serdang, Selangor, Malaysia
[d] Faculty of Mechanical Engineering, Universiti Teknologi Malaysia, 81310 Skudai, Johor, Malaysia
[e] Department of Chemical Engineering and Biotechnology, University of Cambridge, New Museums Site, Pembroke Street, Cambridge CB2 3RA, United Kingdom

ARTICLE INFO

Article history:
Received 13 March 2016
Received in revised form
20 July 2016
Accepted 11 September 2016

Keywords:
Pyrolysis
Microwave pyrolysis
Waste cooking oil
Palm oil
Activated carbon

ABSTRACT

Microwave pyrolysis using a well-mixed bed of activated carbon as both the microwave absorber and reaction bed was investigated for its potential to recover useful products from waste palm cooking oil – a cooking oil widely used in Asia. The carbon bed provided rapid heating (~18 °C/min) and a localized reaction hot zone that thermally promoted extensive pyrolysis cracking of the waste oil at 450 °C, leading to increased production of a biofuel product in a process taking less than 25 min. It also created a reducing reaction environment that prevented the formation of undesirable oxidized compounds in the biofuel. The pyrolysis produced a biofuel product that is low in oxygen, free of sulphur, carboxylic acid and triglycerides, and which also contains light C_{10}-C_{15} hydrocarbons and a high calorific value nearly comparable to diesel fuel, thus showing great potential to be used as fuel. This pyrolysis approach offers an attractive alternative to transesterification that avoids the use of solvents and catalysts, and the need to remove free fatty acids and glycerol from the hydrocarbon product. The pyrolysis apparatus operated with an electrical power input of 1.12 kW was capable of producing a biofuel with an energy content equivalent to about 3 kW, showing a positive energy ratio of 2.7 and ≥73% recovery of the energy input to the system. The results show that the pyrolysis approach has huge potential as a technically and energetically viable means for the recovery of biofuels from the waste oil.