World Academy of Science, Engineering and Technology
International Journal of Energy and Environmental Engineering
Vol:11, No:12, 2017

Studies of the Reaction Products Resulted from Glycerol Electrochemical Conversion under Galvanostatic Mode

Authors : Ching Shya Lee, Mohamed Kheireddine Aroua, Wan Mohd Ashri Wan Daud, Patrick Cognet, Yolande Peres, Mohammed Ajeel

Abstract : In recent years, with the decreasing supply of fossil fuel, renewable energy has received a significant demand. Biodiesel which is well known as vegetable oil based fatty acid methyl ester is an alternative fuel for diesel. It can be produced from transesterification of vegetable oils, such as palm oil, sunflower oil, rapeseed oil, etc., with methanol. During the transesterification process, crude glycerol is formed as a by-product, resulting in 10% wt of the total biodiesel production. To date, due to the fast growing of biodiesel production in worldwide, the crude glycerol supply has also increased rapidly and resulted in a significant price drop for glycerol. Therefore, extensive research has been developed to use glycerol as feedstock to produce various added-value chemicals, such as tartronic acid, mesoxalic acid, glycolic acid, glyceric acid, propanediol, acrolein etc. The industrial processes that usually involved are selective oxidation, biofermentation, esterification, and hydrolysis. However, the conversion of glycerol into added-value compounds by electrochemical approach is rarely discussed. Currently, the approach is mainly focused on the electro-oxidation study of glycerol under potentiostatic mode for cogenerating energy with other chemicals. The electro-organic synthesis study from glycerol under galvanostatic mode is seldom reviewed. In this study, the glycerol was converted into various added-value compounds by electrochemical method under galvanostatic mode. This work aimed to study the possible compounds produced from glycerol by electrochemical technique in a one-pot electrolysis cell. The electro-organic synthesis study from glycerol was carried out in a single compartment reactor for 8 hours, over the platinum cathode and anode electrodes under acidic condition. Various parameters such as electric current (1.0 A to 3.0 A) and reaction temperature (27 °C to 80 °C) were evaluated. The products obtained were characterized by using gas chromatography-mass spectroscopy equipped with an aqueous-stable polyethylene glycol stationary phase column. Under the optimized reaction condition, the glycerol conversion achieved as high as 95%. The glycerol was successfully converted into various added-value chemicals such as ethylene glycol, glycolic acid, glyceric acid, acetaldehyde, formic acid, and glyceraldehyde; given the yield of 1%, 45%, 27%, 4%, 0.7% and 5%, respectively. Based on the products obtained from this study, the reaction mechanism of this process is proposed. In conclusion, this study has successfully converted glycerol into a wide variety of added-value compounds. These chemicals are found to have high market value; they can be used in the pharmaceutical, food and cosmetic industries. This study effectively opens a new approach for the electrochemical conversion of glycerol. For further enhancement on the product selectivity, electrode material is an important parameter to be considered.

Keywords : biodiesel, glycerol, electrochemical conversion, galvanostatic mode
Conference Title : ICGCAE 2017 : International Conference on Green Chemistry and Alternative Energy
Conference Location : Kuala Lumpur, Malaysia
Conference Dates : December 11-12, 2017