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Abstract

Mesoporous CE-SBA15 Catalysts for Algal Biomass Pyrolysis †

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Introduction: Algae have been suggested for use as a biomass-energy resource for fuel production. Biomass or bio-energy has been recognised as a renewable energy source that can be used to replace fossil fuels, with the added bonus that the crops, plants or trees can absorb CO_2 from the atmosphere, reducing the greenhouse effect. Various thermochemical techniques can be utilized with algae to generate fuel in different forms, for example, pyrolysis which is induced by heating the biomass at an anoxic condition and a temperature of approximately 5000 °C [1]. The products obtained after pyrolysis are bio-oil, bio-char and gaseous components, with potentially used in fossil fuel industries. Bio-char with carbon content over 50%, has a highly porous structure, and the addition of bio-char to soil could improve water retention and increase the surface area of the soil, increasing the efficiency of nutrient use [2]. In this paper two mesoporous Ce-SBA15 catalysts based on the soft-templating method were synthesized and used for algal biomass pyrolysis. In the synthesis mesoporous silicas were applied as pore structure templates. Differentiation of the synthesis conditions was type of copolymer, Pluroic P123 or Pluronic P9400, obtaining materials with different structure. The physicochemical properties of the mesoporous materials were characterized by using various techniques: adsorption/desorption of nitrogen, XRD, transmission electron microscopy (TEM) and thermal analysis. In order to verify their applicability for algal biomass pyrolysis complex reactions measurements were performed. Ce-SBA15 catalysts were prepared by soft-templating method using amphiphilic P123 triblock copolymer and Pluronic P9400 as templates and tetraethyl orthosilicate as the silica source according to the method reported by P. Hongmanorom et colab [3]. Catalytic pyrolysis was performed in a laboratory-scale stationary tubular reactor. The components of the bio-oil from the pyrolysis reaction were analysed by gas chromatography. GC-MS Triple Quad from Agilent Technology was used to analyse the oil components. The identification of the peaks is matching of the mass spectra with the NIST standard library from the instrument. The main groups of aromatic hydrocarbons, heterocyclic, phenol, amine, amide, indole, alkane and nitrile were identified in the bio-oil. The length of the carbon chain in the bio-oil was in the range of C7–C17. The pyrolysis process of algal biomass was performed at the temperature of 4500C in a stationary tubular reactor. The main compounds from the GC-MS analysis of the bio-oil are heptadecane, toluene, ethylbenzene and indole. The hydrocarbon groups were found to be in a range of heavy naphthas, kerosene and diesel.

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