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Comparison of bio-oil upgrading techniques

Hasan Merdun and Begüm Güzelçiftçi
Akdeniz University, Turkey

Energy is an important input for industrial applications and social and economical development. Energy obtained from fossil fuels are expected to finish soon and it is a problem for the environment. Renewable energy sources are critical to get rid of these deficiencies of fossil fuels. Renewable sources are solar, wind, hydro, and biomass. Biomass is available everywhere, its conversion technology is variable and developing fast, it is environmental friendly. Therefore, all over the world most people are focusing on the biomass energy. Biomass is defined as all biological materials from plants and animals. Elementally, it is composed of carbon, hydrogen, oxygen, trace amounts of nitrogen, and almost no sulfur. Biomass is composed of up to 400 chemical components such as acids, alcohols, esters, sugars, ketones, phenolics, etc. Five main components of biomass are cellulose, hemicellulose, lignin, extractives and ash. Biomass decomposition of these components depends on the biomass properties like moisture and contents, volatile organic matter content, and particle size; and (fast) pyrolysis process parameters like reactor type, temperature, heating rate, residence time, and carrier gas flow rate. Fast pyrolysis is a thermal decomposition of organic materials in the absence of oxygen under the atmospheric pressure, around 500oC, very fast heating rate, and short residence time with fast cooling of pyrolysis vapor in order to directly produce mainly liquid fuel (bio-oil) in addition to solid (biochar) and gas mixtures. Pyrolysis oil or bio-oil appearance is dark brown and similiar to biomass in elemental composition. As a result, bio-oil has unsuitable properties for internal combustion engines, such as high water and oxygen contents, high viscosity, corrosiveness, and instability, preventing its widespread application. Since the direct applications of bio-oil as fuels are limited by the problems mentioned above, it should be upgraded before using it in engines. Therefore, the objective of this study is to review the bio-oil upgrading techniques and compare their performances in upgrading. Two commonly applied upgrading techniques are hydrodeoxygenation and catalytic cracking. The types of catalysts used in these upgrading techniques are also mentioned in detail. Also, the current problems are summarized and several future development directions of bio-oil upgrading are pointed out.

Biography

Hasan Merdun is currently serving as a faculty member at the Department of Environmental Engineering, Akdeniz University in Turkey. He got his undergraduate degree in Agricultural Engineering in Turkey. He got his MSc degree at Agricultural Engineering Department and PhD degree at Crop and Soil Environmental Sciences in Clemson University, USA, on the subjects of soil and water resources. After getting his PhD degree, he started working at the university as an academician. Around five years ago, he shifted his research interests from soil and water resources to bioenergy production through thermochemical processes / technologies, specifically fast pyrolysis and gasification. He worked with the Catalytic Processes and Materials Group as a Post-doctoral researcher at the University of Twente, Netherlands, during June 4 - September 20, 2013. He studied the effects of different catalysts on the yield and quality of bio-oil and gas mixture produced by fast pyrolysis process. He has a specially designed drop-tube reactor for fast pyrolysis and is currently working on two projects. His research mission is to add value to the national and global bioenergy sector by applying an integrated biorefinery approach for the development of renewable energy technologies.

merdun@alumni.clemson.edu

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