Resurrection of US coal using hydrothermal liquefaction

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Abstract

Since the 1900s, coal, a plentiful raw material in the United States and many other regions of the world, has been regarded a potential raw material for the manufacturing of coal oil. A variety of conversion techniques (e.g., Fischer???Tropsch synthesis, pyrolysis, or direct coal catalytic liquefaction) can be used to produce liquid fuels from coal, but one in particular, hydrothermal liquefaction, is particularly useful. Because of its low cost and ease of application, liquefaction (HTL), also known as hydrous pyrolysis, is appealing. Direct coal liquefaction necessitates the inclusion of hydrogen and costly catalysts, whereas the Fischer-Tropsch process is costly and loses a significant proportion of carbon as CO2. The use of subcritical liquid water in the absence of oxygen to artificially mature coal, kerogen, and biomass samples is known as hydrothermal liquefaction. Because the reaction medium is water, hydrothermal liquefaction does not need sample drying, saving time and money. Low molecular weight hydrocarbons, primarily alkanes, are produced in this method. The application of Hydrothermal Liquefaction concurrently to coal and biomass mixes will be examined in this research with the goal of producing largely carbon-neutral coal oil. With the usage of coal for electricity generation in the United States diminishing and job losses in numerous midwestern states, it is suggested to employ Hydrothermal Liquefaction to manufacture largely carbon-neutral coal oil from coal-waste biomass combinations. While there is an abundance of oil in the United States and refineries are at full capacity, coal oil produced in the United States may be shipped to Asia, which has coal but no oil or natural gas. This policy will allow the US to resurrect coal mining employment in the country, reduce the flow of middle-east oil to Asia, and balance the trade imbalance with nations like China. Furthermore, selling partially carbon-neutral oil to Asia will enable Asian countries to satisfy their carbon emission targets set out in the Paris Climate Agreement. The technical specifics of hydrothermal liquefaction of various types of coal will be discussed in this study, as well as the economics of coal-oil production vs crude oil.

Sustainable development, as defined by the World Commission on Environment and Development, is development that fulfils current demands without jeopardising future generations' capacity to fulfil their own. The globe is moving toward more sustainable and renewable alternatives as people become more conscious of the need to reduce greenhouse gas (GHG) emissions and the inevitable depletion of fossil fuels. The continued increase of sustainable and renewable alternative energy is driven by the desire to reduce fossil fuel consumption and associated GHG emissions. 91 percent of the world's fossil fuel use (coal, natural gas, and oil) is utilised for energy purposes. The worldwide transportation industry consumes 63 percent of crude oil, while 16 percent is utilised to produce building-block chemicals and polymers. With global transportation demand rising, owing in part to population expansion, the task of reducing the world's dependency on fossil fuels necessitates the development of cost-effective, large-scale renewable energy-based transportation fuel projects. The most promising approach for producing biofuel and platform chemicals to underpin a new bio-based industry is through bio refineries. A bio refinery is an industrial facility (or network of facilities) that consists of a set of technologies for converting biomass into fundamental building blocks for the production of food and other products in a sustainable manner. www.mdpi.com/journal/processes; doi:10.3390/pr8101216; Processes 2020, 8, 1216; doi:10.3390/pr8101216 2020, 8, 1216 2 of 23 biofuels, energy, and chemical processes. It's similar to today's petroleum refineries. Bio refineries must have a consistent supply of feedstock, which accounts for 40 to 60 percent of operational expenses, and maximum energy conservation between energy inputs and outputs to be a viable option. Kraft pulping is a well-known technique that may be transformed into large-scale bio refineries that produce biofuels as a primary product. Access to biomass feedstock and supply chains, understanding of biomass refining-type processes, and accessible leftover feedstock, such as black liquor, are all key components for a bio refinery. Traditional chemical pulp mill processing, such as in a Kraft mill, removes between 40 and 60% of high-value pulp or paper products from harvested logs, while the remaining dissolved wood in the form of liquor has a limited economic potentialTo stay profitable, the Kraft pulp industry is under pressure to diversify its product portfolio beyond pulp, heat, and power generation. A pulp mill processes a large amount of biomass feedstock and produces by-product streams such as black liquor (a combination of waste pulping chemicals and lignin), which is partially processed by the pulp manufacturing process. Through burning in a recovery boiler, biomass components—mostly hemicellulose and lignin in black liquor—supply the Kraft mill's energetic requirement (heat and electricity). The inorganic chemical recovery process, which helps to the overall economy of the Kraft process, is also aided by the recovery boiler. The organic component of black liquor has the potential to be converted into bio products with a higher value than utilising black liquor as a heat and power source. HTL is a thermochemical process that depolymerizes wet biomass into liquid fuels in a reactor operating at high temperatures and pressures for long enough to dissolve the solid natural polymeric structure into largely liquid components. Due to the diversity of bio-based or waste feedstock, it is a flexible conversion method that has been successfully tested. The fact that the HTL process' feedstock does not need to be dried is a fundamental reason for its success. In the HTL process, water acts as a reactant and catalyst in the subcritical zone because its characteristics alter dramatically. When compared to ambient water, the dielectric constant of water drops dramatically in the subcritical zone. As a result, hydrophobic substances have a greater solubility than at ambient temperatures. Furthermore, due to the increased ionic product of water in a subcritical environment, the rate of acid/base-catalyzed processes rises.

Biography

Rakesh Govind obtained his M.S. and PhD from Carnegie Mellon University and is currently Professor of Chemical Engineering at the University of Cincinnati. He has published papers on the entrained flow gasification of Ohio coal and on membrane separation.

This work is partly presented at 4th International Conference on Chemical Engineering

September 17-18, 2018 | Vancouver, Canada