More flexible method floated to produce biofuels, electricity

October 14 2008

Researchers are proposing a new "flexible" approach to producing alternative fuels, hydrogen and electricity from municipal solid wastes, agricultural wastes, forest residues and sewage sludge that could supply up to 20 percent of transportation fuels in the United States annually.

The method offers a potential solution to problems that might be created by increasing production of ethanol with conventional methods, which use corn grain as a feedstock. Boosting ethanol production with conventional methods would require additional crops and heavy fertilizer use, increasing runoff into waterways and threatening ecosystems.

The new concept, however, which Purdue researchers call a flexible carbon-to-liquid fuel process, would require no additional crops and use primarily wastes as the feedstock, said Fu Zhao, a Purdue assistant professor of mechanical engineering.

"This technique is more flexible than conventional methods because we can process a wider range of very different feedstocks and, at the same time, we can generate a wider range of end products - not just gasoline and diesel but ethanol and hydrogen. Or we could generate electricity directly from the gas produced," he said.

The method also would be immune to the market fluctuations of corn and other crops and less affected by disturbances such as feedstock supply shocks and market demand changes. The method also could reduce greenhouse gas emissions by more than 50 percent compared

with petroleum-derived gasoline.

Findings were detailed in a paper presented on Sept. 29 during the 6th Global Conference on Sustainable Product Development and Life Cycle Engineering in Busan, Korea. The preliminary analysis was written by Zhao; Purdue doctoral student Dongyan Mu; P. Suresh Rao, the Lee A. Rieth Distinguished Professor of Civil Engineering and Agronomy; and Thomas Seager, an associate professor in the Golisano Institute for Sustainability at the Rochester Institute of Technology.

The system first requires processing carbon-containing waste, such as paper, wood, plastic and rubber, into small pieces with a diameter of a few millimeters, or thousandths of a meter. The pieces would then be fed into a "gasifier," where the materials would be turned into a gas containing hydrogen, carbon monoxide, carbon dioxide, methane and other hydrocarbons.

This gas would be further processed to get rid of everything but the hydrogen and carbon monoxide, referred to as synthesis gas or syngas. This gas could then be used to directly run a turbine to generate electricity, or it could be converted into gasoline and diesel fuel for transportation using a process called Fisher-Tropsch synthesis. The technique could be used to produce ethanol, jet fuel and other biofuels from the solid wastes.

Data indicate enough wastes are generated to support large production facilities using the system. A report prepared by the U.S. Department of Agriculture and Department of Energy found that an estimated 1.3 billion tons of biomass - including agricultural and municipal wastes - are generated annually in the United States. Coal could be used to supplement the waste feedstocks if needed, Zhao said.

The analysis suggests that it is possible to replace 15 percent to 20

percent of transportation fuels consumed daily in the United States with liquids derived from this flexible process. These estimates are based on the present consumption level, which is about 390 million gallons per day, he said.

The researchers estimate the method would be economically competitive with petroleum-based fuels and plan to develop "an integrated process simulation model" to test the technique with a variety of feedstocks, including waste plastics. Raw data for the model will be generated with an experimental gasifier being built at Purdue.

Source: Purdue University