Fuels from biomass:

Use of neutron radiography to improve the design of a salt separator in supercritical-water biomass gasification

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Abstract

Wet biomass, such as manure or wood waste, can be converted into methane via catalytic conversion in supercritical water. However, salts that are present in the biomass may precipitate out and lead to catalyst deactivation. If these salts can be separated and recovered, they may be used as a fertilizer.

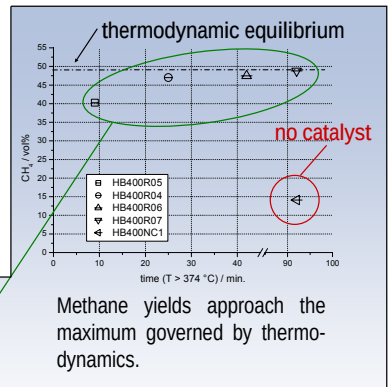
The neutron radiography facilities at PSI provide a unique means to optimize the design of a supercritical-water salt separator for this process. Neutron transmission radiography will be used to visualize the interior of prototype salt separators.

Biomass Gasification Process

Current results

- Batch process which converts woody biomass to near-equilibrium yields of methane, hydrogen, and carbon dioxide.
- Catalytic conversion process in supercritical water. (400°C, 30 MPa).
- The process can handle wet streams that needed to be dried before conventional gasification.
- Produces up to 0.33 grams CH_4 per gram dry biomass. This is a substantially higher yield than by biol. methods.

Woody biomass is gasified into CH_4, H_2, and CO_2. The remaining water contains <2% of the feed carbon.



Methane yields approach the maximum governed by thermodynamics.

$$CH_{1.49}O_{0.68} + 0.29\ H_2O \rightarrow 0.52\ CH_4 + 0.48\ CO_2$$

wood — water — methane — carbon dioxide

Desired process

- Development of a continuous process, capable of converting a wide range of biomass materials into methane, hydrogen, and carbon dioxide.
- Recovery of inorganic constitutents for use as fertilizers.

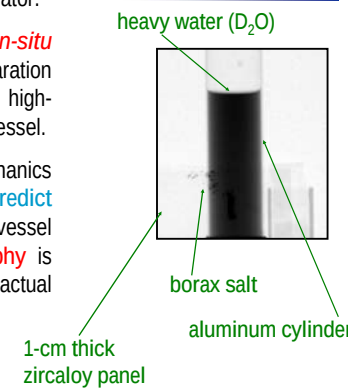
Salts in Biomass

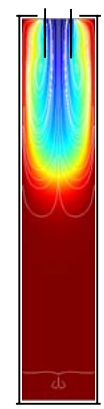
- Biomass can contain a large amount of inorganic constitutents which cannot be converted into fuels.
- These salts can complicate the conversion process, since salts are only slightly soluble in supercritical water.
- The recovery of these salts may lead to the production of a useful fertilizer from the biomass conversion process.

Salt Separator Design

- Neutron radiography will be used to aid in the design of a separator.
- Neutron radiography allows *in-situ* visualization of a separation process occurring in this high-pressure, high-temperature vessel.
- Computational fluid mechanics (CFD) are being used to predict the behavior of proposed vessel designs; neutron radiography is being used to confirm actual vessel behavior.

Scoping Image





CFD simulation of a reverse-flow salt separation vessel.

About Neutron Radiography

Neutron transmission radiography is an imaging technique that allows cross-sectional visualization of objects. Neutrons are passed through a sample; different materials interact with the neutrons with different attenuations. The neutrons that are transmitted through a sample are detected and produce a grayscale image. By the proper choice of materials, phenomena occurring inside of thick-walled vessels can be observed.

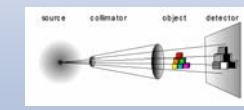


Image from http://neutra.web.psi.ch/

Further Information

See the project homepage at:
http://cpe.web.psi.ch

Waldner, M.H., Vogel, F. Renewable Production of Methane from Woody Biomass by Catalytic Hydrothermal Gasification *Ind. Eng. Chem. Res.*, 2005 (in press). http://dx.doi.org/10.1021/ie050161h

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