

Residual properties by equations of state for a biosludge pyrolysis process

【Associated Sections in Selected Textbooks】

- *Introduction to Chemical Engineering Thermodynamics* [1] Sec. 6.1

【Module Learning Objectives】

- Calculation of enthalpy, internal energy, entropy and other thermodynamic property values from PVT and heat-capacity data.

【Problem】

Generally, fuel derived from biomass can be considered biofuel. In the case we will examine, pyrolytic liquid and gas are the main biofuels obtained from biosludge. Biosludge is generated when wastewater is biologically treated. In several studies, along with paper fines (biomass wood waste), biosludge is blended and converted to mixed fuel gas which are then burned for energy, and also wastes that can be disposed of at lower costs than the initial waste [2, 3]. Below is a schematic of how biodegradable wastes are utilized pyrolytically to create biofuels and reduce the impact of the wastes economically and environmentally by neutralizing wastes and allowing for energy recovery [3].

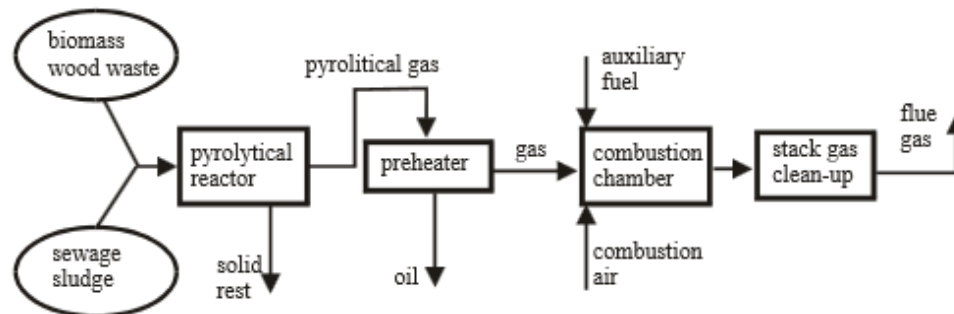


Figure 1 Schematic flow for biodegradable waste pyrolytical utilization

In another study, biosludge was taken from a petrochemical wastewater treatment plant and pyrolyzed in a nitrogen atmosphere [4]. Noting that pyrolysis is a thermochemical decomposition of organic material at elevated temperatures in the absence of oxygen. Generally there is 75–80% water content in sludge cakes coming out of the pyrolytical reactor, and about 65–70% weight of water vapor and volatile compounds were volatilized during the drying process. Propylene, propane, 1-butene, *n*-butane, isobutene, toluene and benzene were the major volatile organic compounds (VOCs) of the pyrolytic gas [4].

Calculate Z , H^R , and S^R by the Redlich/Kwong equation for one of these compounds, propylene, at 475K and 75bar.

Bibliography

- [1] J. Smith, H. Van Ness and M. Abbott, Introduction to Chemical Engineering Thermodynamics, 7th Ed. ed., New York: McGraw Hill, 2005.
- [2] M. Holtzapple, "A Process to Convert Industrial Biosludge and Paper Fines to Mixed Alcohol Fuels," [Online]. Available: http://cfpub.epa.gov/ncer_abstracts/index.cfm/fuseaction/display.abstractDetail/abstract/1148/report/0. [Accessed 2014].
- [3] P. N. K. A. K. ORGANICKÉHO, "Pyrolysis of Sewage Sludge and Municipal Organic Waste," *Acta Metallurgica Slovaca*, vol. 12, pp. 257--261, 2006.
- [4] K.-H. Lin, H.-T. Hsu, Y.-W. Ko, Z.-X. Shieh and H.-L. Chiang, "Pyrolytic product characteristics of biosludge from the wastewater treatment plant of a petrochemical industry," *Journal of hazardous materials*, vol. 171, pp. 208--214, 2009.