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Hydrothermal Gasification of Cattle Manure for Hydrogen and Hydrochar Production †

Sonil Nanda [1], Ajay K. Dalai [1,*], Janusz A. Kozinski [2]

[1] Department of Chemical and Biological Engineering, University of Saskatchewan, Saskatoon, Saskatchewan, Canada; sonil.nanda@usask.ca (S.N.); ajay.dalai@usask.ca (A.K.D.);
[2] Faculty of Engineering, Lakehead University, Thunder Bay, Ontario, Canada; jkozinski@lakeheadu.ca (J.A.K.);
* Correspondence: ajay.dalai@usask.ca (A.K.D.);
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Abstract: Horse manure was explored as a candidate for hydrothermal gasification to produce hydrogen and hydrochar. The gasification was performed under aqueous conditions in the presence of supercritical water. Hydrothermal gasification of horse manure was performed at variable temperatures (400-600°C), biomass-to-water ratio (1:5 and 1:10), and residence time (15-45 min) at a fixed pressure range of 22-25 MPa. The biomass-to-water ratio of 1:10, higher temperatures of 600°C, and longer residence time of 45 min resulted in higher yields of H_2 (2.5 mmol/g) and total gases (9.9 mmol/g) owing to improved water-gas shift reaction. Homogeneous alkali catalysts such as Na_2CO_3 (5.3 mmol/g) improved H_2 yields from horse manure compared to K_2CO_3 (5.2 mmol/g), NaOH (4.9 mmol/g), and non-catalytic gasification (2.5 mmol/g). The hydrochar produced from horse manure was physicochemically characterized to study their composition, morphology, and features for industrial and environmental applications. The hydrochar samples revealed higher ash content, carbon content, alkalinity, surface area, pore-volume, and thermal stability at higher gasification temperatures and longer residence times. While the hydrogen-rich syngas produced from the hydrothermal gasification of horse manure can be used for energy applications, the resulting hydrochar could be potentially used for value-added industrial applications.

Keywords: horse manure; hydrogen; hydrochar; supercritical water gasification; process optimization.

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Conflicts of Interest

The authors declare no conflict of interest.