

Title: Improving the Quality of Waste Biomass by Reducing the Ash Content and the Inorganic Constituents

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Abstract

Fuel pellets can be produced from forest residues and agricultural crop residues. This study aims at improving the quality of crop residues (canola straw, wheat straw and corn stover) by reducing the ash content and the inorganic constituents using mechanical size fractionation and water leaching in sequence as the pretreatment techniques. It is desirable to minimize the need for leaching, as the subsequent drying of the biomass for further processing into fuel pellets can be energy intensive thus increasing the production cost. Experimental treatments involve water temperature (25, 45°C), leaching time (3, 12, 24 h) and water-to-sample mass ratio (30:1) after preliminary tests were conducted to identify the appropriate levels for these parameters. Results indicated that the finest fraction of ground crop residues (particle size < 0.25 mm) had much higher ash contents than the coarser fractions up to 3.15 mm. Hence, size fractionation can effectively reduce the need for leaching to remove ash and it is most effective for corn stover. Subsequently, leaching test was performed on the finest fraction of crop residues. Canola straw was found to have the best leaching performance compared to wheat straw and corn stover, as it had the highest ash removal efficiency and element removal efficiency (greater than 90% and 50% for K_2O and SiO_2 respectively). Leaching time of 3 h or 12 h at 25 ^oC temperature was sufficient for effective ash removal for canola straw, yet longer leaching time of 24 h would improve the ash removal efficiency for corn stover and wheat straw. Leaching temperature had negligible effect on K_2O removal efficiency, but significant effect on SiO_2 removal efficiency. A preliminary cost analysis indicates that pretreatment by mechanical size fraction followed by water leaching would lead to a 30% increase in the total production cost (TPC) of agro-pellets, whereas the TPC would increase by 66% if the pretreatment is done by water leaching only.

Recent Publications

1. Oveisi E, Sokhansanj S, Lau A, Lim C, Bi X, Preto F, Mui C (2018) Characterization of recycled wood chips, syngas yield, and tar formation in an industrial updraft gasifier. Environments 5(7): 84-96.
2. Petrov O, Bi X, Lau A (2017) Impact assessment of biomass-based district heating systems in densely populated communities. Part II: Would the replacement of fossil fuels improve ambient air quality and human health? Atmospheric Environment 161: 191-199.
3. Rezaei H, Bi X, Lim C, Lau A, Sokhansanj S (2016) A numerical and experimental study on fast pyrolysis of single woody biomass particles. Applied Energy 198: 320-331.
4. He X, Lau A, Sokhansanj S, Lim C, Bi X, Melin S (2014) Investigating gas emissions and dry matter loss from stored biomass residues. Fuel 134: 159-165.

Biography

Anthony Lau obtained his BSc (Eng.) and MSc degrees in Agricultural Engineering from the University of Guelph and PhD degree in Interdisciplinary Studies/Bioresource Engineering from the University of British Columbia. Currently, he is an associate professor in the Department of Chemical and Biological Engineering at UBC. He is a member of the Biomass and Bioenergy Research Group within the Clean Energy Research Center. His research interest is in the area of waste management for resource recovery, focusing on two major sub-areas: 1) biomass feedstock engineering, and 2) bioconversion processes and systems. Biomass feedstock engineering may include the preprocessing, storage and quality improvement/management of lignocellulosic waste biomass as some of the major components of the supply chain logistics. Studies on bioconversion processes and systems are primarily aerobic composting and anaerobic fermentation of non-woody waste biomass.

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