World Academy of Science, Engineering and Technology
International Journal of Environmental and Ecological Engineering
Vol:10, No:12, 2016

Water Re-Use Optimization in a Sugar Platform Biorefinery Using Municipal Solid Waste

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Abstract : Municipal solid waste (MSW) is a virtually unlimited source of lignocellulosic material in the form of a waste paper/cardboard mixture which can be converted into fermentable sugars via cellulolytic enzyme hydrolysis in a biorefinery. The extraction of the lignocellulosic fraction and its preparation, however, are energy and water demanding processes. The waste water generated is a rich organic liquor with a high Chemical Oxygen Demand that can be partially cleaned while generating biogas in an Upflow Anaerobic Sludge Blanket bioreactor and be further re-used in the process. In this work, an experiment was designed to determine the critical contaminant concentrations in water affecting either anaerobic digestion or enzymatic hydrolysis by simulating multiple water re-circulations. It was found that re-using more than 16.5 times the same water could decrease the hydrolysis yield by up to 65 % and led to a complete granules desegregation. Due to the complexity of the water stream, the contaminant(s) responsible for the performance decrease could not be identified but it was suspected to be caused by sodium, potassium, lipid accumulation for the anaerobic digestion (AD) process and heavy metal build-up for enzymatic hydrolysis. The experimental data were incorporated into a Water Pinch technology based model that was used to optimize the water re-utilization in the modelled system to reduce fresh water requirement and wastewater generation while ensuring all processes performed at optimal level. Multiple scenarios were modelled in which sub-process requirements were evaluated in term of importance, operational costs and impact on the CAPEX. The best compromise between water usage, AD and enzymatic hydrolysis yield was determined for each assumed contaminant degradations by anaerobic granules. Results from the model will be used to build the first MSW based biorefinery in the USA.

Keywords : anaerobic digestion, enzymatic hydrolysis, municipal solid waste, water optimization
Conference Title : ICWEEM 2016 : International Conference on Water, Energy and Environmental Management
Conference Location : Bangkok, Thailand
Conference Dates : December 12-13, 2016