Mass and Energy Recovery from Rice Straw as a Biomass Source

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Egypt is a country that faces major environmental issues; ranging from pollution of water bodies to the litter piling up in the streets to the severely polluted air. Egypt is facing an energy crisis because the energy consumption of oil has increased due to the increase in population, while the production has remained stagnant. One of the best ways to tackle this problem is to use renewable energy. The proposed solution that is capable of partially solving the air pollution, agricultural solid waste and energy crisis problems is the production of fuel from rice straw. The Dutch Avantium Technologies proposed using ethoxymethylfurfural (EMF) as a fuel which is produced from furfural.

Furfural can be produced by acid hydrolysis of the carbohydrates and sugars found in biomass. The biomass waste selected was rice straw due to its abundance in Egypt and the adverse effect it has on the environment by being burnt in open fields. The composition of the rice straw was determined to ensure the presence of the saccharides necessary for the production of furans. Six different factors with the potential to affect the furan production were assessed using ANOVA. From this analysis, the optimum operating conditions were evaluated and found to be 210°C, 100 minutes residence time, 50 mM hydrochloric acid (HCl), 1.19 mm rice straw particle size, and 4.4 weight percent of the sodium chloride (NaCl) catalyst.

A model was created to represent the concentration of the different components present in the reactor with respect to residence time. The reaction kinetics of the formation and subsequent degradation of furans were also determined experimentally and found to be first order with reaction rate constants 0.068 min-1 and 0.1188 min-1 respectively.

All tests and analyses carried out were done using standard methods.

Production of furans by acid hydrolysis was found to be possible. Optimum operating conditions for furan production from rice straw were experimentally determined using analysis of variance to ensure statistical significance. Reaction kinetics were determined to be used in the design of a reactor in a furan production plant.

Furans are emerging with increasing value in many fields. The ability to easily produce furans from rice straw, which would otherwise end up as a solid waste cannot be overstated. This has the double advantage of reducing solid waste and creating a valuable product that can greatly impact the renewable energy sector.

According to the studies carried out, Egypt has a potential of producing at least 1.7 million metric tonnes of furans from the rice produced in 2017 so far.