
EFFECTS OF MOISTURE AND OZONOLYSIS ON SUGARCANE BAGASSE PRE-TREATMENT

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ABSTRACT

Sugarcane bagasse is the residue of the production of sugar and ethanol, which can be used as a substrate for glucose production through enzymatic hydrolysis. The lignin present in the bagasse reduces the action of the enzyme and is sensitive to reactive compounds such as ozone. To reduce the lignin content, pre-treatments with different ozone processing time and bagasse moisture were evaluated. The results showed that the better pre-treatment conditions were: 40,59% of bagasse moisture and 19,5 minutes of ozonolysis. This condition presented good results regarding the carbohydrates found in the sugarcane bagasse despite the reduction of the insoluble acid lignin.

1. INTRODUCTION

The greatest difficulty for sugarcane bagasse use as a substrate for enzymatic hydrolysis is the physical barrier of the lignocellulosic components. These materials are highly recalcitrant due to the crystalline cellulose and the crosslinks between hemicelluloses and lignins, making them difficult for the enzymes to reach the substrate. Several pre-treatments can be applied with the aim of reducing the lignin content and facilitate the subsequent enzymatic hydrolysis by cellulases (Mosier et al., 2005; Vásquez, 2007). The use of ozone as an active agent in the oxidative process is interesting for the biomass pretreatment since the production of large amounts of strong oxidants agents can mineralize and destroy recalcitrant compounds, such as the lignin present in the biomass cell wall structure. The differences in the chemical characteristics between lignin and carbohydrates result in

the selectivity of the oxidation process towards lignin. According to Travaini et al. 2013, lignin is the most susceptible component to ozone oxidation due to its aromatic structure. Since the main advantages of ozone treatment are the non-formation of products that can inhibit hydrolysis or Fermentation, and the reactions can be carried out at ambient temperature and pressure.

2. MATERIALS AND METHODS

2.1. MATERIALS

The sugarcane bagasse was washed with water to remove particulate matter and remaining sugars and dried after that. After drying, the sugarcane bagasse was ground in an analytical mill (IKA-A10). The material was then sieved, and particles average size of to a 0.3 mm were used. After sieving, the bagasse was moistened with distilled water and dried in an oven at the desired humidity.

2.2. PRE-TREATMENTS

The pre-treatments were performed on a cylindrical glass column measuring 2.5 x 20 cm, coupled to a Model O & L1.5 Portable Ozone Generator, manufactured by OzoneLife. Oxygen flow was maintained at 250 mL per minute, and ozone production was maintained at 65 mg / L. The exposure time of the sugarcane bagasse to the ozone was controlled according to the planning described in Table 1. The total mass of sugarcane bagasse used for the pretreatment was standardized on 3 g of dry bagasse.

Table 1. Pre-treatments parameters

Pre-treatments	Moisture (%)	Ozonolysis time (min)	Applied mass of ozone (g) /dry bagasse mass (g)
Control	-	-	-
Pre-treatment A	8.78 %	39.0	0.845
Pre-treatment B	8.99%	19.5	0.420
Pre-treatment C	40.59%	39.0	0.845
Pre-treatment D	40.59 %	19.5	0.420

2.3. CHARACTERIZATION OF *IN NATURA* AND PRE-TREATED BAGASSE.

The control (*in natura*) and the pre-treated bagasse were chemically characterized by quantitative acid hydrolysis, which breaks the polysaccharides and exposes the lignin of the material, making possible the gravimetric analysis. The carbohydrates: cellulose, glucose, and hemicellulose, as well as acetic acid and other inhibitors, were determined by high-performance liquid chromatography (HPLC) in an Agilent 1260 Infinity System (Wilmington, Delaware, EUA) equipped with a refractive index and a UV-visible detector. Separation was achieved using an Aminex HPX-87H column (Bio-Rad Laboratories Inc., America). The mobile phase was sulfuric acid (5 mmol/L), the flow rate was 0.7 mL/min and the column temperature 60 °C (Sluiter et al., 2012).

3. RESULTS AND DISCUSSIONS

Pre-treatments A and B (bagasse with 8.78 % of moisture) promoted a decrease of all evaluated carbohydrates. The total cellulose and glucose content decreased from 36.53% to 18.28% comparing treatment A and B. Xylose decreased from 8.62 % to 5,41 % with the ozonolysis time reduction from 39 min to 19.5 min. The acid-insoluble lignin decrease from 33.48 % to 20.36 %. Acetic acid was not detected after 19.5 min of ozone exposure. The decrease observed reducing the ozone exposure time of the low moisture bagasse is probably due to a more severe carbohydrate degradation, which reflects a non-uniform exposure of the low moisture bagasse.

Table 2. Ozonolysis results

	Control	Pre-treatment A	Pre-treatment B	Pre-treatment C	Pre-treatment D
Glucose + cellulose	42.77	36.52	18.28	51.03	56.15
xylose	12.47	8.62	5.40	11,16	12.30
Acetic acid	0.81	0.19	-	0.55	0.54
Acid insoluble lignin	39.14	33.48	20.36	26.50	26.03

Different behavior was observed comparing pre-treatments C and D (bagasse with 40.59 % of moisture). The glucose and cellulose content increased from 51.03 % to 56.15 % , and xylose content increased from 11.16 % to 12.30 % when the ozonolysis time decreased from 39 min to 19.5 min. However, the acid-insoluble lignin content was close (26.50 % and 26.03 %). The ozonolysis time

reduction from 39.0 to 19.5 min did not enhance the lignin degradation in sugarcane bagasse with 40.59% of moisture.

4. CONCLUSIONS

The pre-treatment with 40.59 % moisture and 19.5 minutes of ozonolysis obtained with an oxygen flow at 250 mL per minute and ozone production of 65 mg / L, presented good results regarding the conservation of the carbohydrates found in the sugarcane bagasse. A significant reduction of the acid-insoluble lignin content in the sample compared to the non-treated sample was achieved along with an increase in glucose and cellulose content. The results indicate that the use a moisturized bagasse is more interesting tha the dried one. The pre-treatment will be further optimized for ethanol second generation production.

5. REFERENCES

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