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Study on the Production of Pulp from Corn Cob

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ABSTRACT
The corncob is a product found in significant amounts in the residues of agriculture, which has potential for use underexplored. This paper presents the study of the production of pulp from corn cob. Pulping of corn cob was carried out using Kraft and Organosolv methods of pulping with the kraft liquor containing 73.25g NaOH, 33.875g Na_2SO_4, 17.875g Na_2CO_3 and the organosolv method containing ethanol as the only solvent of digestion. 20grams of the corn cob was heated in 400ml of the Kraft liquor at 95°C for 180mins and 20g of the corn cob was heated in 400ml of ethanol for 270mins at 65°C. The kraft and organosolv process yielded 50.38% and 34.51% of the pulp respectively. Also, the residual lignin present in the produced pulp was 2.39% and 2.69% respectively. This indicates that the Kraft method is advantageous and efficient for pulping corn cob.

Keywords: Kraft, Organosolv, Corn, Cobs

I. INTRODUCTION

Recently, special attentions have been given to the use of agricultural byproducts as wood substitute in papermaking with the focus of maintaining a sustainable environment.

Chemical processes are the most common for obtaining pulp of cellulose fibers, among which stands out the 'sulfate process', commonly known as 'kraft process' due to the high physical-mechanical resistance of the pulps produced (kraft means strength in German) and is currently the most widely used process in the world (80% of total chemical pulp) Many agricultural wastes have been found to have great potential for paper production; among others are bagasse, wheat straw, rice straw and banana stem (Jiménez et al., 1999; Jiménez et al., 2000).Corn cob is the central core of an ear of maize. It is the part of the ear on which the kernels grow. The ear is also considered a cob or pole but it is not fully a pole until the ear is shucked or removed from the plant material around the ear. Corn cob can be used to produce biodiesel, briquette, activated charcoal, microorganismwhen decomposed and other useful products(Bamigboye, 2013). The use of the corn cob is largely due to its cellulosic content. (Deenik et al., 2011).In the specific case of corn cobs, it is considered that the xylans usually present a chemical structure formed by 4-O- methyl- D -glucuronic acid, L- arabinose and D-xylose in the ratio 2:07:19 (Silva et al., 2013)

II. EXPERIMENTAL METHOD

Preparation of raw material

The corn cob was taken and washed several times with distilled water to remove impurities such as dust, sand and some related particles. The raw material was fed into an oven and dried for 120 minutes at a temperature of 120°C to remove the moisture content, the sample was then removed and allowed to cool for 20minutes and reweighed. This was repeated until a constant weight was obtained.

Digestion of the raw material

Organolsov Pulping

20 grams of the corn cob was heated in 200ml of the cooking liquor for 270minutes fir 65°C and stirredcontinuously to ensure uniform distribution of the temperature and the liquor. The pulp produced was then collected and washed. The pulp yield was calculated.

Kraft Pulping

Kraft's looking liquor is a mixture of NaOH, Na_2CO_3 and Na_2SO_4. 1000ml of the

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mixture must weigh a total of 125 gram. The composition of the mixture is as follows;
58.6% NaOH, 27.1% Na_2SO_4, 14.3% Na_2CO_3 . Giving rise to 73.25g NaOH, 33.875g Na_2SO_4, 17.875g Na_2CO_3.

20 grams of the corn cob was heated in 400ml of the cooking liquor for 180 minutes at 95°C. Throughout the process, the sample was continuouslystirred. The pulp produced was washed and screened (Ramgopal et al., 2016).

Pulp Lignin Number and Kappa number

A measured weight of 1.0 g of dried pulp was soaked in a 30 ml of deionized water and was ground into paste with the aid of ceramic mortar and pestle. It was moved into a 2000ml beaker and the solution was made up to 1200ml with deionized water and stirred thoroughly. A mixture of 40 ml each of 0.1 N Potassium permanganate and 4 N Sulphuric acids was added to the solution, stirred at room temperature for 5 min, 5ml 1N Potassium Iodide was added and was properly stirred. The temperature of the reaction was noted and a 25 ml of the solution was titrated against 0.1 N solution of sodium thiosulphate , two drops of starch indicator solution was added to the titrant and the titration was continued until a colorless solution was observed.

The calculation of Kappa value and the amount of Lignin were evaluated as follows:

$$P_{NO} = 75 + V \quad (5.0)$$

$$K_{NO} = \frac{P_{NO} \times f}{w} \quad (6.0)$$

The Kappa Number corrected to 50%

$$\%L = K_{NO} \times 0.155 \quad (9.0)$$

Where;
P_{NO} = Permanganate number, V= Titre Value (ml)
L= Lignin content, K_{NO} = Kappa number, f= correction factor (50%) and w= weight of the crude wood sample mixed with distilled water (g) Ibrahim et al., (2011).

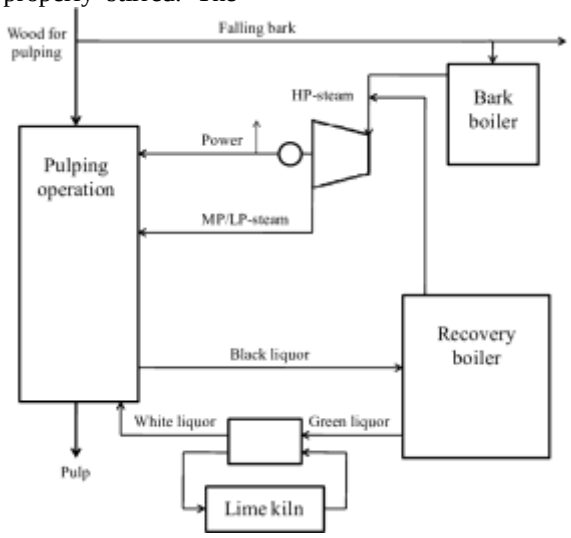

Figure 1. Schematic process flow chart for a Kraft pulp mill (Johansson et al., 2015)

III. RESULTS AND DISCUSSION

Proximate analysis on the raw material: the chemical composition of the corn cob was determined as follows: 32.3% cellulose, 10.3% lignin, 39.8% hemicellulose, 6.8% and 10.8% moisture content.

Table 4.1:

S/N	Process	Yield	Kappa number	Lignin content
1	Organolv	34.51	18.31	2.69
2	Kraft	50.38	16.25	2.39

Kraft pulping requires only 180mins to dignify the corn cob whereas it took 270mins to completely dignify the sample using Organsolv method. This shows that in Kraft pulping, low amount of heat is required to completely break the lignin molecules linking the fibres of the corn cob. Ramgpoal et al., 2016 reported that low amount of heat was consumed in Kraft method of pulping groundnut shell than soda pulping. As a result, Kraft pulping yielded more than the organosolv method. This is also due to the strong penetrating power of the chemicals that constitutes the Kraft

cooking liquor as compared ethanol as the sole constituent of the organosolv liquor.

The Kappa number of the pulp produced from the Kraft process which is 16.25 is found to be lower than that of the Organosolv pulp which is 18.31. This indicates that the Kraft pulp can consume least amount of potassium permanganate compared to organosolv pulp due to the least presence of the residual lignin in the produced pulp. Hence, 2.39% lignin content of Kraft pulp and 2.69% in Organosolv pulp. This can be attributed to the strong basic nature of the Kraft Cooking Liquor. Although, the organosolv method is environmentally friendly since it doesn't produce a yellowish compound of sulphur as does the Kraft method. From the results, it is shown that the Kraft process is an effective and efficient method for the production of pulp fromcorn cob.

IV. CONCLUSION

Kraft process of pulping yielded high amount of pulp with least amount of residual lignin and least consumption of heat energy compared to the organosolv process.

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