The Concora Medium Test Value of Medium Paper Using Sugar Bagasse in the Furnish

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ABSTRACT

This work is part of a continuing sustained effort for increasing competitivity of Medium Paper as important part in the composition of corrugated paper by means of partial employment of alternative pulps, with special interest in the use of recycled paper and the fibers obtained from the Organosolv Process (etanol-water) based on cane sugar bagasse. The results of this work shows that a combination of 33% of Old Corrugated Container (OCC) and 67% of Organosolv pulp (1,5% Soda and high levels of alcohol with Kappa Nr. 84.5 produces similar results in Concora Medium Test (CMT) 140.58 N (31.6 Ib_f) to the ones obtained from the combination of 65% of OCC with 35% of Organosolv Pulp (1.5% Soda and low levels of alcohol) with Kappa Nr. 78.5

Keywords : CMT, Kappa Nr., Organosolv

INTRODUCTION

The pulp and paper industry does not escape from the effects of the current world scenario characterized by a policy of globalized markets and trade opening. For the production and commercialization of agricultural and industrial products, the packing, shipping, and handling expenses represent a challenge to be faced with minimal costs "optimal marketing" and a maximal protection of such products. Consequently, the pulp and paper industry has to become efficient in using the atlernative raw materials of every country to optimize such activities, taking care in protection and full of natural resources, with the goal of being more competitive in the global markets.

Countries with limited availability of natural forest resources as source of virgin fiber must face the challenge using recycled fiber, which is not neverthless the single alternative.

The use of recycled fiber has a direct and positive impact on the environment since it reduces the demand of forest resources and increase the employment of a solid fraction of the urban waste (paper). In the specific case of corrugated paper, cleaner technologies can be employed, as this process does not require the use of chemicals and the solid wastes are, generally organic fines, which are relatively gentle to the environment. This goes hand-in-hand with the possibility of reducing the water demand in the process by means of a partial or total circuit closing. With these objectives the

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process is consistent with the global trend of applying the ISO 14000 standards.

The use recycled fiber generally leads to poorer value of the finished product as compared to the use of virgin fiber purposely obtained. That is why, in this work, it is studied the use of biomass (fibrous materials from annual plants) subjected to an environmentally friendly semi-chemical process as an alternative to offset with new fibers the loss of the values previously set as response factors.

As it is known, tropical countries have efficiently developed the sugar cane production, which facilitates the availability of bagasse as a source of raw material and energy. In this sense the paper production is one of the alternatives with more attractive experience and prospect.

The cane bagasse fiber is short and it has a thin cellular wall, so the obtainment of fiber by means of a chemical process produces short fibers with low rigidity and aggressive wastes, while using an extractive process more rigid fibers are obtained, as well as partial recovery of other sources of raw materials like lignin. In particular by utilizing the Organosolv System with ethanol, it is possible an energy and material integration between the paper and sugar industry, since alcohol is locally produced as another byproduct resulting from the sugar cane industrialization.

Based in the previous analysis, the results of this study the advantages of combined employment in right proportions, of recycled Old Corrugated Container (OCC) and virgin Organosolv pulp.

LITERATURE SURVEY

In the last years, pulping processes with organic solvents, (ethanol, methanol, butanol, propanol among others) have been intensively studied due to several factors: Easy recover of solvent, less pollution, possibility for recovering byproducts (lignina and degraded carbohydrates) and higher yield, when undergoing Kraft pulping /2//3//4//5//6/.

Alcohols have been used as deslignifying agents for more than fifty years. However their utilization was limited to studies of dissolution, structure and properties of lignina. At present, these agents are being increasingly used as additives, which improves the pulping processes/7/.

Ethanol-water process produces slightly higher yield with high quality pulps than the Kraft porcess, specially related to resistance, drainage and lignin final content of the pulp. This process as the ones already known, it cannot surpass certain critical deslignification value, which is high enough as to render the obtained pulps inconvenient for commercial bleaching. After an 80% deslignification based on the general tendency of the values, it can be assumed that selectivity decrease almost to zero and a halt in deslignification occurs with a considerable increase in the loss of polisacarids. This effect is more significant as the maximal cooking temperature increases. /8//9//10/

The potential advantage of using ethanol in pulping is the combination of this compound with alkaline processes /7/. since it has been discovered, that the addition of alcohol and aminas during alkaline pulps production increases the selectivity dislignification of traditional pulping processes as Soda and Kraft/5/.

Recently Marton and Granzow/11/ assessed the effect of different percentages of soda in a mixture 1:1 with ethanol-water using Red Spruce revealing that the best pulps were obtained with a 15% soda, and that the utilization of soda reduces the digestion period, since approximately 60% of lignin was removed in the first 45 minutes.

Sanjuan/12/ showed in his work that the appropriate pulping for bleaching and with a wide dislignification level is possible through a two-stage process: In the first stage using ethanol-water mixture and in the second one just single addition of soda.

The application of ethanol-water in the first stage is relevant/convenient as it influences the extraction of wood tannic compounds. The absence of inorganic substances favors a rapid impregnation and speeds up the deslignification process in the second stage.

When comparing Organosolv pulps obtained in two cooking stages with Kraft pulps of similar Kappa number and refining degree, it is observed that tension strength is similar, while tearing, burst and folding strength are lower.

In some countries the employment of ethanol in pulping is a possibility, since it is locally produced and the industry engaged in its production is very

important one (sugar industry). The alcohol production is relatively cheap and the potential of sugar industry ensures the supply for a long time of bagasse and ethanol. Both materials are basic for pulp production by means of processes with alcohol application. These justify the idea of bringing together the pulping and sugar industry./13/

Pulping with alcohol is an old idea, which if subjected to a current economic analysis can be set as a probability that will eventually comes true. In this context, the interest in developing this work emerged with the objective of obtaining good quality pulps for the production of industrial paper through a process with low impact on the environment. Moreover with the increased lignin selectivity, as exist the possibility of using it in high by value products, contributing to the efficiency of the process.

Recycling of OCC generally provides a mixture of long and short fibers but with low rigidity, which not generate response properties required for the corrugated paper (medium) like CMT value, this value is the result of the Concora Medium Test method, which is defined as the Flat Crush of corrugating medium T 809 om 93, or the maximum pressure that the board will sustain until the fluting collapses, when the pressure is being applied perpendicularly to the plane of the board. If OCC recycled fibers are subjected to a more intense refining process, they can be turned into cutted but not short fibers, and this kind of fibers has long fiber flexibility patters. So medium paper does not meet the properties required for corrugated paper.

Paper production comprise a lot of parameters and processes, whose influence on the product (paper) can be measured, using a complex statistical model of better adjustment obtained by mathematical correlation methods using multiple regression.

However the furniture of three or more components becomes a problem, specially when it is requried to know the effect of composition and refining degree of each component on the furniture's properties.

Lafflamme/14/ got good results in the study of three kinds of wood furniture intended to determine the optimal pulp, based on the Simple Railing proposed by Schoffe/15/ and applied successfully by Gonman and Hinman /16/ on petroleum byproducts. In the light of the experience provided by these previous researches, Garcia et al /17/ developed the procedures for studying the formulation of ternary furniture based on sugar cane bagasse pulp with success.

METHODOLOGY

The application of Simple Railing Design Method in the formulation of three component in paper furniture offers significant advantages, it is suitable for the study of the formulation of paper furniture of three or more components at laboratory scale, as it requires a minimal experimental plan and provides full information on the behavior of the furniture's properties at any composition.

This method assumes that the addition of each component's proportion in the furniture should be the unit and consequently, the space factor is regular and simple, being the same for any composition point in the set. According to Scheffe when the space factor is analyzed in the composition points suiting a known order as Simple Railing, the responses depending just on the components proportions can be represented by simplified general polynomials. The resulting design includes the whole composition space and it is suitable for the evaluation of a multicomponent system, in which all the operation areas should be analyzed. In this particular case is accepted that the sum of fractions constituting the furniture has to be the unit, so that the composition space factor will be regular and simple and specifically in a three component system.

Although the behavior of pulp properties is not lineal, the simple railing method was chosen to assist the trial work. The requirements to be observed are that the tests be effected at six points of the composition railing. For most properties, a measure at each point of the railing is enough, but it is important to make some replicas to a point conveniently located in any areas of the railing, in order to get a computation of the trial error i.e., any error in mixing, testing, etc., which can take place at any time of the analysis.

The responses of three component measured in the six composition points of quantum design are represented by a six term simplified general polynomy, as represented below.

$$Y=b_1X_1+b_2X_2+b_3X_3+b_{12}X_1X_2X_3+b_{13}X_1X_3+b_{23}X_2X_3$$

Based on this polynomy, the response surface

of each property can be determined according to the composition variations. In the resulting diagram, a working area can be distinguished, where the composition values bearing similar property's magnitutes are found contingent to process restrictions.

RESULTS

In light of the trial results, the following analysis was developed:

In the formation of the handsheets the pulp was refined according to the ISO 5264/111-1979 in a Jokro mill with a different refining degree °SR (Schopper Riegler) as determined by the behavior of the grinding curve of the different components. In this way, the recycled paper and the semi-chemical bagasse pulp were refined for six minutes, it was reached up to 21 and 22 °SR. The Organosolv pulps with 1.5% of soda (NaOH), both for the variant based on the experience of Universidad de Guadalajara "M" and the variant of the Universidad Central de Las Villas "C" were refined for 15 minutes (11 °SR) and in the case of 3% of NaOH for ten minutes (13.5 °SR). In the light of the results, a six point simple railing was made and handsheets (135 g/m²) were formed by T 205 om 88 standard method, the sheets were evaluated according to the T 809 om 93 to get Concora Medium Test values (CMT) as triangle corners for studying ternary furniture related to 50% of:

Semi-chemical bagasse	+ OCC
"M" Organosolv	+ OCC
"C" Organosolv	+ OCC

The same design was applied in the case of pulps at 1.5 and 33% Soda obtaining the next equation:

$$CMPT=b_1X_1+b_2X_2+b_3X_3+b_{12}X_1X_2X_3+b_{13}X_1X_3+b_{23}X_2X_3$$

Where:

$b_1 = Y_1$ + CMT of component 1, 100% (Organosolv pulp)

$b_2 = Y_2$ + CMT of component 2, 100% (OCC)

$b_3 = Y_3$ + CMT of component 3, 100% (Semi-chemical bagasse)

$b_{12} + 4\ Y_{12} - 2Y_1 - 2Y_2$

$b_{13} = 4\ Y_{13} - 2Y_1 - 2Y_3$

$b_{23} = 4\ Y_{23} - 2Y_2 - 2Y_3$

X_1 = Fraction of component 1, 100% ;

X_2 = Fraction of component 1, 100% ;

X_3 = Fraction of component 1, 100% ;

$1 = X_1 + X_2 + X_3$

The results for the four kinds of Organosolv pulp obtained and the different furniture composition with handsheets are the following :

a) For high soda application (high Soda %)

Response	Experiment 1	Experiment 2	Furniture
Y_1	74, 59	74, 331	Organosolv pulp
Y_2	211, 77	211, 77	OCC
Y_3	178, 13	178, 13	Semi-chemical pulp
Y_{12}	103, 769	115, 12	Organosolv pulp - OCC
Y_{13}	102, 79	108, 31	Organosolv pulp - OCC - Semi-chemical pulp
Y_{23}	140, 58	140, 58	OCC - Semi - chemical pulp

b) For minimal soda application (low Soda %)

Response	Experiment 1	Experiment 2	Furniture
Y_1	99, 62	74, 331	Organosolv pulp
Y_2	211, 77	211, 77	OCC
Y_3	178, 13	178, 13	Semi-chemical pulp
Y_{12}	103, 769	115, 12	Organosolv pulp - OCC
Y_{13}	102, 79	108, 31	Organosolv pulp - OCC - Semi-chemical pulp
Y_{23}	140, 58	140, 58	OCC - Semi - chemical pulp

RESULTING IN THE FOLLOWING MODELS

Determination of the useful formulations for each kind of Organosolv pulp

In determining the necessary formulations for each kind of Organosolv pulp mixed with recycled paper, it was considered the properties of the ternary furniture models of being reduced to binary furniture models by ignoring the value of the third compound. Thus based on the productive experience, the requirement of CMT was established, according to T 809 om 93, to 50 % of semi-chemical pulp and the equivalent amount of recycled paper for an optimal furniture, i.e. 140.58 N (31.6 lb_f). As a result the equations are reduced in all cases to:

Consequently, the recommended formulation should be adjusted to those values as follows :

$$140,58 = CMT = 74,59\ X_1 + 211,77\ X_2 + 178,13\ X_3 - 157,644\ X_1X_2 - 94,28\ X_1X_3 - 226,48\ X_2X_3$$

For X_3 = zero the equation is reduced :

$$140,58 = CMT = 74,39\ X_1 + 211.77\ X_2 + 178,13\ (0) - 157,644\ X_1X_2 - 94,28\ X_1X_3\ (0) - 226,48\ X_2X_3(0)$$

or : $140, 58 = 74,39\ X_1 + 211,77X_2 - 157,644\ X_1X_2$;

Then for the binary furniture:

$1 = X_1 + X_3$ and the next relation can be used; $X_2 = 1 - X_1$ and the equation is.

$$140,58 = 74,59\ X_1 + 211,77(1-X_1) - 157,644X_1\ (1-X_1);$$

By algebraic solution, it is arrived to the second grade equation :

$$0 = 71, 19 - 188, 19 + 73, 04\ X_1^2$$

X_1 can be determined solving the second grade equation, where two solutions for X_1 will result, one positive and the other negative. The latter is dismissed as it is not real, being obtained $X_1 = 0.6729$, i.e., 67.29%. which means 32.71%.

In case of the "M" Pulp at a 3% Soda.

$$CMT = 74,9\ X_1 + 211,77\ X_2 + 178,13\ X_3 - 157,644\ X_1X_2 - 94,28\ X_1X_3 - 226,48\ X_2X_3$$

In case of the "C" Pulp at a 3% Soda.

$$CMT = 74,331\ X_1 + 211,77\ X_2 + 178,13\ X_3 - 111,722\ X_1X_2 - 71,68\ X_1X_3 - 217,48\ X_2X_3$$

For "M" Pulp with 1, 5% Soda:

$$CMT = 96,62\ X_1 + 211,77\ X_2 + 178.13\ X_3 - 226,48\ X_1X_2 - 73,04\ X_1X_3 - 38,06\ X_2X_3$$

For "C" Pulp with 1, 5% Soda

$$CMT = 92, 655\ X_1 + 211,77\ X_2 + 178,13\ X_3 - 226,48\ X_1X_2 - 127,11\ X_1X_3 - 43,77\ X_2X_3$$

With these bases was determined the necessary formulation for each kind of Organosolv pulp.

According to the models obatined, and establishing as a target CMT (140.58 N o 31.6 lb_f), according to T 809 om 93; It was obtained for the values with a 50% formulation of cutting and bagasse semi-chemical pulp, the following relations:

1. Furniture with 65% OCC and 35 % Organosolv pulp (1.5% sosa with low alcohol level)
2. Furniture with 33% OCC and 67 Organosolv pulp (1.5% sosa and high alcohol level)
3. Furniture 85% OCC and 15% Organosolv pulp with 3.0% sosa and low alcohol level.
4. Furniture 74% OCC and 26% Organosolv pulp with 3.0% sosa and high alcohol level.

CONCLUSIONS

By means of the Organosolv Process, It is feasible the obtainment of a material not totally defibrillated, but with high axial compression strength due to the conservation of fibrous aces, which makes possible, in the structure of the corrugated carton, the support of heavier loads.

The 100% Organosolv Pulp could not be corrugated, but the results were significantly improved, when mixed with different percentages of recycled Kraft fiber, reaching CMT strength values of 148.5 N (33 lb_f) proper of the industrial paper.

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