

The Influence Of Recycled Fiber In The Mechanical And Physical Properties Of Paper

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Abstract

The recycling of paper is the use of used paper to the production of new papers, and has important environmental and social contribution. To check the quality of the final paper, you must do several tests with it, among these stand out the physical-mechanical tests. The most common tests are: tensile index, burst and tear. The tensile index measures the maximum force of traction per unit width of the paper supports before it break. The burst index measures the maximum pressure that a single sheet of paper can withstand under test conditions. Tear index measures the force perpendicular to the paper required to tear one or more sheets of paper through a specified distance. The objective of this work is to form sheets with different percentages of recycled fibers to verify its influence on physical-mechanical properties. Sheets were formed using short fiber (Eucalyptus) and recycled (newspaper) and made pulp microscopy. The sheets were obtained in laboratory former, and kept in a controlled environment for realization of physical-mechanical tests. Tests for burst and tensile index increased significantly with increasing the percentage of recycled paper. The tear index did not follow a trend. In the pulp with 100% of short fiber observed that the fibers are "entire", but there is little links between them. In the pulp containing 100% recycled fiber we noticed that most of the fibers are "broken." In the pulp containing 50% recycled fibers we observed that the "broken" fibers from the recycled pulp fill the gap of the "entire" fibers of short-fiber pulp. The use of recycled paper increased the physical properties of paper. This occur because of the fibers of recycled pulp has the function to fill the empty spaces of intertwining short fiber pulp causing better formation of the paper.

Keywords: recycling, paper, physical and mechanical properties.

Introduction

The activity of paper recycling in Brazil is very old and, therefore, it is confused with the own origins of papermaking in the country. Our first paper mills used scrap paper or exported to other plants abroad. Only since the 70's we began to produce paper using raw materials of national origin. Along with the increasing production of paper in the country widened to recycling activities (PERES, 2006).

The recycling of paper is an activity that has been over the years reaching global importance, both economically and ecologically. The need to use alternative raw materials and cheaper than the problem of waste disposal has created opportunities for increased use of recyclable materials (Oliveira and Silva, 1999).

Recycling is the use of cellulosic fibers from wastepaper and scrap for the production of new paper. Almost all types of paper waste could be used. Technically, the fibers contained therein could replace virgin fibrous raw materials such as chemical pulp, semi-chemical or mechanical (TECHNOLOGY RESEARCH INSTITUTE, 1981).

The recycling of various materials is extremely important and positive to reduce the mountains of urban waste, in the case of paper, to relieve pressure on world demand for wood. The recycling of paper in Brazil in recent times has been increasingly highlighted in that it contributes to the preservation and conservation of the environment and the solution of the question disposal of urban waste. It further states that recycling is, in fact, complementary to the production of primary fibrous materials, which is the gateway to the whole process.

Experimental

The materials used in this work are made up of an industrial eucalyptus pulp unbleached and a pulp of recycled paper (old newspapers were used).

Preparation of pulp

The pulp industry, consistently around 4%, were washed (due to residual alkali contained in the pulp), dewatering, air dried, and packed in plastic bags.

The newspaper sheets were broken, air dried and packed in plastic bags.

Formation of the sheets to the physic-mechanical

The sheets were obtained in laboratory type trainer Tappi, 200 g/m² ± 5 in accordance with standard TAPPI 205 om-81. They were stored in air-conditioned environment with temperature of 23 ± 1 ° C and relative humidity of 50 ± 2% to achieve the physical and mechanical tests. Were made ten sheets of each composition.

Physic-mechanical tests

Tests and analysis applied to each treatment and their standards are presented in Table 1:

Table 1. Standards for each test

Tests	Standards
Tear Index	TAPPI T 414 om-88
Burst Index	TAPPI T 403 om-91
Tensile Index	TAPPI T 494 om-88

Source: TAPPI TEST METHODS (1996-1997)

Tear Resistance

The tear resistance is the force perpendicular to the paper required to tear one or more sheets of paper through a specific distance. The fiber length is an important dimension in the development of resistance to tearing. It also said that intrinsic resistance of the fibers, related to the thick cell wall, is proving influential in the development of resistance to tearing, these features were more significant in long fibers.

Burst Resistance

The burst resistance is defined as the pressure required to produce the burst of the material, by applying a uniformly increasing pressure, transmitted by an elastic diaphragm, a circular area equal to 962 mm². Pulp with lower levels of fines and longer fibers in general, produce papers with higher resistance to burst.

Tensile Resistance

Tensile strength is the maximum traction force per unit width of the paper or card supports before they break, under defined conditions. It is in direct tension force needed to break the paper, when applied longitudinally or transversely. The interfibrillar connections occurred in the formation of the role will be critical to discuss this property.

Zeta Potential

The zeta potential is the electrical potential near the surface of a particle in suspension. It's a way to quantify the burden of the fibers. Does not depend on sample size and help predict how fast the suspension will agglomerate.

It can be affected by pH, conductivity, temperature and ionic strength.

The zeta potential indicates the adsorption capacity of the fiber and is actually the additive was adsorbed. Thus, one can predict the stability of colloidal suspensions.

The better retention of colloidal particles in a papermaking occurs when the Zeta potential (ξ) is close to zero. Although the majority of roles in manufacturing occur between - 40 mV to + 40 mV, depending on the type of fiber, type of pulping, the presence or absence of additives.

Despite the Zeta potential (ξ) is not a simple parameter, is an indirect measure of a number of interacting factors, each of which could be dominant under certain conditions. Soon the zeta potential is to give us an idea if the system is well operated or not and also to show us flaws during production.

Conductivity

It is the numerical expression of the ability of an aqueous solution to conduct electrical current. This capacity depends on the presence of ions, their total concentration, mobility, valence, concentration and temperature measurement. It is expressed in S / cm, in whole numbers.

Results and Discussion

Table 2 shows the values of tensile index, burst and tear:

Table 2. Results of physical tests

Composition of recycled paper (%)	Tensile Index(Nm/g)	Burst Index(kPa.m ² /g)	Tear Index(mN.m ² /g)
0	25,31	1,34	6,85
10	22,67	1,08	5,70
30	23,07	1,35	8,73
40	25,28	1,26	8,68
60	21,99	1,33	8,02
80	22,33	1,27	6,45
90	24,09	1,35	5,10
100	29,48	1,54	4,10

$$\text{Tensile Index} = \frac{\text{Tensile (KN / m)}}{\text{grammage (g / m}^2\text{)}} \times 1000$$

$$\text{Burst Index} = \frac{\text{Burst (KPa)}}{\text{grammage (g / m}^2\text{)}}$$

$$\text{Tear Index} = \frac{\text{Tear (mN)}}{\text{grammage (g / m}^2\text{)}}$$

As one can not precisely control the grammage of the sheet formed is used to calculate the index. Thus we can compare the tests because they are adjusted according to the grammage of each sheet.

Figures 1,2 and 3 show the evolution of the values of physical tests in accordance with the percentage of recycled fiber used:

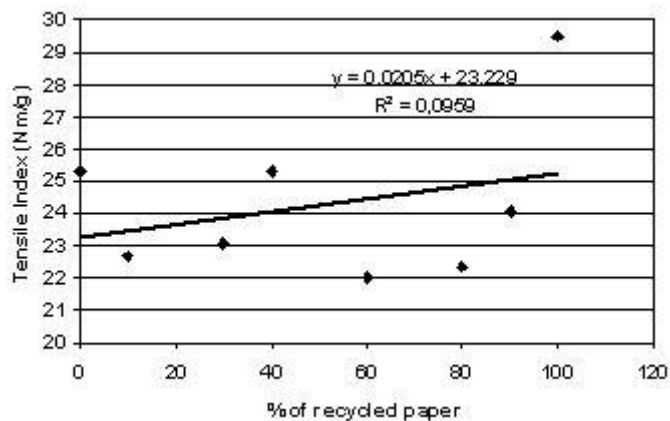


Figure 1. Comparison of tensile index.

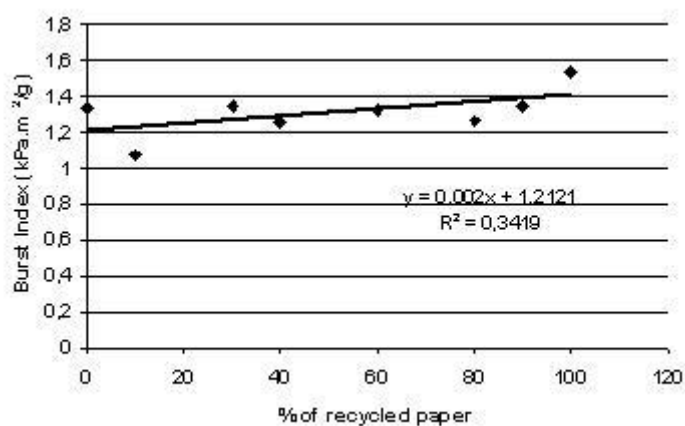


Figure 2. Comparison of burst index.

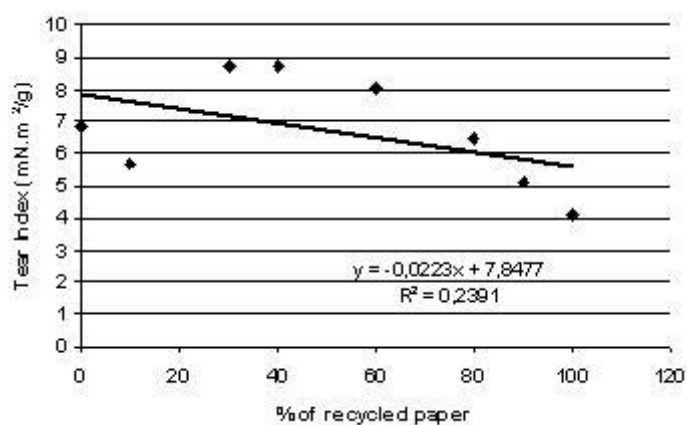


Figure 3. Comparison of tear index.

Table 3 presents the values of zeta potential and conductivity analyzed:

Table 3. Zeta potential and conductivity

Composition of recycled paper (%)	Zeta Potential (mV)	Conductivity (mS)
0	-183,0	0,1044
30	-190,4	0,1238
40	-207,0	0,1323
60	-202,9	0,1530
80	-179,8	0,1842
90	-157,7	0,1904
100	-139,6	0,2040

Figures 4 and 5 show the evolution of values analyzed:

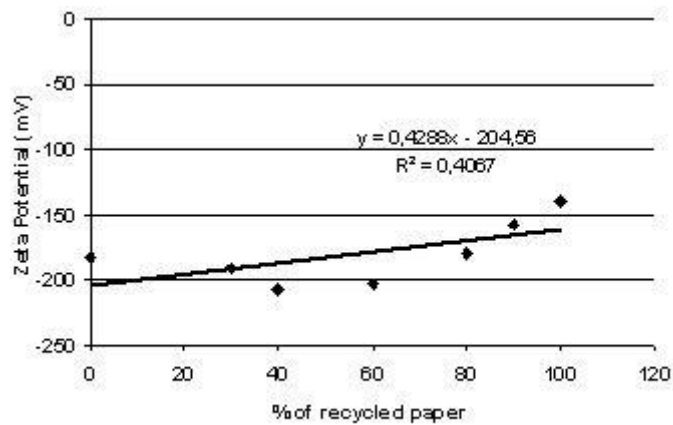


Figure 4. Comparison of zeta potential.

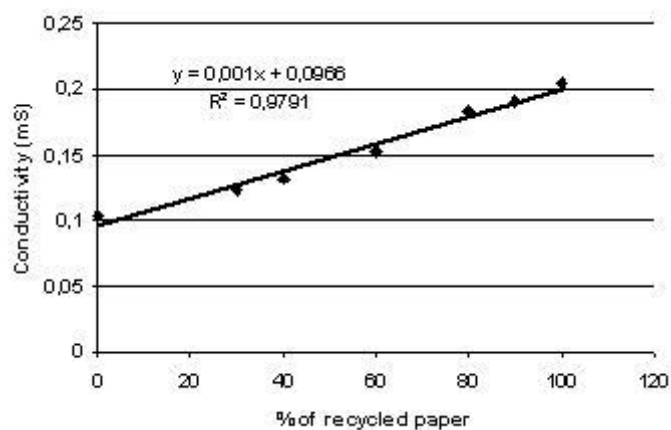


Figure 5. Comparison of conductivity.

The zeta potential decreases with increasing the composition of recycled fibers. For advanced training, the ideal value is close to zero. We observed that the values are outside this specification. This may explain the variations that occur, especially with the tensile tests that did not follow a trend.

The conductivity increases with increasing the composition of recycled fibers. We can say that this is due to increased presence of ions in solution.

To examine the links between the fibers were made of microscopy following compositions:

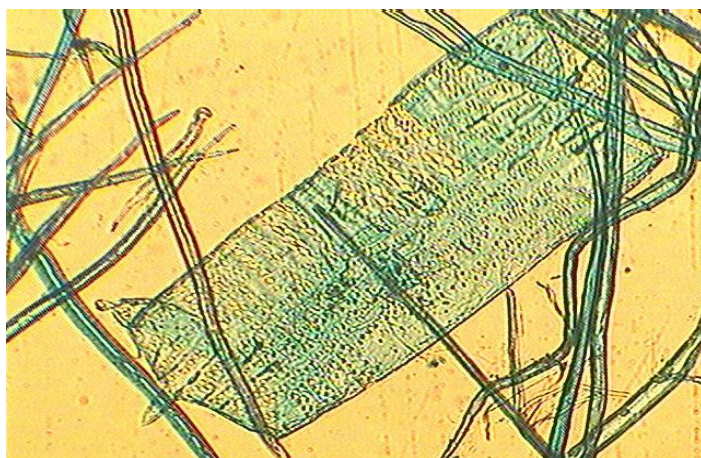


Figure 4. 100% hardwood.



Figure 5. 100% recycled fiber.



Figure 6. 50% recycled fiber.

In pulp containing 100% of short fibers observed the presence of vessel elements. We note that the fibers are "whole", but there is little intermingling between them. Interlacing (refining) of fibers is a factor that influences the physical-mechanical properties of paper formed.

To obtain the pulp containing 100% recycled fiber use newspaper. This type of paper is obtained by the process of Mechanical Pulp, where the wood goes through a grinding wheel. So we found that most of the fibers are "broken".

In pulp containing 50% recycled fiber, we observe that the fibers "broken" recycled pulp fibers fill the void "whole" of short-fiber pulp. That is why it increases the physical and mechanical resistance of the paper. For the sheet will have better training, since all voids are filled by the fibers.

As seen, the better retention of particles occurs when the potential is near zero. To this we add a product to the mass cationic. Table 4 shows the results obtained with the zeta potential near zero:

Table 4. Results of physical tests

Composition of recycled paper (%)	<i>Tensile Index</i> (Nm/g)	<i>Burst Index</i> (kPa.m ² /g)	<i>Tear Index</i> (mN.m ² /g)
0	18,79	0,95	8,03
50	25,79	1,19	11,73
100	33,14	1,90	9,32

Figures 7, 8 and 9 show the comparison between tests with zeta potential near zero:

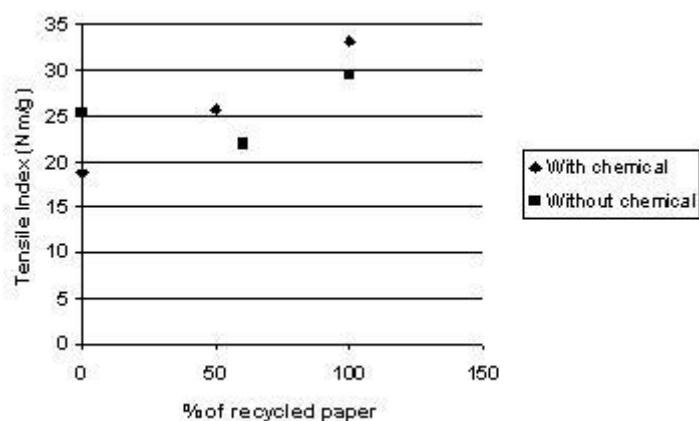


Figure 7. Comparison of tensile index.

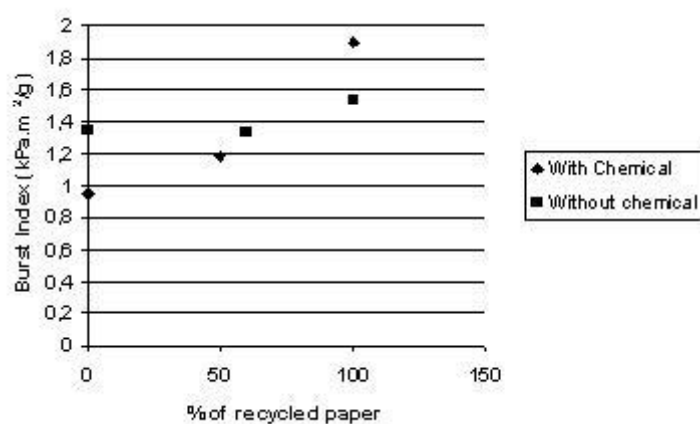


Figure 8. Comparison of burst index.

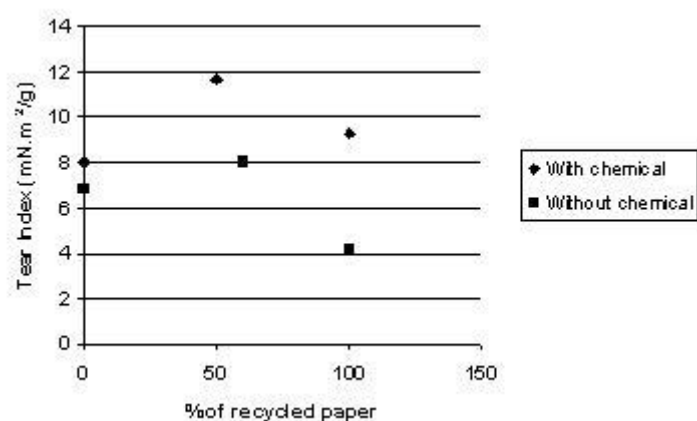


Figure 9. Comparison of tear index.

The sheets that were added chemicals have a better trend. The tensile index and burst index increases with increasing the composition of recycled fiber.

Tear index presents a different variation than that in which the chemical was not used. With 50% recycled fiber and it increases with 100% recycled fiber, it decreases. This is due to the fact the test tear not correlate with the bonding.

As we can see the zeta potential influence on physical and mechanical properties of the paper. Because it retains the colloidal particles, and these in turn improve the sheet formation.

Conclusions

The use of recycled paper has actually increased the physical properties of paper. We observe that as increases the percentage of recycled paper in the sheet properties increase. We also observe that this improvement occurs to a level (50% recycled fiber). Because the recycled pulp fibers have the function to fill the empty spaces of intertwining short pulp fibers causing better paper formation. The zeta potential is a very important factor in paper manufacturing. Because we observed that the leaves formed with near zero zeta potential had a better trend.

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