Improving Mechanical Properties of Paper by Blending Natural Wood Pulp with Polymers

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Co-operation between pulp and paper industry and synthetic polymer industry is showing upward trend. New products has been developed from the raw materials of both industries with functional properties that could not be achieved by using material from only one industry. The evidence of growing co-operation between the paper and synthetic polymer industry can be seen from leading paper making and paper converting firms diversifying their manufacturing activities in to fields of plastics in some cases replacing paper with plastics. Previously paper was made only from wood pulp and hence it did not have much durability. In order to improve the durability and mechanical strength of natural fibres; synthetic polymer pigments and fillers are added. These materials increase mechanical properties such as tear resistance, burst factor, breaking length etc. In this study we observed the improvement in the quality of paper when it is blended with nylon 66 and poly- formaldehyde resin. They have been added in different percentage and sheets were made. The remarkable improvements in the mechanical properties have been investigated.

INTRODUCTION

Paper manufactured from natural cellulose fibres obtained from the pulp mill is not yet show satisfactory performance for several reasons. First even though the fibres are saturated with water, they do not cohere well when the sheet is formed and dried and paper of low bursting and tensile strength results. In order to develop a good fibre bonding and high paper strengths it is necessary to beat and refine the fibres. Natural fibres also having marketed tendency to entangle and flocculate, which causes uneven formation of paper[1] Finally natural fibres produce a paper that lacks in several desirable characteristics such as surface smoothness, sizing, color etc.

Correction of these deficiencies requires numerous additions such as sizing agents, dyes, white color pigments, natural and synthetic polymers of various type, foam and pitch control chemicals. Processing the fibre and incorporating this additive comprises stock preparation[2].

New synthetic polymer products have been (and are being) developed for the paper industry in order to improve the productivity of papermaking and to create paper products possessing better functional properties. In addition when synthetic polymers products are used as retention aids they contribute to cost savings by reducing losses with mineral fillers and the fine fibres; they also reduce stream pollution by paper mill effluents. Although various types of paper differ in raw materials from which they are produced and in applied production methods, they have properties in common that are superior (to a varying extent) to those of conventional pulp based papers, particularly with regard to tear resistance, chemical resistance, dimension stability and folding endurance[48]. The important factor here is that wood pulp paper consumes more water and emits much more sewage than the composite paper. It was therefore felt that with the possibility of technological improvements in quality of paper, this paper might prove more advantageous than wood pulp paper[3].

Objectives

The objectives of the present study are to improve the mechanical properties of paper by adding the polymer to natural wood pulp. For this purpose polyamide (nylon 66) has been chosen as the polymer and polyformaldehyde resin as the binder. The synthetic pulp has been prepared by fibrillation method, which consists of orienting and extruding plastic film or tape

to such an extent that the fine fibrils are formed or of beating cut pieces of orienting film in fibrous structure similar to beaten wood pulp. Then the wood pulp is blended with synthetic pulp using polyformaldehyde as a binder.

In India several research worker had carried out the work in the field of pulp and paper technology by chemical modification. None has given the emphasis on blending technique with adding various additives like polyamide, bakelite, hexamine and calcium oxide which acts as binder. So all the reaction study will be more advantageous due to globalization and rapid growth rate of Indian chemical industry (pulp and paper). The scope is in the field for the improvement of the properties such as burst factor, breaking length[5,8,9,11],

EXPERIMENTAL

Blending Procedure

A binder of some sort must be added because almost complete lacks of bonding of the nylon fibre either with themselves or with cellulose pulp fibre. Even with the best of the binder, the great dissimilarities in fibre properties do lead to value at certain bleed levels, which are lower than those of either of the two-homo fibre sheets.

The fine fibril are formed by beating cut pieces of nylon-66 fibre, the consistency is similar to beaten wood pulp, (till the uniform dispersion of the fibre is observed). The synthetic pulp is then blended in mixed proportion with natural wood pulp. The poly formaldehyde resin is used as a binder. The precaution should be taken regarding uniformly distribution of polymer fibrils. Then the sheets are made by TAPPI standard method.

Table 1 : Apparatus Requirements

S.No.	Standard Equipment
1	Disintegrator
2	Sheet making machine
3	Couch Roll
4	Couch plate
5	Pump
6	Pressure Template for centering the sheets and plate in Press.
7	Drum drier for Drying paper sheet
8	Freeness Tester
9	Beater

From results as shown in Table No. 4, it can be concluded that due to addition of fibrous nylon-66 and phenol formaldehyde resin the vital properties like . Burst factor, Breaking length improves, however improvement is limited only up to addition of 1.5% to 3.0% of these material and any further increase in the addition shows declination in the properties. This is due the fact that due to addition of these additives homogeneity of

Table 2 : Composition Of Pulp In Various Sheet With Binder And Additvies

(As per TAPPI standards)

Sheet No.	Composition (%by mass)	Binder/additives
1	Pure pulp sheet	Without binder
2	Pulp + 1.5% Nylon 66	With binder
3	Pulp + 1.5% PF resin	With binder
4	Pulp + 1.5% Nylon 66 + 1.5%PF resin	With binder
5	Pulp + 1.5% Nylon 66 + 1.5% PF resin + 0.225% hexamine + 0.225% calcium oxide	Binder and additives
6	Pulp + 3.0% Nylon 66	With binder
7	Pulp + 3.0% PF resin	With binder
8	Pulp + 3.0% Nylon 66 + 3.0% PF resin	With binder

Chemically and mechanically modified paper is tested for different parameters as per TAPPI standards, as follows

Table 3 : Parameters For Papermaking

SR. No.	Parameter	Number
1	Physical Strength of pulp hand	T - 220, OS - 71
2	Bursting Strength	T - 403
3	Tearing Strength	T - 414
4	Folding Strength	T - 511, T - 423
5	Tensile Strength	T - 404
6	Moisture	T - 412
7	Stretch	T - 494
8	Rosin in paper	T - 408, OS - 74
9	Bilk Density	T - 21, OS - 74
10	Freness of pulp	T - 227, OS - 58
11	Consistency of pulp	T - 240, OS - 75
12	Alkali solubility	T - 235, OS - 76
13	Brightness of pulp	T - 217, OS - 48
14	Drainage time of pulp	T - 221, SU - 72
15	Fibre length of pulp	T - 232, SU - 68
16	Hypo Number	T - 253, PM - 75
17	Laboratory processing of pulp (Beater method)	T - 200, OS - 270
18	Standard Integrator	T - 205
19	Sheet Making	T - 205
20	Tear Factor	T - 220
21	Basis Weight	T - 412
22	Standard condition	T - 402
23	Air Permeability of paper	T - 251, PM - 75

mixture decreases and additive do not wipe well to the pulp. The most interesting part of the result is the properties shown by nylon-resin pulp mixture. It shows remarkable increase in properties like formation, breaking length, burst factor and tear factor up to 1.5% of the additives (Graph No. 2). This is due to the fact that, in this mixture resin acts as binder, which causes alignments of both nylon and natural pulp fibres.

CONCLUSIONS

1) The properties of the paper can be improved by addition of small amount of polymeric martial to natural cellulose fibre.

2) A test was carried with nylon 66 and Phenol Formaldehyde Resin (Novolac) as per shown in graph No. 1 and satisfactory results up to certain concentration limit were obtained because nylon resin pulp mixture shows remarkable improvement in mechanical properties. This is because mixture resin acts as binder that causes alignment of both nylon and natural pulp fibre.

3) The further scope of this work is to try different polymeric materials and to find the cheap, and easily available additive that can improve the properties of paper as desired.

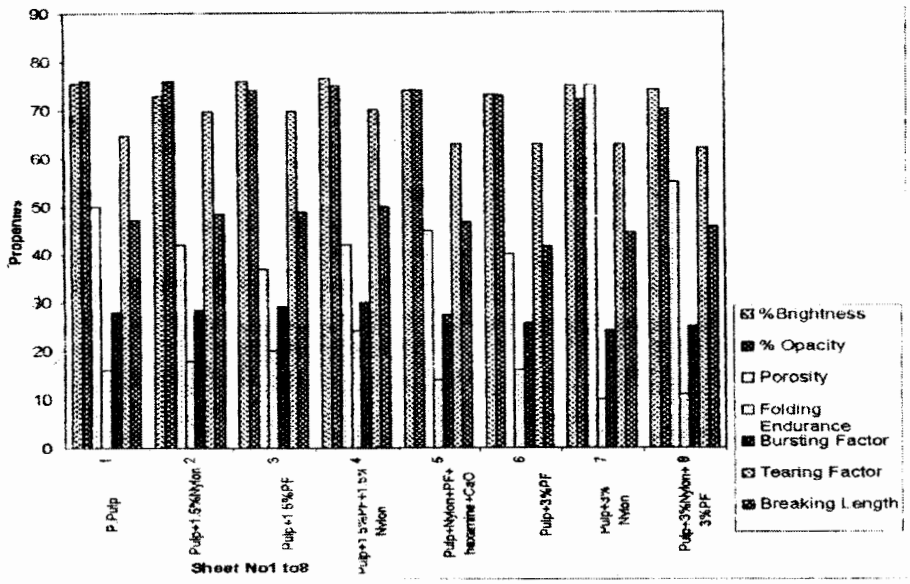

Fig. 1 : Comparision of properties of Paper

RESULTS AND DISCUSSION

Table 4 : Evaluation of Characteristics of different Composition Sheet (with and without) binder and additives

Proerties	Sheet No.1	Sheet No.2	Sheet No.3	Sheet No.4	Sheet No.5	Sheet No.6	Sheet No.7	Sheet No.8
Basis Weight	60	60	60	60	60	60	60	60
% Brightness	75.5	73.0	76.0	76.5	74.0	73.2	75.0	74.0
% Opacity	76	76	74	75	74	73	72	72
Formation	4.0	8.4	8.1	6.8	9.8	8.9	8.6	9.2
Smoothness ml/min	900/ 1500	1250/ 1850	800/ 1500	900/ 1500	1100/ 1500	900/ 1400	800/ 1400	1000/ 1500
Porosity	500	420	370	420	450	400	750	550
Folding Endurance	16	18	20	24	14	16	10	11
Bursting factor (g/m^2)	28.0	28.3	29.2	30.0	27.5	25.8	24.1	25.0
Tearing factor (g/m^2)	64.6	69.7	69.7	70.0	62.9	62.8	62.9	61.9
Breaking Length (m)	4720	4830	4880	5000	4680	4166	4445	4568

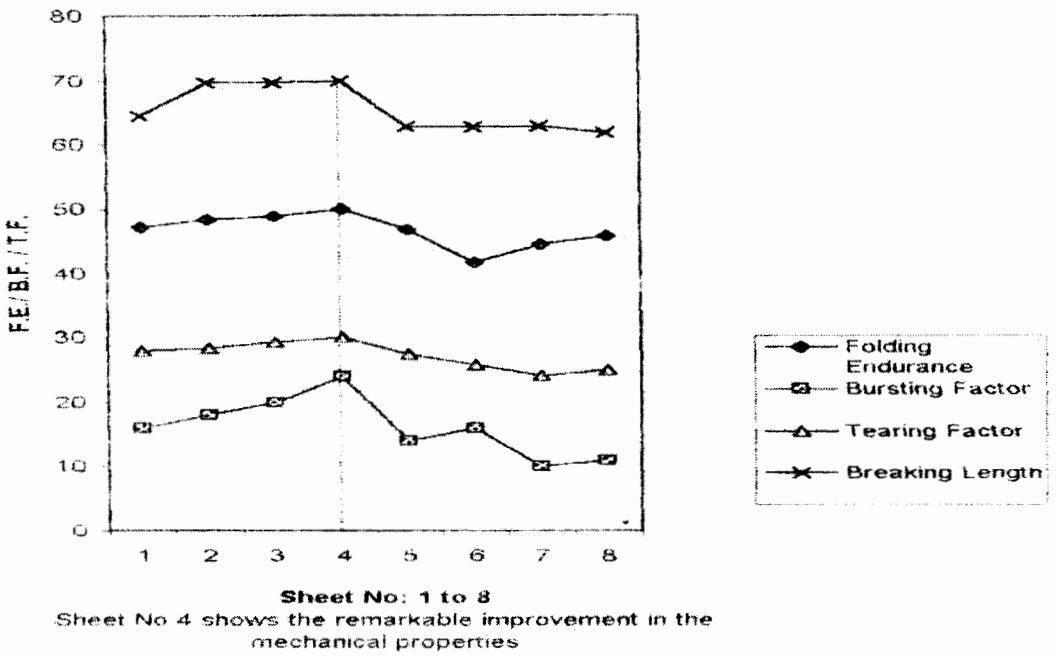

Fig. 2 : Comparision of Mechanical

4) The properties of paper can be improved by addition of small amount of binder and additives to natural cellulose fibre. In this study we observed the change in the quality of paper when it was blended with nylon 66 and PF resin.

5) The remarkable improvement in the mechanical properties like folding endurance, burst factor and tearing factor with respect to breaking length has been observed. (Graph No.2).

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