Quality Assessment of Some Varieties of Weste Paper Available in Andhra Pradesh AS A Furnish for Multiply Board Manufacture

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ABSTRACT:- Seven varieties of waste paper available in Andhra Pradesh and imported NDLKC have been evaluated in the laboratory for the yield, fines content and strength properties. Also studies have been carried out to improve strength of the waste paper pulps by treatment with Caustic Soda.

The yield of pulp on A.D. waste paper basis has ranged from 77.2% to 86.8% but redilution and thickening these on inclined deckers reduces yield to 69.3% to 82.7% indicating further losses during thickening operation (In plant this occurs during thickening after centricleaning). Analysis of pulps for fines content (-200 BS mesh fraction) indicates high fines content (34.6% to 46.0%). Hence to reduce fines loss in plant operations, filtrate after thickening needs to be recirculated.

From analysis of waste papers & the corresponding pulps for Ash content it is seen that the pulps have slightly higher ash level indicating slightly increased loss of pulp fines as compared to filler fines in the pulping and thickening operations.

The strength properties of these pulps are quite low as compared to virgin pulps and also imported NDLKC, but there is significant difference among varieties. The evaluation helps optimization of blends with respect to strength, quality and cost. It may be necessary to blend virgine pulps or imported waste paper pulps to achieve required qualities for certain varieties of Duplex and Triplex Boards.

INTRODUCTION

Recycling of paper has become a necessity both from the point of view of economy and also to ensure an eco-friendly sustainable growth. There was a time when industrial growth was considered as an indicator of development irrespective of its effect on the environment and on the future of growth itself. However, fortunately now most of the countries have understood that growth has to be eco-friendly and sustainable. The Brundland Commission (1) report defines sustainable development as that development "which meets the needs of the present generation without compromizing with the ability of future generations to meet their own needs. Most of the countries have accepted this concept of growth.

Recycling of paper has both advantages and disadvantages. The advantages are that it helps conserve precious fibrous raw material resources.

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reduces waste disposal problems and is eco-friendly. The disadvantages are that recycling tends to degrade quality of the product, the waste paper quality is highly heterogeneous and cannot be used in all varieties of paper because of their poor quality and solid & liquid wastes which are generated, pose disposal problems. However, technical solutions are being developed to properly collect and classify and also to improve quality of waste paper pulp. As on today, only limited improvements have been achieved and the problem still remains.

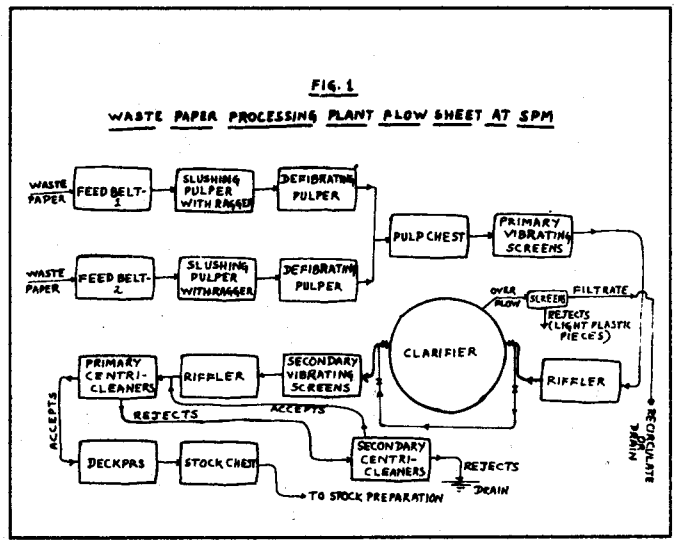
The decision to use waste paper in the furnish in any mill depends on the quality and varieties of paper and/ or board to be manufactured. The ratio of waste paper furnish and virgin pulp furnish has to be worked out by experimentation and trials to ensure that the output quality is maintanined at the desired level. To do this, evaluation of the quality of waste papers is a primary step.

In India, no systematic grading system has been established similar to the systems of USA & Europe. The Paper Stock Institute of USA describes 51 grades in addition mentions 33 speciality grades. No specification is given for specialy grades and purchase of these should be based on samples and buyer-seller agreement (2). The Bureau of Indian Standards has constituted an Ad-hoc panel to indentify the source, classification, terminology, etc. on the recycled paper. This task, when completed should serve as a basis for suppliers & purchasers of waste paper. Secondary fibre is not manufactured to specifications as is wood pulp which is produced from specific trees by pulping, bleaching and refining processes. It consists of a waste from manufacturing operations (3). But in India, the waste paper also comes after primary use of paper & paper products. Because of the very nature of sources from which it is collected, it is contaminated. In addition, the waste paper contains prohibitive material or contraries which have to be removed.

The waste paper processing system needed depends on the quality and the purpose of which the resulting pulp has to be used. If the pulp is needed as filler pulp for Duplex or Triplex board, the processing would be less sophisticated as compared to the one needed for higher quality pulp by deinking and with/ without further bleaching. In the succeding paragraphs we will be confining to the systems for production of filler pulps for Duplex & Triplex Board manufacture.

WASTE PAPER PULPING & PROCESSING SYSTEM AT SIRPUR PAPER MILLS LTD.

The flow sheet of the process is given in Fig.1. From the flow sheet it can be observed that the system consists of all basic feature for obtaining clean waste paper pulp. We would like to add that the waste paper received, is directly fed to repulper without any presorting. The repulper is equipped with ragger to remove contraries of roping tendency. The vibrating screens removed most of the plastics, metals and such materials. However, the accepts from vibrating screen still contain small plastic pieces which pass through the screen perforations. Recent waste paper processing plants use pressure screens with perforated and slotted screens to remove such impurities. However, we have a hydraulic system where the plastic pieces are floated & removed. This system is performing excellently in our Mills. Secondly, sand and such other high density impurities are generally removed by high density cleaners in modern systems. However, our system of Rifflers is serving the purpose well. Further purification is carried out in Two-Stage centricleaners. After centricleaning the pulp is thickened on inclined side hill screens. The thickened pulp is stored in a supply chest and pumped to Stock Preparation. In the stock preparation, the pulp is passed through deflaker before the refining operation.



LABORATORY WORKS ON QUALITY ASSESSMENT

As discussed earlier, though there is no standard system of classification of wastepaper, the types of waste paper received by us are classified as below.

1. Kraft	consists of used kraft, corrugated carton pieces (bitumin free) brown envelops, etc.
2. Books	Mostly printed books, and sheets.
3. News paper	Old news paper without any contamination.
4. B.B. Grey	Coloured & unbleached, printed paper & Board
5. Unsorted waste	Consists all sorts of paper & board, printed, coloured unbleached, etc.
6. Office Records	Mixture of printed and written waste of white and coloured papers.
7. White cuttings	Pure White cuttings (trimmings) unprinted but with & without ruling with some ledger paper.

EXPERIMENTAL

Representative samples of SEVEN varieties of waste paper were collected from Waste Paper Plant. Imported NDLKC waste was also collected along with indigenous varieties for comparison Contrary materials were hand sorted and weighed separately. Waste Paper (after removal or contraries) equivalent to 1.5 Kg O.D. material was repulped in the laboratory repulper at 3% consistency in cold water and it was run for around 30 minutes. After repulping operation the resulting pulp was thickened on laboratory side hill screen of 100 mesh (BS). The pulp on the screen was further thickened to 25% consistency by hand squeezing, granulated and equilibriated in a polythene bag and yield determined.

This pulp was further diluted to 1% consistency and rethickened on side hill screen (100 BS mesh) and retention and thereby the yield was determined. The second dilution & thickening was carried out to ascertain the loss of thickening stage. The results are given in Table-I.

The pulps obtained (1st stage thickened) were beaten in the laboratory valley beater to 40°SR. standard hand sheets were made and tested for strength properties. Hand sheets were made on British Standard Sheet former without any recirculation. However, instead of diluting to full level in the mould, the sheets were made with two-litre dilution (consistency 0.066%)

Literature (6) indicates that alkali treatment can improve the strength properties of waste paper pulp. To ascertain the extent of improvement achievable, the pulps were treated with 3% NaOH at 10% consistency at 70°C for 30 minutes with frequent

Table-1

YIELD, FINISH AND ASH CONTENT OF DIFFERENT VARIETIES OF WASTE PAPER

Property / Type of Waste Paper	Initial Moisture %	Contrairies on A.D. material basis%	Yield on A.D. raw material basis %		Fibre Classification of Pulp (A)		Ash % (OD Basis)	
			A	B	+200 BS mesh Fraction %	-200 BS mesh Fraction %	Raw Paper	Pulp (A)
1. Kraft	45.2	2.0	86.1	76.2	62.6	37.4	8.2	9.4
2. Books	8.6	0.2	84.7	77.9	60.5	39.5	8.7	10.6
3. Newspaper	8.4	Nil	88.5	82.7	65.2	34.8	5.1	3.7
4. B.B. Grey	20.7	1.1	84.4	69.3	54.0	46.0	12.8	18.3
5. Unsorted Waste	13.2	3.6	77.2	72.8	59.5	40.5	11.3	14.6
6. Office Records	15.5	3.2	76.5	76.0	58.1	41.9	11.4	11.5
7. White Cuttings	9.0	0.4	86.8	78.0	65.4	34.6	9.0	9.2
8. Imported NDLKC	8.5	Nil to 0.5	87.2	--	77.1	23.9	2.2	2.2

"A" = 1st thickening from 3% consistency to 5% consistency on inclined decker (100 BS mesh)
"B" = Pulp (A) was diluted to 1% consistency and thickened to 5% consistency on inclined decker (100 BS mesh)

Table-2

Strength Properties of Pulps At 40°SR

Pulp Type / Properties	Kraft		Books		New Paper		B.B. Grey		Unsorted		Office Record		White Cuttings	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B
Initial Freeness °SR	28	29	27	28	41	41	24	26	24	26	29	30	39	38
Final Freeness °SR	40	40	40	40	41	41	42	40	40	40	40	40	39	41
Beating time minutes	15	12	10	9	Nil	Nil	12	10	12	10	11	9	Nil	5
Grammage g/m²	62	61	60	58	61	63	61	58	64	61	61	62	62	61
Caliper µm	100	94	84	81	104	101	105	100	125	94	106	106	90	88
Bulk, Cm³/g	1.61	1.54	1.40	1.39	1.70	1.60	1.72	1.72	1.95	1.54	1.74	1.71	1.45	1.44
Breaking Length, m	3145	3442	3083	3348	2432	3174	2363	2399	2213	2432	2213	2581	3151	3460
Tensile Index (N.m/g)	30.85	33.76	30.24	32.84	23.85	31.13	23.18	23.53	21.70	23.85	21.70	25.31	30.91	33.94
Burst Index (kPa-m²/g)	1.86	2.09	1.72	1.94	1.33	1.77	1.19	1.06	1.07	1.23	0.94	1.27	1.65	1.78
Tear Index (mN-m²/g)	3.09	4.23	3.92	3.82	5.10	5.60	2.52	4.28	3.37	2.89	3.84	2.94	4.34	4.75
Fold Number (Kohler Molin) (Number of D.F.S)	7	8	4	5	4	5	3	2	2	2	2	2	5	7
Strength Index*	785	949	750	806	726	897	515	521	484	506	475	490	805	905

* (B.F. x T.F. x Log D.F.'s)$^{1/3}$ x 100

"A" = Pulp after repulping waste paper

"B" = repulped pulp treated with 3% NaOH at 10% consistency, 30 min. at 70°C and then washed.

mixing during the retention period. The pulps were washed with minimum amount of water on 300 BS-mesh, beaten in the valley beater to 40°SR, standard hand sheets were made and tested for strength properties. The results of strength properties of pulps before & after alkali treatment are given in Table-II.

DISCUSSIONS

From Table-I it is observed that the yield for different types of waste paper varies quite widely. Yield values obtained after repulping and thickening is in the range of 76.5% to 88.5%. However if these pulps are further diluted to 1% consistency & thickened, there is yield loss. The resulting yield ranges from 69.3 to 82.7%. This clearly indicates that the yield achievable is very much depending on the dilution & thickening operations. The losses of fines in the filirate is quite substantial and it becomes necessary to recirculate the filtrate with in the system to reduce fines loss. It is possible to reduce fines loss where thickening is carried out using vacuum drum washers but the operation of these washers also will be difficult in view of the possibility of clogging of wire cloth with fines.

From Table-I, we find the fines content (-200 BS mesh fraction) of these varieties of waste paper. It is ranging from 34.6 to 46.0% which is quite high, but as expected, in view of the poor quality of the waste paper. As indicated above, to ensure good yield from these, waste papers, it is necessary to retain good proportion of fines. However, the quality of the pulp will be poor as the retention of fines fraction is increased. There is possibility to improve pulp quality by discarding some fines with reduced yield and also leading to fines disposal problem.

The contrary materials range from Nil to 3.6% which are mainly plastics, metal pieces, ropes, etc. because of the presence of these materials waste paper pulp production needs an elaborate system (please see Fig.1). The system given in Fig.1 is sufficient to produce acceptable pulp for filler pulp of duplex and triplex boards without any presorting manually. However for deinking and bleaching, the system becomes more elaborate requiring higher capital expenditure.

The Ash content of these waste papers and the resulting pulp (Table-I) also contribute for the poor quality and fines content. Table-II gives strength properties of these pulps at 40°SR both before & after caustic soda treatment. Also Table-III gives strength properties of our plant pulp (chemical kraft) both bleached & unbleached. Comparison of data

of Table-II with that of Table-III clearly indicates that the strength properties of waste paper pulps are very low.

From literature survey (4) it is seen that, drying of chemical pulps is known to reduce the reswelling ability of the fibres an effect called hornification. The same effect takes place also with fines. Also as per M. Mousa Etal (5) the damage to the fibre usually manifests itself in hornification and surface inactivation of fibres. The low strength properties of the waste paper pulps can, therefore, be attributed to the hornification and surface inactivation phenomena. It has to be noted that the paper made in India even by virgin pulp is weaker than those of the west because of two main reasons namely (i) higher amount of short fibre length pulp in the paper furnish and (ii) high degradation of fibres during bleaching because of the use of hypochlorite stage in bleaching.

Research work has been carried out to improve the strength properties of waste paper pulps and one simple method is to treat the pulp with caustic soda (6). We have also subjected the waste paper pulps to this treatment and the strength properties of alkali treated pulp is also given in Table-II(B). It can be observed that there is some significant improvement in strength properties by this treatment but still the strength levels are very much lower than Virgin pulps. Therefore it can be inferred that irreversible change takes place. This type of pulp when it forms a part of the furnish of any paper is bound to bring down the strength. To ensure quality only a small part of such pulp can be considered as furnish.

However, the case of Duplex & Triplex boards are slightly different. Though bonding potential of the pulp is important, it is not needed at a very high level to make good quality board. In his excellent paper (7) Mr. Olle Alsholm has described the function of different layers of a multiply carton board. From this it is easy to visualize the nature of furnish quality needed for different layers.

The top surface should have the required microporosity smoothness, the next layer should provide Tensile stiffness and the next should provide BULK and the next again tensile stiffness. The three layers (2nd, 3rd and 4th) should provide stiffness when we say a layer here, it can be from a single mold or former or from more than one mold or former depending on the grammage.

From the above we can observe that the middle layers provide bulk (and bending stiffness) and it is in these layers we can use our waste paper pulp effectively. These layers do not need high tensile strength and the bonding strength needed should be sufficient to prevent delamination.

Bending stiffness is given by the expression $Et^3/12$ where 'E' = elastic modulus & 't' = thickness. Hence as our waste paper layers provide good bulk. they provide good bending stiffness as it is proportional to the 3rd power of thickness though elastic modulus is lower.

Therefore, the waste paper pulps can be effectively used as middle layers of Duplex & Triplex Boards. From the Table-II, it can also be observed Kraft waste paper pulp gives good tensile strength and news paper pulp-good tear. others are poor in both strengths. Hence the filler furnish should be so

Table-3

Strength properties of typical Plant Pulp (Kraft Chemicals with 65% Bamboo + 35% Hardwood furnish) and Imported NDLKC pulps received from three seperate consignment.

Properties \ Pulp Type	Plant Kraft Chemical pulps		NDLKC pulps		
	Unbleached	Bleached	May,94	Dec.94	Aug.95
Kappa No. of pulp	26.3	--	49.1	56.4	51.7
Initial Freeness °SR	16	17	20	17	17
Final Freeness °SR	40	40	40	40	41
Beating time, min.	50	40	30	45	55
Grammage, g/m²	62	61	59	64	60
Caliper, µm	92	80	90	95	90
Bulk, Cm³/g	1.48	1.31	1.53	1.48	1.50
Breaking length m	7341	7667	7571	6979	5856
Tensile Index (Nm/g)	72.0	75.2	74.26	68.46	57.44
Burst Index (kPa m²/g)	4.61	4.75	4.38	4.53	4.51
Tear Index (mNm²/g	6.84	5.78	7.97	8.07	7.35
Fold Number No. of DFs (Kohler Molin)	213	205	155	226	305
Strength Index (B.F. x T.F. x Log D.F.)$^{1/3}$ x100)	1968	1876	1995	2076	2046

proportioned to optimize strength and cost.

Also imported waste papers such as NDLKC or OCC can also be considered as part of the furnish to improve strength. The strength levels of NDLKC are much better than Indian Waste Papers and are comparable to virgine pulps. (Please see Table-II). Also use of virgin pulp in the top & bottom layers gives the board required brightness, printability and tensile stiffness. The grammage of layers, proportion of different furnishes have to be worked out considering strength required for the final board and also the cost.

CONCLUSIONS

1. The waste papers available in A.P. are of poor quality and yield pulps of low strength. However with proper mixing of different varieties with good repulping and cleaning system, acceptable pulp for Duplex and triplex board manufacture, can be obtained from these waste papers.
2. The pulps of these waste papers contain substantial proportion of fines (34.8% to 46.0%) which is one of the reasons of poor strength and also can lead to substantial yield loss if steps are not taken to retain this in the system.
3. Caustic Soda treatment of these waste paper pulps improves strength significantly but still are substantially of lower strength than virgin pulps and also as compared to imported NDLKC waste paper pulp.
4. The evaluation of these waste papers as carried out in this study helps to optimize waste paper furnish composition to be used commercially with respect to cost & quality.

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