Reuse of waste paper—present problems and future needs

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SUMMARY

Growing demand for paper making fibers in future; when bamboo, wood and other raw material shortage is likely to become accute; may be partially met by increasing the reliance on waste paper. Being a by-product from the manufacture of a product or used product, its processing poses peculiar problems. The present paper reviews the various factors involved in recycling waste paper, advantages of secondary fibers and restrictions which limit their use.

Waste paper processing has been subdivided as pulping process, cleaning process, deinking-bleaching and fiber sorting, refining and paper or board making. Emphasis is given to stock preparation schemes for obtaining stock at best possible strength. Problems in processing and methods of alleviating the same are discussed. Energy considerations in a waste paper based mill and methods of reducing the energy consumption have been outlined.

In the recent past, the paper industry in our country has been facing problem of raw material scarcity, power shortage, coal short supply and rising cost of chemicals. The installed capacity and production statistics of paper and board industry are presented in Table 1. These statistics indicate a decreasing trend in the capacity utilization. The need for developing alternate raw material resources yielding fibers at lower chemical and energy costs is well known. Waste paper as a source of paper and board making fibers and some of its processing aspects are discussed in the present paper.

Growing demand for paper making fibers in the industry may be best fulfilled by increasing our reliance on recycled waste paper. Recycling waste paper not only reduces the dependence on declining bamboo resources and hardwoods but also saves energy (particularly coal) and chemicals. A comparison of average consumption of steam, electricity and chemicals in a typical 20-40 TPD waste paper based duplex board mill and in a 100-150 TPD bamboo/hardwood based integrated paper mills is presented in Table 2. The table indicates that the energy consumption in waste paper based board mills is 30-40% of that in an integrated paper mill. Also, the total BOD load per ton of paper is about 8-10 times the BOD load per ton of waste paper Board.

Several other advantages are found in the recycled fibers. Recycle fibers are shorter; they form better and require less refining energy. They have better dimensional stability; reduced curling tendency, increased opacity and increased bulk. (Table 3.)

The tensile, burst and tear strength characteristics of the recycled fibers deteriorate with recycling. Each time a fiber is pulped, it is subject to mechanical attrition, swelling and diswelling as the fiber is dried. This hardens the fibers and as a result the inter-fiber bonding properties diminish.

The recycled fiber has about 55-57% of its original tensile strength and burst factor (Table 3.) In the second cycle the strength is only 32-35% of the virgin fiber sheet. The loss in strength is due to hardening of the fiber and generation of fines (Table 4.) during repeated refining.

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TABLE No. 1 PAPER AND BOARD STATISTICS OF INDIA (EXCLUDES NEWSPRINT PRODUCTION)

Year	1976	1977	1978	1979	1980	UNIT
Total production of paper and Board	880	937	1006	1020	1017	X 1000 Tons
Installed capacity of Paper and Board	1171.0	1137.5	1164.5	1380.5	1538.0	X 1000 Tons
Capacity utilized	79.7	82.4	86.4	73.9	71.2	%

Source : 1. Paper Industry an overview, Financial Express, Februaty 2, 1980
2. Business Information Bureau, Budget Session 1980, Issue No 10, July 1, 1980.
3. Business Information Bureau, Winter Session 1980, Issue No 24, December 6, 1980.

TABLE No. 2 ENERGY CONSUMPTION AND EFFLUENT VOLUME OF 20-40 TPD WASTE PAPER BASED BOARD MILL AND 100-150 TPD INTERGATED PAPER MILL-A COMPARISON

Description	Unit	20-40 TPD DUPLEX BOARD MILL	100-150 TPD INTERGRATED PAPER MILL
Steam Consumption	Ton/Ton	3-3.5	10-12
Electrical Energy	KWH/Ton	650-750	1600-1800
Effluent Volume	Gal/Ton	20,000-30,000	50,000-1,00,000
Effluent B.O.D.	PPM	80-150	200-300

TABLE No. 3 SHEET PROPERTIES OF A RECYCLED BLEACHED SOFTWOOD KRAFT PULP, REFINED AND ONE PERCENT ROSIN ADDED IN EACH CYCLE.

Recycle No.	Freeness ml CSF	Basis wt. gsm	Sheet density g/cc	Tear factor	Burst factor	Tensile strength psi	Opacity percent
0	285	59.5	0.66	108.7	47.0	6890	79.8
1	285	61.2	0.57	118.3	26.9	3870	87.5
2	270	61.2	0.55	128.1	16.8	2178	90.7
3	255	61.3	0.52	105.5	12.8	1880	91.5
4	260	61.2	0.51	86.8	9.2	1487	92.6

Source : R. A. Horn, Paper Trade Journal, 159 (718) : 78 (1975)

TABLE No. 4 BAUER McNETT SCREEN ANALYSIS OF RECYCLED, BLEACHED SOFT WOOD KRAFT PULP.

Recycle No.	R 14 %	R 28 %	R 48 %	R 100 %	P 100 %
Virgin, Unbeaten	63	19	8	5	5
0	31	27	13	11	19
1	25	29	14	12	20
2	20	31	14	11	24
3	19	31	16	11	23
4	18	31	14	12	25

Source : R. A. Horn, Paper Trade journal, 159 (718) : 78 (1975).

A wide range of products like mill board, grey board, ticket board, wrappers, fluting medium, second grade writing papers and tissue papers having physical characteristics with IS Specifications may be produced from waste paper. Also, the market specifiations of these boards/paper can be easily matched. For reference purpose, the physical characteristics of waste paper based duplex boards which have found acceptance in the market is shown in Table 5. Office record grade waste paper having physical characteristics as shown Table 6 is normally used in the manufacture of these boards.

WASTE PAPER RECYCLING

Reuse of waste paper in the production of paper and board involves the following steps.

1. Procurement.
2. Stock preparation :
   Pulping, cleaning and refining
   Fiber upgradation techniques
3. Board making.

An analysis of the process problems and their probable solutions are discussed below :

WASTE PAPER PROCUREMENT

Although waste paper suppliers have made many improvements in both collection and sorting of the waste paper, the recovery rate and waste paper quality is still poor Table 6. The recovery and utilization rate of waste paper in our country is low as compared to many other developing countries. A comparison of waste paper recovery and consumption pattern in Europe, N. America, Asia, Africa and Latin America is made in Tables 7 and 8. Since the rate of consumption waste of paper by a country is dependent on its rate of waste paper recovery, import or export of waste paper, and its own consumption of paper and board, the following definitions have been used in the construction of the tables 7 and 8.

$$\text{Waste paper recovery rate} = \frac{\text{Waste paper collected}}{\text{Paper and board consumed}}$$

$$\text{Waste paper consumption rate} = \frac{\text{Waste paper used}}{\text{Paper and board production}}$$

A study of Tables 7 and 8 reveals that Netherlands, UK, Denmark, Republic of Korea, Taiwan, Thailand, Egypt, Morocco, Mexico and El Salvador

TABLE No. 5—CHARACTERISTICS OF WASTE PAPER BASED ON INDIAN DUPLEX BOARDS

Top liner — Virgin pulp
Filler liner — Waste paper
Bottom liner — Waste paper

S. No.	Particulars	Unit	Range
1	Substance weight	g/m^2	250 — 350
2	Moisture	%	7 — 9
3	Total ash	%	7 — 12
4	Top liner	%	28 — 46
5	Breaking length		
	M. D.	meter	3000 — 4800
	C. D.	meter	1500 — 2200
6	Burst factor	—	16 — 27
7	Porosity	s/100 ml	65 — 130
8	Smoothness (Bendsten)		
	Top	ml/min.	100 — 300
	Bottom	ml/min.	1000 - 2200

TABLE No. 6—CHARACTERISTICS OF WASTE PAPERS – A LABORATORY EVALUATION
PULP FREENESS 400–500 ml CSF.

S. No.	Waste Paper Grade	Moisture %	Yield %	Ash %	Breaking Length, m	Burst Factor	Brightness PV
1.	Light Grey	9–12	80–83	8–10	1200–1300	6–6.5	50-52
2.	Office Records	11–16	76–79	10–13	1068–1110	4.7–5 5	45–50
3.	Kraft	14–18	65–80	7–9	1400–1900	8-10	25–27
4.	Road Sweepings	15–19	75-80	9–10	900–1030	4.5–5	33–38

White Cuttings has not been included here.

TABLE No. 7 WASTE PAPER RECOVERY AND CONSUMPTION PATTERN : EUROPE AND N. AMERICA

S.No.	Country	Paper & Board Consumption X 1000 T		Waste Paper Recovery X 1000 Tons		Waste Paper Recovery %		Waste Paper Consumption X 1000 Tons		Waste Paper Consumption %		Waste Paper Import X 1000 T		Waste Paper Export X 1000 T	
		1978	1979	1978	1979	1978	1979	1978	1979	1978	979	1978	1979	1978	1979
1.	Belgium	1316	1425	379	430	28.8	30.2	175	234	21.9	27.1	50	72	254	268
2.	Denmark	848	881	na	na	—	—	152	163	63.6	62.9	na	na	na	na
3.	Finland	898	1079	195	216	21.7	20.0	189	202	3.7	3.5	9	2	7	9.5
4.	France	3892	6251	1828	1956	31.0	31.3	1738	1863	35.1	35.4	256	292	328	362
5.	Germany, East	1334	1362	584	578	43.8	42.4	545	565	45.2	46.4	—	—	59	30
6.	Germany, West	8749	9534	3050	3268	34.9	34.3	2952	3198	43.1	43.0	324	422	424	503
7.	Italy	4584	5244	1453	1339	31.6	25 5	2060	2036	44.7	41 1	608	757	—	—
8.	Netherlands	2047	2205	886	935	43.4	42.4	866	886	51.8	52.0	212	242	236	335
9.	Poland	1479	1439	502	462	33.9	32.1	488	443	37 0	35.5	—	—	14	19
10.	Spain	2205	2335	874	911	39.6	39.0	1032	1073	47.4	47.7	170	175	12	13
11.	Sweden	1523	1718	507	509	33.3	29.6	539	634	9.5	10.1	78	148	84	88
12.	Switzerland	951	1014	na	na	—	—	285	315	35.0	35.5	na	na	na	na
13.	U. K.	7298	7495	na	na	—	—	2094	2184	50.4	52.0	51	50	40	117
14.	U. S. A.	61856	64251	15233	16330	24.6	25.4	13583	14152	21.1	24 0	64	59	1451	1905
15.	Yugoslavia	1005	1032	275	380	22. 4	36.8	358	487	37.5	47.1	87	90	—	—

Source : Pulp and Paper International, 25 July, 1980.

TABLE No. 8—WASTE PAPER RECOVERY AND CONSUMPTION PATTERN : ASIA, AFRICA AND LATIN AMERICA

S. No.	Country	Paper & Board Consumption x 1000 T		Waste Paper Recovery x 1000 T		%		Waste Paper Consumption X 1000 T		%		Waste Paper Import X 1000 T		Waste Paper Export X 1000 T	
		1978	1979	1978	1979	1978	1979	1978	1979	1978	1979	1978	1979	1978	1979
	ASIA														
1.	India	1228	1241	260	300	21.02	24.2	260	300	23 5	30.9	—	—	—	—
2.	Japan	16300	17525	6973	7732	42.8	44.1	7038	7830	42.7	43.8	126	131	61	33
3.	Pakistan	124	136	na	na	—	—	30	33	38.0	39.8	na	na	na	na
4.	Republic of Korea	1357	1607	452	599	33.3	37.3	1000	1197	69.6	79.4	484	598	—	—
5.	Taiwan	1138	1305	550	600	48.3	46.0	950	1050	82.0	78.0	336	426	na	na
6.	Thailand	377	415	na	na	—	—	143	169	55.9	59.9	na	na	na	na
	AFRICA														
7.	Egypt	279	289	na	na	—	—	82	90	66.1	74.4	na	na	na	na
8.	Morocco	139	166	na	na	—	—	50	66	59.5	71.7	na	na	na	na
	LATIN AMERICA														
9.	Argentina	777	942	na	na	—	—	310	337	47.4	42.1	na	na	na	na
10.	El Salvador	52	71	na	na	—	—	9	21	75.0	80.8	na	na	na	na
11.	Brazil	2717	3152	na	na	—	—	800	1070	31.5	35.6	na	na	na	na
12.	Mexico	1921	1865	na	na	—	—	878	1006	49.9	58.1	218	195	na	na

Source : Pulp and Paper International 25 July, 1980.

utilize more than 50 percent waste paper in the manufacture of paper and board as against 24-31 percent in our country.

Waste paper recovery rate of a country is the best indicator of conservation awareness in the people of that country. East Germany, Netherlands, Japan and Taiwan have a waste paper recovery rate exceeding 40 percent as against 21-24 percent in our country. Even the fiber-rich countries like Sweden, Finland and United States have recovery rates of 30-33 percent, better than our recovery rate. Considering cost of manufacture of paper and board from virgin fibers, the waste paper recovery system in our country needs a boosting. A complete understanding of waste paper sources is therefore beneficial in studying waste paper recovery methods.

The probable waste paper sources are :

1. Domestic refuse — news paper, magazines, board cartons.
2. Industrial refuse — corrugated board, solid packaging board, paper sacks.
3. Office refuse — Ledgers, files and papers from Government offices, universities and large business organitions.
4. Trade refuse — Duplex Board trimmings from converters and package manufacturers, paper savings from printers.
5. Road sweeping

News paper and magazines are usually recycled directly as packaging papers and therefore they are not available for the mills in the first rejection. Other fibrous domestic refuse probably find their way into road sweepings. Office refuse usually end up as mixed waste. Other sources, namely trade refuse and road sweepings are well organised in the urban areas. Concentrated efforts to recover waste paper from office, domestic and industrial refuse are likely to enhance the recovery rate.

Quality of the waste paper and the contaminents (contraries) present in it affect the quality of the board manufactured. A waste paper with less contaminents make its processing simpler. Waste paper traders should consider initiating 'sort the waste paper at the source' programme with the help of local authorities. The following methods may be considered while initiating such programmes.

1. In an office, sorting may be simplified by having different waste paper baskets for better quality waste papers, for second grade envelopes and papers and for carbon paper, plastics and other wastes.
2. Through increasing the awareness of fiber conservation amongst the housewives, the non-cellulosic materials may be sorted from waste paper in the domestic refuse. Incentive may be given in the form of lucrative prices for waste paper.
3. Educating people regarding the different paper qualities—corrugations, kraft, bleached and wet strength papers.
4. Isolation of over soiled, greasy waste boards from industrial refuse.

One serious problem faced in processing of waste papers is the wide variation in the strength characteristics of the waste paper pulp. Waste paper traders should develop methods and assure supply of waste paper of uniform quality.

STOCK PREPARATION ASPECTS OF WASTE PAPER

Stock preparation scheme followed in the processing of waste paper determines the board quality. Contaminents present in the waste paper, its nature and fiber length and strength characteristics of the waste paper determine the processing conditions to be employed in a mill The various contaminents present in the waste paper are as follows :—

a) Metals— pins, clips, nails etc.
b) Glass, sand, ceramics and grit.
c) Plastics — bags, laminations.
d) Textiles.
e) Rubber bands, styrofoam.
f) Bitumen, adhesives aud latexes.
g) Wet strength papers.

The steps involved in waste paper processing, and the influence of above contraries on these steps are described below.

PULPING

Vertical Shaft Pulpers :

Most mills use vertical shaft pulpers wherein various rotor and trough designs are available. The contraries belonging to the groups (a), (c) and (d) are problematic in such pulpers. Energy consumption in such pulpers are fairly high.

Horizontal Shaft Pulpers :

Horizontal shaft pulpers are trouble-free in handling gross heavy contraries and plastic contraries.

Rotary Drum Pulper :

In rotary drum pulper[1,2] the furnish is gently slushed by tumbling and falling movements in the drum at consistencies of 15-20 percent. The slushed mass conveyed axially in the pulper is washed and discharged in the perforated section of the drum. This pulping method does little damage to the fibres and separates all the gross contraries and wet strength papers in their original form.

Baracuda Pulper.

Another innovation in waste paper pulping is Baracuda pulper from Beloit. In this pulper, the rotor slushes the waste paper and the slushed pulp is refined during the (continuous) extraction step.

DEFLAKERS

Fibrous bundles present in the pulper extract are further size reduced in this equipment. Hett separator[3] which is a vertical type secondary pulper cum screen, can deflake separate light and heavy contraries in a single unit.

HEAVY DENSITY CLEANERS

For separation of glass, ceramics, stones and metals.

JONSON SCREENS

For separation of fiber bundles and gross contraries.

CENTRIFUGAL CLEANERS FORWARD TYPE

The centricleaners operate at 0.7—1% consistency and separate sand, metals and other heavy contraries. This type of cleaning operation is power intensive. Substantial power savings can be realised by operating at suitable higher consistencies low pressure, higher consistency centricleaners are now available in Sweden. (System : Cleanpac 130 and 350[4]) Suitable vatiations of these need to be designed to handle our waste paper pulp stock.

PRESSURE SCREENS

These are used to separate oversized and fiber bundles from the stock and have slotted screens or punched/conical drilled hole screens. Hett Separator, an equipment developed recently in Germany working on a simlar principle is equally efficient in the separation of light contraries as well as heavy contraries. The Hett Separator also deflakes the unslushed fiber bundles to some extent.

CENTRIFUGAL CLEANERS—REVERSE TYPE

Plastics shredded in the pulper and deflaker, rubber bands, styrofoam particles, bitumen, adhesives and latexes (stickies) can not be separated in centrifugal cleaners or in pressure screens. Most of these light weight contraries if not separated give an unsightly appearance to the paper and cause many operating problems by blinding wires, felts, presses and dryers all of which lead to numerous sheet defects. The non-fibrous, light contraries can be conveniently separated in hydroclone type devices. Cellulosic fibers being heavier than these light contraries will move towards the wall and come out of the conical bottom nozzle. Light contraries and some fibers discharge from the straight nozzle located near the stock inlet. These units are called reverse cleaners and have been developed by M/s. Black Clawson, CE Bauer and Voith GmbH and others. The design parameters or operating conditions of these cleaners need to be optimised for our fiber stock.

REFINING :

Secondary fiber refining power requirements are low since they were refined earlier in the manufacture of paper. The properties of these fibers can be preserved by maintaining gentle refining conditions. In high consistency refining (Kneading), where fiber-to-fiber rub action dominates, the pulp developes better strength at lower power consumption levels. Laboratory experiments also confirm this fact. As may be observed from Table 9, kneader refined pulp hand sheets have 8-10% higher breaking strength as compared to the pulp refined in a conical refiner. The kneader refining energy requirements are about 25-30 percent of the conventional refining energy requirements.

TABLE No. 9—HIGH CONSISTENCY KNEADING/REFINING OF WASTE PAPER PULP STOCK : OFFICE RECORDS

S. No.	Property	Units	Initial Stock	Low Consistency refined stock	High Consistency refined stock
1.	Consistency	%	3-4	3-4	15-20
2.	Freeness	ml CSF	300-330	240-270	220-270
3.	Burst Factor	—	7-7 3	8.7 -8.8	8.8 -9.0
4.	Breaking Length	meters	1320-1380	1620-1700	1750-1850
5.	Refining : Power Consumption	KWH/Ton	—	230-280	65-75

WASTE PAPER UPGRADATION METHODS

DEINKING :

Deinking is probably the most successful fiber upgradation method used today. A 60,000 TPY deinked market pulp mill commissioned recently in Finland is an indicator of the developments in deinking. Pulp to the raw materials used by deinkers, namely magazines and news papers command a good price in the waste paper market in our country. They are used as wrapping paper by grocers and other consumer oriented merchants.

The record grade waste paper can be deinked—bleached and second grade paper for not books, envelopes, and other low cost papers may be manufactured. Another application is in duplex board where a higher opacity, is required. Medium brightness deinked pulp can be used as an underliner and replace some of the virgin pulp usedin the top liner.

The high cost and poor strength properties of Indian waste paper as compared to lower priced better quality of U.S. waste paper (available to US deinkers) makes deinking process not very attractive. Higher percentage of fiber fines present in the waste paper results in larger shrinkages in the deinked pulp. A detailed study of the deinking process is required to establish the optimum process conditions (consistency, temperature; chemicals and time) and to ascertain the products that may be manufactured from the deinked pnlp.

STOCK DISPERSION

Coloured specks, bitumen and other hot melts present in the filler and bottom liner of duplex boards can be dispersed and a pulp with slightly darker but uniform coloration can be obtained. In the stock dispersion process, the pulp stock at 25-40 percent consistency and a temperature of 65-90°C is treated in a disperper. Treated stock is normally found to contain minute specks

FIBER FRACTIONATION

Separation of fines from the pulp stock yields a fiber stock reletively free from fines. Fiber fines separated may either be rejected or fed to the board machine without refining. Fibre fraction free of fines can be used in the manufacture of better quality boards. The economic viability of the fiber fractionation process depends on operating costs of fiber fractionation as compared to the enhanced value of the pulp.

ENERGY CONSIDERATIONS IN STOCK PREPARATION

Design of the waste paper processing scheme depends to a large extent on the contaminents present at the waste paper and the quality of the pulp required at the paper or board machine Equipment availably for waste paper processing and their typical energy requirement per ton of waste paper are given in Table 10. Current practices in stock preparation section and their drawbacks are discussed below.

Batch pulping of waste papers or continuous pulping of waste papers in hydrapulper with small extraction holes is employed in most mills. In these designs, a sizable portion of the pulped stock circulates in the pulper trough unextracted. Also the contrarie in the waste paper are size reduced in the pulpers leading to increased maintenance costs.

Large Hole continuous pulping system with secondary pulper (Fig. 1) and large Hole pulping system with

TABLE No. 10—STOCK PREPARATION EQUIPMENT ENERGY REQUIREMENTS

S. No.	Description	Energy KW/TPD	S. No.	Description	Energy KW/TPD
	PULPING			**SEPARATING/ CLEANING**	
1.	Batch pulper	2.1 -3.3	11.	Perforated screen	0.15-0.3
2.	Small hole continuous pulper	1.85-2.4	12.	Slotted screen	0.4 -0 8
3.	Large hole continuous pulper	0.8 -1.2	13.	Hett separator	0.4 -0.5
4.	Secondary pulper	0.6 -1.1	14.	Conventional cleaning	0.2 -1.5
5.	Deflaker	1.7 -2	15.	Reserve cleaning	0.4 -2.1
6.	Large hole pulping & secondary pulper	1.7 -2.7	16.	Thickening	0 -0.7
7.	Large hole pulping & full stream deflaker	2.3 -2.9	17.	Refining	0 -16.5
8.	Large hole pulping & partial stream deflaker	2	18.	Agitation	1.3 -2.6KW/M
9.	Helical rotor continuous pulper	0.875-1			
10.	Rotary (Fiber flow)	0.63-1.1			

separating screen (Fig. 2)[7] facilitate better extraction of the pulped stock and thus result in lower energy consumption per ton of the waste paper. Better still is the scheme shown in Fig. 2 where partial flow deflaking is used. The partial flow deflaking scheme can be easily implemented in most of the board mills.

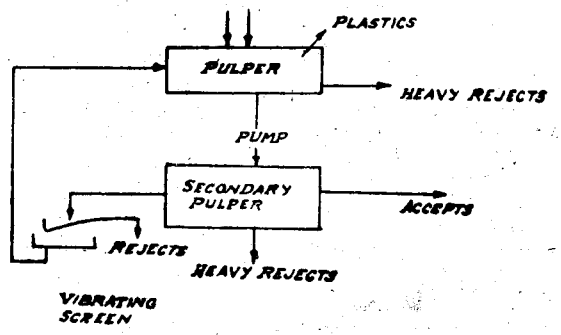

Fig. 1. Large hole continuous pulping system with Secondary Pulper.

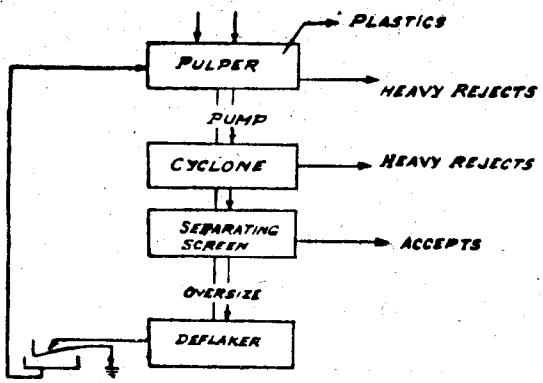

Fig. 2. Large hole continuous pulping with Separating Screen.

A minor variation in the commonly used stock cleaning system is shown in Fig. 3. Two pressure screens are used namely primary screen and secondary screen. Primary pressure screen rejects in the present method are processed separately in a secondary pressure screen. With this modification increased productivity and reduced energy consumption may be realized and stock cleanliness can be improved. Addition of reverse cleaners should be considered if a clean pulp free of chits, plastics and stickies is a criteria.

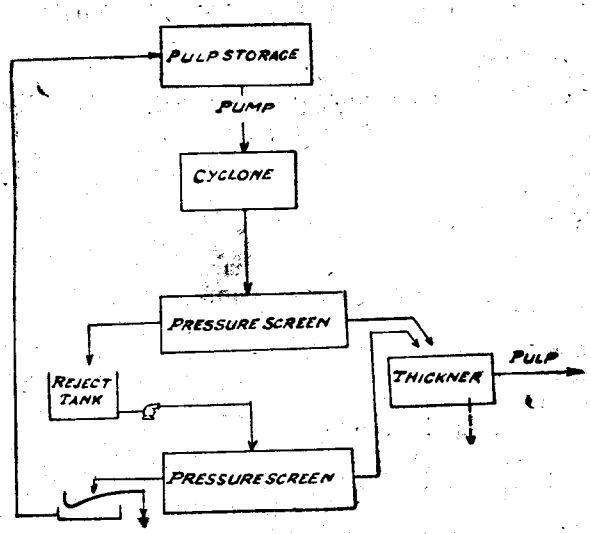

Fig. 3. Screening Systew

Individual mills can develop their own stock preparation process, modifications depending on the waste paper they consume, product mix required and the mill equipment available. While designing a new or improving an existing stock preparation system, the following principles may be followed to the fullest advantage :

1. Choose a pulper operating at higher consistency with the least tendency to disintegrate the contraries.
2. Segregate the partially processed pulp stock slurries and process them separately. For example while processing waste paper in a large Hole pulper, the pulper extract may be separated into larger flakes and loosened fiber. Only the flakes rich stream needs to be deflaked (see Fig. 2). Such segregation techniques must be practised whenever economics permits.
3. Streams segregated for recycle purposes should be mixed with such a stream where the characteristics of the two streams are nearly equal. For example the vibration screen accepts (Fig. 2) may be recycled to the deflaker or to the separator rather than to the hydrapulper.
4. Operation at higher stock consistency requires lower energy and increase the equipment capacity. This may be practised whenever the stock cleanliness is not a dominant criteria in the manufacture.
5. Using more efficient centrifugal cleaners operating at higher consistency and lower pressure. These

cleaners[4] save electrical energy. The cleanliness of the stock should be given priority.

6. Choosing optimum number and size for storage chests.

ENERGY SAVING METHODS IN BOARD MACHINES

Press section of a board machine offers maximum scope for saving energy. The most important variable affecting the pressibility of (higher grammage) wet sheets are the compressibility of the wet sheet and the resistance to flow of water in the fiber mat. In the board mills, crushing of the sheet is usually observed at higher nip pressures. Lower nip pressures and longer dwell times are therefore required if a board with good physical characteristics are required at the pope reel By selecting proper roll size, roll cover and press felts, it is possible to obtain higher nip widths. Double felting of press rolls allow the water to leave the wet sheet from both sides and is well suited for higher grammage boards.

Dewatering in the press section can be improved by increasing the temperature of the wet sheet entering the press section. Lowering of viscosity and surface tension at higher temperatures (45-55°C) decreases the flow resistance to water in the fibrous structure of the web.

In the driers, installation of dryer screens and providing pocket ventilation will aid in increasing the productivity of the machine. In the slow speed board machines, ends af the dryers may be conveniently insulated to reduce the steam demand at the dryers. Steam exhaust from the MG dryer hood and pocket ventilation steam exhaust can be used at the vaccum boxes to increase the wet web temperature entering the press section. Installation of formers may be considered to improve the paper or board quality and lower the operating energy costs.

EFFLUENTS AND RECYCLING OF WASTE PAPER

The effluent from the waste paper based board mills has 80-120 ppm BOD, 250 ppm COD, 100-500 ppm suspended solids and pH 6-7. Fines present in the effluent pose some problems in the clarifiers. There is ample scope for closing the water loop in the board mills.

Water consumption in the stock preparation section can be reduced by closing the water loop in the stock preparation section. Tertiary centricleaner rejects may be the only water rejecting station. Make-up water required at the hydrapulper can be drawn from the stock thickner back water and machine white water.

Board machine effluent consists of felt cleaning shower water, cylinder mould cleaning shower water and vaccum pump seal water. Felt shower water may be easily reused after proper straining and treating the same in a suitable way.

CONCLUSIONS AND RECOMMENDATIONS :

Pulp and paper industries consume a considerable amount of energy in the manufacture of pulp and paper. This being the history of the waste papers, it is appropriate that we reuse the waste to conserve paper making raw materials and energy. Following is the summary of conclusions and recommendations.

1. Reuse of waste paper can increase the production of boards and certain varieties of writing, tissue and packaging papers.
2. Waste paper recovery and utilisation rate in India is very low. There is a pressing need to study our waste paper collection method to reorganise it.
3. The scope for sorting the waste paper at the source should be explored. This can help in reducing the contaminents also. Educating the people in this regard should be given maximum priority.
4. Waste paper merchants must try to maintain the uniformity in the waste paper quality. Raw material uniformity permits a more efficient operation in the mill and a superior product can be obtained.
5. Recycle potential of the virgin fibers used in our country needs to be evaluated. Methods of improving the recycle potential must be established.
6. Quality of Indian waste paper is markedly different from the quality of the North American or European waste paper. The stock processing equipment currently used must be critically evaluated and the equipment required in future must be developed on this basis.
7. Stock preparation required attention in the following fields :
   a) Development of pulpers operating at higher consistencies without disintegrating the contraries.
   b) New cleaning, screening methods working at higher consistencies and lower energy demand.

c) Deinking of waste paper at lower temperature, lower chemical consumption levels and at higher yields.

d) Process development of low temperature stock dispersion units for the dispersion of asphalt and bitumen.

e) Fiber fractionation devices.

8. Recirculation of machine hood and dryer pocket exhaust steam to increase the temperature of web entering the process.

9. Development of pick up and press felts and minimising the soiling rate of felts.

10. Government can set targets for waste paper recovery and utilization rate for the future. It should help the waste paper merchants and waste paper based mills in achieving these targets.

REFERENCES :

1. Sandman, F., and Venho, J., *Tappi* **61** (8) : 73 1978.
2. Rutquist, S., Sandman, F., and Venho, J., *Pulp and Paper International*, 19 (3) : 53 (1977).
3. Hett Separator, Maschinenfabrik & Giessrei Alexander Hett GmbH Haupstrasse 50, Postfach 20, D-8764 Kleinheubach, West Germany.
4. Cleanpack 130, Cleanpack 350 Cleaners, AB Celleco, Box 29012. S-100052 Stockholm, Sweden.
5. Annon, *Pulp and Paper* **186** (7) : 54, 1980.
6. Seifert P., and Long, P.J., *Tappi* **57** (10) : 69, (1974).
7. Annon, *Pulp and Paper International* **22** (9) : 56 (1980).
8. Miller, G., *Tappi* 63 (10) : 86 (1980).