Effective Recycling of Waste Paper for Production of Good Quality Newsprint

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ABSTRACT

The quality of raw material generally depend upon availability & cost. The quality of raw material plays a major role for final paper. The impact of raw material quality variation can be minimized by process & chemical optimization. The most common goal of chemical optimization is minimizing cost. The waste effluent comes out from the deinking plant consists of ink, fillers, spent chemicals and other coating materials present in the waste paper. To reduce the chemical consumption in ETP, It is to be treated separately.

Introduction

It has been estimated that recycling one tonne of waste paper results in a saving of 70% raw material, 60% coal, 43% energy and 70 % water, as compared to making virgin paper from wood. Due to inadequate availability of indigenous waste paper, Indian mills rely heavily on imported waste paper to meet the raw material demand. The removal of post consumer paper from the garbage cycle would considerably reduce the environmental load on the eco-system. In India the collection of waste paper is mainly performed by the informal sector, i.e., by rag pickers and door to door collectors/vendors. As much as 95% of the collection of waste paper in the country is carried out by the informal sector.

Newsprint quality importance:

The functional requirements of newsprint are press room runnability, Printability, good appearance at lower price.

Runnability: Ability to run the web through the presses without break.

Printability: Ability to accept and preserve the imprinted ink pattern with minimum rub off, set off, and show through. (Show through and ink absorption)

Appearance: Brightness, whiteness, cleanliness, opacity.

De-inking process to optimize the above requirements:

Focusing on main steps of the process, - Pulping, Screening, Centricleaning, Floatation, Dispersing & Bleaching for the following-

a. Screening, cleaning and flotation for improving the overall yield with reduced losses.
b. Reduced energy consumption.
c. Further Reduction in stickies & dirt.
d. Improvement in brightness.
e. Improvement in strength properties.
f. Improvement in cleanliness.

The expectation for all above parameters has gone higher even with lower quality input material.

Steps involved in deinking process

The following steps involved are:

1. Slushing and Deflaking

The first step is to break down the raw material into individual fibers as much as possible to form suspension so that at least it can be pumped. HC pulper gives steepest reduction in flake content and is preferred over LC.

2. Screening

Screening is to remove debris and contaminants from pulp.

3. Centricleaner

The Centricleaner are used to remove materials that are denser than pulp fibers to move outward and be rejected.

4. Deinking Floatation

In deinking floatation the principal of selective floatation is used in removing ink particles. The separation criterion is different surface wettability of the particles to be removed and the fibers to be retained. Particles, where surface is or has been hydrophobic i.e. watering repellent, can be floated within a certain size range. These particles included printing inks, stickies, fillers, coating pigments and binders.

5. Dispersion

The primary task of dispersion is

- Reduce dirt specks below the visibility limit
- Break down stickies

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- Break down coating and sizing particles
- Detach ink or toner from recycled fiber
- Mix in bleaching agents
- Treat fiber mechanically for retaining or improving their strength characteristics
- Treat fibres thermally to increase the bulk

6. Bleaching

Peroxide and Hydrosulphite bleaching are used for bleaching.

Problems associated with raw material

- The raw material generally mixture of old newsprint (ONP). old magazines (OMG), sorted office waste (SOW), mixed colour cuttings (MCC), note books and other chemical pulp containing white papers etc. are used as furnish components for newsprint manufacturing in India .

- The proportion of each component generally depends on the availability and cost. Considering the different variety of waste paper in details ONP has a high percentage of mechanical fiber, groundwood or thermo mechanical pulp.

- In addition to the fiber components of the furnish, additives required for the production of newsprint are also present in ONP ranging from 3 to 12% by weight. These include starch, inorganic fillers and dyes for colour control. Ink amount is about 1 to 2 % by weight in the ONP furnish.

- OMG is a highly variable raw material. The fiber component of the magazine can range from 100% chemical pulp to 100% ground wood. A single magazine may include coated free sheet, coated ground wood, and uncoated mechanical fiber. Also the additives are also highly variable.

Table-1. Variation in pulper brightness due to raw material quality variation

Month	Brightness (%)		ERIC (ppm)	
	Min.	Max.	Min.	Max.
Jul.12	41.8	45.4	869	1187
Aug.12	41.5	45.3	890	1208
Sep.12	41.6	44.9	909	1208
Oct.12	41.7	44.5	907	1180
Nov.12	41.8	44.9	906	1185
Dec.12	41.6	44.7	921	1201

- Fillers such as clay, alum, precipitated calcium carbonate (PCC) are also present which had been added during the paper making process to improve the sheet characteristics. In magazine stock this inorganic portion of the furnish can range from 10% in the uncoated sheet to as high as 40% in a sheet that is coated on both sides.

- Adhesive associated with bindings, thermal plastics and hot melts can all contribute to stickies. Ultraviolet cured inks, common on magazine covers, are difficult to deink. Ink can range from 1 to 7% by wt. in magazine grade of waste paper.
- Sorted office waste, mixed colour cuttings and notebooks contain mainly chemical pulp as pulp component. Chemical pulp component in indigenous waste contains mainly short fibred pulps like agricultural residues, bamboo and hardwood.

Due to the above said problem, lots of variation in the pulp quality is faced as variation in brightness, pH, alkalinity, conductivity, charge etc. resulting web break on paper machine.

Table-2. Variation in storage tower pulp properties (M-alkalinity, Conductivity, Turbidity, Charge Demand) due to raw material quality variation.

Storage tower pulp properties							
Month	Value	pH	M-Alk. (ppm)	Cond. (µs/cm)	Turb. (NTU)	Charge Demand (µeq/Lit)	TDS (mg/l)
Jul.12	Min.	6.60	698	1625	547	750	1040
	Max.	7.06	800	2565	933	1100	1641
Aug.12	Min.	6.85	706	1898	640	635	1215
	Max.	7.12	800	2287	891	852	1464
Sep.12	Min.	6.82	660	1961	528	559	1255
	Max.	7.06	760	2846	773	849	1821
Oct.12	Min.	6.81	640	2121	533	599	1357
	Max.	7.10	780	2935	817	922	1878
Nov.12	Min.	6.90	665	2256	534	782	1478
	Max.	7.10	790	2958	877	1235	1908
Dec.12	Min.	6.95	680	2504	495	1000	1602
	Max.	7.10	780	2960	865	1250	1894

Table-3.Head box pulp properties (M-alkalinity, Conductivity, Turbidity, Charge Demand) after chemical treatment

Head box pulp properties							
Month	Value	pH	M-Alk. (ppm)	Cond. (µs/cm)	Turb. (NTU)	Charge Demand (µeq/Lit)	TDS (mg/l)
Jul.12	Min.	7.00	330	1114	40	110	398
	Max.	7.44	400	1456	55	180	780
Aug.12	Min.	7.18	302	1142	30	140	390
	Max.	7.45	400	1560	55	210	628
Sep.12	Min.	7.21	300	1406	24	150	420
	Max.	7.58	380	1641	59	230	586
Oct.12	Min.	7.03	300	1556	23	170	350
	Max.	7.44	385	1800	35	310	740
Nov.12	Min.	7.10	315	1830	24	140	450
	Max.	7.47	395	2089	41	280	775
Dec.12	Min.	7.15	300	2042	25	170	530
	Max.	7.41	385	2156	38	290	876

The results in table -1 show, how the brightness & ERIC at pulper are varied due to raw material quality variation.
Study done at Emami Paper Mills Ltd.

The furnish mix at Emami paper mills is ONP 75-80%, Office Record 3-5% & OMG 15-20%.

The final pulp & paper brightness is maintained by close monitoring of the pulper brightness, process optimization & appropriate dose of chemicals. This has been shown in table.7

A similar variation has been observed in storage tower pulp parameters as shown in table-2.

The quality of final pulp & paper is improved by systematic optimization of different process unit operations like deinking, fines retention at wire part, calendering and by chemical adjustment.

Chemicals use at wet end to control the fluctuation of turbidity, conductivity & charge demand, are Alum, Sulphuric acid, Cationic starch, Retention aid polymer. The head box pulp alkalinity, conductivity & turbidity are shown in table-3.after chemical treatment.

Out throws

Except the above said problem, waste paper that is put into recycling bins can be contaminated by other materials that are plastics,glass,wood,stone pieces etc.This prohibitive materials are harmful for paper making & equipments also. The out throw quantity is not fix by keeping the same raw material ratio.

Out throws removal from Raw material approx-0.5%

Out throws (Mainly plastic waste) removal from drum screen approx-1.0%

The out throws from drum screen (mainly plastics) are sent to cement mills to use as fuel in their kiln.

Stickies

The stickies is also a critical issue with waste paper. When paper containing hot melts is recycled, passing through pulpers and other high shear mechanical processes, the hot melts are sheered and broken down into particles commonly known as stickies. The stickies may be in the visible range (macrostickies) or below visible range (microstickies, colloidal stickies). These stickies, if not effectively handled, can create significant problems at both the wet and dry ends of the paper machine as well as the converting plant. For example, hot melt stickies can form deposits on press felts, rolls, and dryer cans. These deposits can lead to picking, sheet breaks and subsequent machine downtime

RCF Quality

The paper can only be recycled somewhere between five and seven times. The fibers in the paper get shorter each time they are recycled & the strength properties of paper being manufactured is reduced. New printing presses have greatly increased automation for production efficiency and product quality. These systems include automatic color setting, automatic camera-based registration and compensation setting systems. These high speeds increase the strength demands on the paper as well as lessening the tolerance for defects such as holes and shives in the sheet. To maintain the strength property of paper, Emami is procuring English ONP mainly from metropolitan cities like Chennai, Bangalore, and Hyderabad & Kolkata. In English ONP, imported newsprint is also being used which contains virgin mechanical fiber along with the

Table-4. Stage wise macro stickies reduction in DIP (Emami report)

S.No.	Sampling Points	Macrostickies Counts (Nos./kg)	Macrostickies Area (mm^2/kg)
1	HC Pulper	13280	5363
2	Primary Hole Screen Inlet	5580	2543
3	Primary Hole Screen Outlet	1600	628
4	Primary Hole Screen Reject	10733	2810
5	Secondary Hole Screen Outlet	3540	1178
6	Secondary Hole Screen Reject	32000	25930
7	IC Slot 1st Outlet	1520	508
8	IC Slot 1st Reject	23033	12923
9	IC Slot 2nd Outlet	7500	1183
10	Centricleaner Inlet	8350	3112
11	Centricleaner Outlet	7400	3095
12	Primary Flotation 1st loop Inlet	4180	2237
13	Primary Flotation 1st loop Reject	8380	1488
14	Primary Flotation 1st loop Outlet	2200	959
15	Secondary flotation Cell Loop 1 Outlet	1770	410
16	Pressure Slot Screen 1st Inlet	4180	1483
17	Pressure Slot Screen 1st Outlet	1820	336
18	Pressure Slot Screen 1st Reject	2280	992
19	Pressure Slot Screen 2nd Outlet	2680	255
20	Pressure Slot Screen 2nd Reject	2260	1608
21	Pressure Slot Screen 3rd Outlet	917	174
22	Disc Filter – 1st Outlet	1420	308
23	Disperser Inlet	220	48
24	Disperser Outlet	260	42
25	Primary Flotation Loop 2 Inlet	344	42
26	Primary Flotation Loop 2 Outlet	469	64
27	Primary Flotation Loop 2 Reject	1949	266
28	Secondary Flotation Loop 2 Outlet	208	12
29	Disc Filter – 2nd Outlet	255	18
30	MC Pump 2nd Outlet	305	24
31	Storage Tower Outlet	255	18

The above data are based on CPPRI system audit done at Emami Paper Mills in 2012.
The overall macro stickies reduction in the deinking plant is 99% which is achieved by the process & chemical optimization. The deinking plant stage wise stickies removal is given in table-4.

recycled fiber. A comparison has been done between Emami newsprint paper & imported newsprint paper which is shown in table-5.

Chemical optimization at deinking plant

To make the best pulp from DIP, optimizing the deinking chemical & bleaching chemical is essential.For the optimization of deinking chemical, the dose of deinking chemical were varied, and all other parameters were kept constant. Then a optimize dose of deinking chemical was chosen with the aim of obtaining higher deinking

Table-5.Comparison of Emami newsprint paper properties with imported newsprint paper

Characteristics	Emami SNP Properties	Imported NP Properties
Basis weight, g/m^2	45 ± 1	45 ± 1
Thickness, micron	68 ± 2	68 ± 2
Bulk, cc/g	1.5 ± 0.05	1.5 ± 0.05
L*	= 82.0	= 82.0
a*	0 to -2.0	0 to -2.0
b*	2.5 to 4.0	2.5 to 4.0
Brightness ,% (ISO)	= 57	= 57
Opacity, %	92.5 – 93.5	93.0 – 94.0
Porosity, ml/min	200 ± 20	200 ± 20
Smoothness (Bendtsen), ml/min	175/145	180/120
Tensile Index, Ratio MD/CD	3.1:1	3:01
Tear Index, mN.m2/gm CD	7	6
Moisture ,%	8 ± 0.2	8 ± 0.5

efficiency, ISO brightness, and lower residual ink. The results are given in table-6.

The same was done for sodium hydrosulphite keeping the required brightness level. The L*, a*, b* value are maintained by adjusting the dose of dyes M.Violet & Rhodamine. The results are shown in table-7.

Capacity enhancement of deinking plant

The deinking plant is designed for 300TPD & our pulp requirement is 330TPD to operate both Newsprint paper machine PM-II & PM-III at full capacity.

Action Taken

Step: 1

Table-6.Deinking chemical optimization

Before optimization of Deinking chemical									
Period	Storage Tower				Deinking chemical Kg/MT	Paper m/c-III			
	Brightness (%)		ERIC(ppm)			Brightness (%)		ERIC(ppm)	
	Min	Max	Min	Max		Min	Max	Min	Max
Year 2011	57.4	59.2	292	375	3.8	57.2	58.6	334	398
After optimization of Deinking chemical									
Jul.12	57.6	58.6	340	395	3.4	57.1	58.1	355	418
Aug.12	57.9	58.7	330	405	3.13	57.0	58.2	345	419
Sep.12	58.1	59.2	318	355	3.33	57.5	58.1	327	381
Oct.12	58.0	59.3	311	360	3.19	57.8	58.7	331	402
Nov.12	58.2	59.4	292	355	3.02	57.2	58.3	310	389
Dec.12	58.0	59.5	297	345	2.87	57.5	58.5	315	375

Table-7. Sodium hydrosulphite optimization

Before optimization of Sodium hydrosulphite L* ,a* , b* value								
Period	Storage Tower				Sodium Hydrosulphite Kg/MT	Paper		
	L*	a*	b*	Yellowness		L*	a*	b*
Year 2011	82.87	-1.99	5.5	10.5	6.2	82.2	-0.5	3.40
After optimization of Sodium hydrosulphite								
Jul.12	83.39	-2.01	6.43	12.04	6.2	82.1	-0.07	3.40
Aug.12	82.43	-1.92	5.76	12.10	6.1	82.2	-0.86	3.60
Sep.12	82.97	-1.97	6.31	11.63	5.0	82.6	-0.72	3.70
Oct.12	83.01	-1.94	6.42	11.78	4.4	82.5	-0.59	3.70
Nov.12	82.83	-2.00	7.12	13.25	4.4	82.3	-0.56	3.90
Dec.2012	83.76	-1.76	6.91	17.85	3.8	82.0	-0.85	3.60
Jan.13 to May.13	82.20	-1.80	6.80	13.20	4.0	82.1	-0.85	3.70

To meet the 30 TPD excess pulp requirements, in the initial stage during commission of plant, pulper discharge consistency has been increased to raise the production rate. The two fiberizers were running simultaneously for discharge the pulper. When the pulper discharge consistency was increased, the fiber carry-over along with plastic increased through rejection. It was due to the uneven dilution of both fiberizers during pulper discharging.

To resolve this issue; one fiberizer was taken in operation after increasing the screen perforation from 6.0 mm to 8.0mm & the dilution water was adjusted to reduce the fiber carry-over. After this modification, we were able to increase the discharge consistency without fiber loss & this reduces the 300 Kwh peak load on turbine during discharge. Ultimately we have one discharge system as a spare.

Step: 2

Hole screen 1st differential pressure became high frequently. The rpm were increased from 380 to 420.

Step: 3

In the disperser section, the equalizing screw got jammed due to the pulp accumulation in the discharge chute. A paddle was fitted to equalizing screw for evenly distribution of the pulp & high pressure shower nozzle was fitted in the discharge chute to avoid the pulp accumulation. It is operated from DCS with a timer. If this shower opens continuously, it will reduce the disperser inlet consistency. So it was connected to DCS & operates with timer after a certain interval for a few second.

This countermeasure taken had improved the throughput of the plant and reduces the fiber loss and energy consumption. After capacity enhancement of deinking plant we could able to increase the Paper machine-II speed from 450 mpm to 510mpm & PM-III is running at full capacity (250TPD). Due to this the paper machine II production has increased 9.5MT per day.

• Effluent

Treatment of the effluent from De-inking Plant is highly critical. The

Table-8. Treated water parameters

Sl.no.	Parameter	Unit	Achieved
1	TSS	ppm	35
2	COD	ppm	180
3	BOD	ppm	18

Table-9. Deinking Plant Specific Steam & Power Consumption

DIP Steam & Power Consumption		
Period	Steam (kg/MT of pulp)	Power (kwh/MT of Pulp)
2008-09	515	339
2009-10	440	303
2010-11	430	298
2011-12	448	295
2012-13	407	290

waste effluent comes out from the deinking plant consists of ink, fillers, spent chemicals and other coating materials present in the waste paper. As the effluent is high in pH and having high level of surfactant and tends to generate foaming problem in the treatment plant. The effluent from DIP was taken in primary clarifier directly resulting inconsistent performance & disturbance in biomass. To improve the performance of primary clarifier, DIP Flotation cell rejection taken directly to sludge dewatering plant. The performance of primary clarifier improved, Biomass in the secondary system remain stable however, Chemical consumption increased by Rs125/- per ton of sludge and fresh water consumption increased by 400m^3/day.

To reduce the chemical consumption in ETP, the same is treated separately in a clariflocculator as pre-treatment, thereby removing the heavy ink and solids by settling process. Further, the filtrate goes for the conventional Effluent treatment process. & the results of final treated water are given below in table-8.

Energy & Fresh Water Consumption

The plant is operating with a low specific Energy consumption. The results are shown in table-9.

The fresh water addition into the system is practically zero as the entire operation is being carried-out in closed loop cycle. The entire back water from the paper machine is getting recycled.

Conclusion

The waste paper cost is increasing and the quality is getting deteriorated. The expectations of the printers are going-up with respect to quality and reduction in price.

At this juncture it is a challenge for the RCF based paper manufacturers to improve their quality of product in reduced cost of production. To achieve the targets the following points are very much essential.

- Close monitoring of waste paper quality is being done to maintain the paper quality & machine runnability.
- The quality of final paper is maintained at par with the imported quality (even after deterioration of waste paper quality) by process optimization & chemical adjustment.
- 99 % removal of macro stickies is done by Deinking process with latest technology.
- Capacity enhancement of deinking plant (from 300TPD to 330TPD) is done to meet the pulp requirement of both the paper machine which also resulted in the reduction of specific energy (Power -339 kwh/MT to 290 kwh/MT & steam 515 kg/MT to 407 kg/MT) & improved the productivity of both the paper machines.
- Reduction of Deinking chemical from 3.8 to 2.8 kg/MT & sodium hydrosulphite from 6.2 to 4.0 kg/MT has been done by chemical & process optimization.
- Fresh water (except for sealing & cooling) consumption is zero in deinking plant.
- Treatment of the Deinking flotation cell rejection is highly critical & is done separately in the ETP to improve the final quality of discharge water.

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