Waste Paper Quality and Seasonal Impact on Deinking Process & Remedial Measures - A Case Study at Emami.

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ABSTRACT

Quality news print can be obtained from recycled fibers by optimizing furnish, deinking process and water circuit. It has been observed that longer aging time, summer effect decreases pulp brightness with increase in ERIC values. Open yard storage under direct sunlight and rain also found to be the most harmful for ONP & OMG. Another challenge is sticky. Use of talc is also effective in the stickies control. This paper emphasizes on the remedial measures taken to overcome seasonal effect, aging and quality variation in furnish.

Introduction

The use of deinked fibers in the paper industry has increased in recent years, and with current environmental awareness and legislation, this trend is expected to grow further. In the process of deinking, screening, centricleaning, flotation, and washing are to be controlled effectively for better results. Although flotation deinking is considered to be more effective and economical, one has to take much care for effective plant operation. Different variety of waste paper like old news paper (ONP) old magazine (OMG), sorted office waste (SOW), light weight coated (LWC) are used for news print furnish. ONP has a high percentage of mechanical fiber with starch & inorganic filler ranging from 3 to 12% by weight & amount of ink is about 1-2 % by weight.OMG can be 100% chemical pulp to100% mechanical pulp. In magazine inorganic furnish can range from 10% in uncoated sheet to as high as 40% in a sheet. Now a days OMG contains more uncoated supercalendered papers in which ink print is applied on to the fiber surface and not on to a coatent, the ink detachment & flotation problem often experienced on these grades are aggravated when the filler contain is low or the print is aged. In India many combination of available waste paper is used for manufacturing newsprint, but the standard production with full de-inking & bleaching facility will be using 70 to 80% ONP & 20-30% magazine as the furnish. Stickies are one of the biggest technical challenges in using recycled fiber in papermaking. Stickies cause quality problems, such as holes and specks in paper, which may lead to higher paper rejection or customer complaints, runnability problems, such as sheet breaks, occur both at the paper machine and at printing houses. More down-time & low yield due to washing and cleaning are the consequence of the stickies.

At Emami, a modern state of the art Deinking plant with a capacity of 300 TPD installed having high ink and dirt removal efficiency. Deinking plant is equipped with High consistency Pulping, High density cleaner, Combi-Screening, Heavy Weight centri cleaning, Pre-Flotation, Fine Screening ,Dispersing system ,Oxidative Bleaching ,Post Flotation ,Reductive bleaching system. The plant achieved highest level of efficiency with regular out put of 320TPD and feeding the quality pulp to two paper machines to produce 45 gsm of international quality. The average brightness gain across the deinking plant is 15-16% ISO.

Area of concern in De-inking process & steps taken at Emami to produce quality news print pulp

1. Ink type and paper surface

Deinkability behaviour depends mainly on four factors, -Ink type, Printing technique, printing conditions and aging of the print. Paper surface and ink properties are the most important, since they strongly influence deinkability. Ink detachment from the sheet depends on the ink formulation, printing conditions, and aging, while removal of detached ink particles from the pulp depends on ink formulation (ink particle size, ink particle surface properties, ink or soluble dye). Paper surface properties are also important, since they affect the ease of ink detachment.

Inks printed on a coated paper surface detach more easily than inks printed directly on the fibers of an uncoated sheet. Flexo printed paper is not possible to deink with a conventional deinking process. Washing is effective for ink particles in the 3-25 micron size range with the highest efficiency obtained for 5-15 micron particles. Flexographic printing in news paper is employed mainly in Italy and to a lesser extent in USA and U.K. However, the development of this printing process for newspaper in the future seems to decrease strongly because of a lower quality and may be slightly higher cost. Reduction in the pH (5.5-7) level is the best option to minimize the flexo ink impact on deinking.

When the flexo printed paper is found in the imported waste paper in our mill, it is being segregated and used maximum (2%) in the furnish to minimize the adverse impact on brightness.

2. Quality variation in raw material

The standard furnish mix for news print is 70-80% ONP & 20-30% imported magazine. The ONP supplies mainly from metropolitan cities.Inspite of this, lots of variation are being faced in the incoming ONP.Some times vernacular ONP quantity is high, aged ONP, road sweep, wet ONP etc. which reduces the brightness of the pulp. Uncoated magazine quantity varies from 20 - 50% in the imported magazine. Due to this initial brightness of the pulp & calcium hardness level goes down, which adversely affect the deinking process. Calcium hardness level should be minimum 150-200 ppm for better deinking with Fatty acid base deinking chemical. To minimize the negative impact of uncoated magazine in the furnish, the trials were taken in plant with various synthetic deinking chemicals. However the trials were not successful, as more fluctuations in the brightness, low gain, low yield, high foaming at paper machine & ETP were observed during the trial. The results are shown in table-1.

Table -1.Brightness gain results during the trial of surfactant.

Particulars	Br. % gain Pre-Trial	Br.% gain During Trial
Br. % gain of Flotation -1 (Flotation -1 O/L -Flotation-1 I/L)	8.4	8.2
Br. % gain of Flotation -2 (Flotation -2 O/L -Flotation-2 I/L)	4.3	3.8
Br.% gain of Loop-1(Flotation-1 O/L -Pulper)	4.2	3.7
Br. % gain H2O2 Bleach (Bleach Tower O/L -Flotation-1 O/L)	1.8	1.5
Br.% gain of Loop-2 (Flotation-2 O/L -Bleach tower O/L)	2.5	2
Br.% gain Na2S2O4 Bleach(Bleach tube O/L-Flotation-2 O/L)	6.3	5.9
Br. % gain from Pulper to Bleach tube O/L	14.8	13.1
Br. % gain from Pulper to Final Tower	15.4	13.9

Hence the ratio of coated & uncoated magazines has been determined (Coated - 80% uncoated -20%). When uncoated magazines are more then GCC /$Cacl_2$ is being added in the pulper / flotation inlet or finally OMG ratio has to increase to maintain the required hardness level when such types of magazines are used.

3. Effects of Aging Conditions

The study shows that natural and accelerated aging of offset inks by both oxidation and greater penetration of the fiber mat reduces ink removal efficiency .It is observed that the ink particles are detached and pulverized at re-pulping. Penetration of ink particles deeper in fibers and strong attachment of ink particles as a result of aging contribute in poor detachment of ink particles from fiber. Therefore, some of the ink will remain intact on the fibers if pulping time is not enough long. On the other hand, excessive pulping in order to detach ink particles from fiber can contribute in generation of smaller particles in two forms: 1. Pulverizing already detached ink particles with excessive pulping of the aged ONP with a hope to detach the rest of the ink particles from the fibers.2.Brittleness of ink particles of aged ONP due to cross-linking of vegetable oil-based ink as a result of aging. Based on our lab trial, it has been observed that brightness is almost 1% ISO lower for the aged newsprint compared to fresh newsprint as given Table-2.Aging period at normal temperature to be referred less than two months is ok.

Table- 2.Comparision between four months aged & fresh ONP brightness as on lab trial

Sample	Brightness (%ISO)average value	ERIC(ppm)
ONP Aged for four months	41.0	1275
ONP Fresh	41.9	1244

Types of storage

Indoor and outdoor. For indoor storage, the ONP and OMG are kept in warehouse, but for outdoor storage, they are kept either covered or uncovered. For those, which are kept indoor or kept outdoor but covered, the major contributors in aging are heat, air and moisture, while for the outdoor storage; Sun light plays a major role on yellowing the lignin-rich ONP pulp. Many mills are suffering from out side storage effect at different degrees. In our mills initially storage facility of waste paper in covered godown was inadequate as it was practically difficult to use first come first use.ONP stored in the godown was getting aged. Due to this wide variation was observed in the pulper brightness as shown in Table -3. To compensate this higher % of magazine or chemicals were used. Ultimately this leads to higher cost of pulp production. Now a days system is developed to use the material on first come first out.ONP is stored for a period of maximum two month only in the covered shade.

The ONP pulp which have many color printings are not suitable for deinking, since the color ink is more difficult to remove when aged. The optimum condition for processing of the aged ONP was found to be at lower pulping time.

Table- 3. Variation in pulper brightness due to inadequate storage facility

Month	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sep.	Oct.	Nov.	Dec.
Average brightness variation % ISO in pulper (2008)	4.1	4.3	4.0	4.2	4.3	4.2	3.8	3.8	3.9	4.0	4.1	3.8
Average brightness variation % ISO in pulper (2011)	2.8	2.9	3.0	3.0	3.2	3.3	3.4	3.6	3.2	3.2	3.0	2.7

4. Effect of wet aging condition

It is observed that the ink reduction rate is lower for the waste paper aged at wet condition. This is due to development of microorganism at wet condition and chemical reactions among the chemical elements of fiber and ink formulation. It could also be speculated that the fiber-swelling at wet condition and de-bonding between the fibers, as a result of aqueous environment, could facilitate ink migration between and within the fibers, thus results in poor ink detachment.Genrally the rainy season period is from mid June to mid October of the year in Emami.OMG was kept in the outdoor storage. The results in table -4 show, how the brightness gain & ink removal in De-inking process are adversely affected during rainy season at Emami. To overcome from this, OMG ratio (Min. 4-5%) has to increase in the furnish mix.

Table-4. Brightness gain (% ISO) from pulper to Final Tower & Reduction in ERIC from pulper to Final tower in (ppm)

	For the year -2010						For the year -2011					
Month	Pulper Br. % ISO	Pulper ERIC, ppm	Final Tower Br. ,% ISO	Final Tower ERIC, ppm	Br.gain from Pulper to Final Tower, % ISO	Reduction in ERIC from Pulper to Final Tower, ppm	Pulper Br. ,% ISO	Pulper ERIC, ppm	Final Tower Br. , % ISO	Final Tower ERIC, ppm	Br.gain from Pulper to Final Tower, % ISO	Reduction in ERIC from Pulper to Final Tower, ppm
Jan.	44	1065	59.9	316.0	15.9	749.0	44.0	1054	59.5	322	15.5	732
Feb.	44.3	1056	59.9	314.0	15.6	742.0	43.8	1079	59.1	330	15.3	749
Mar.	44	1080	59.6	320.0	15.6	760.0	43.9	1084	59.3	325	15.4	759
Apr.	44.2	1068	59.4	330.0	15.2	738.0	43.7	1099	59.8	320	16.1	779
May.	43.8	1078	58.7	360.0	14.9	718.0	44.0	1070	59.0	338	15.0	732
June.	43.7	1100	58.8	358.0	15.1	742.0	43.7	1046	58.5	366	14.8	680
July.	44.5	1034	58.7	350.0	14.2	684.0	43.8	1042	58.4	380	14.6	662
Aug.	44.2	1056	58.8	361.3	14.6	694.7	44.0	1054	58.6	380	14.6	674
Sept.	44.0	1050	58.5	385.0	14.5	665.0	43.8	1049	58.5	375	14.7	674
Oct.	44.3	1045	58.9	378.0	14.6	667.0	43.9	1060	58.6	368	14.7	692
Nov.	43.8	1069	59.2	340	15.4	729.0	44.1	1063	59.2	345	15.1	718
Dec.	44.1	1055	60.2	310	16.1	745.0	43.7	1088	59.4	353	15.7	735

Table- 5. O.D Yield from dump tower to storage tower in %

Month	Jan.	Feb.	Mar.	Apr.	May	June	July.	Aug.	Sep.	Oct.	Nov.	Dec.
O.D.Yield % for the year 2010	84.84	84.80	84.92	84.95	84.80	84.76	84.37	84.63	84.50	84.11	84.17	84.60
O.D.Yield % for the year 2011	84.80	85.00	85.13	85.15	85.13	84.64	84.42	83.90	83.82	83.86	84.14	84.68

A similar trend has been observed in the yield as shown in Table-5.

Losses are calculated from the outdoor storage of magazine during rainy season. These are given below.

Losses from open yard in rainy season

Final paper brightness drop (% ISO)		0.5-1.0
Carpet loss in Magazine (%)		0.5
Low yield in Magazine (%) Considering 5 months of rain		1.5-2.0
Total Magazine used in 5 months (MT)		12500
Magazine Pulp cost Rs/MT		20833
Average pulp production. (TPD)		310
Total production days (considering average Production days 27 in a month)		135
Over all yield loss due to Magazine (0.5%)	Rs	3557250
Over all final paper brightness drop 0.50 % ISO (Rs-300 for 1.0% ISO)	Rs	6277500
Total loss during rainy season in a year	Rs	9834750

After understanding this loss additional covered shed of 2800 m^2 was constructed.RCC floor was available to make the shed. The total cost of covered shed was 1crore.

5. The Summer Effect

The increased ink fragmentation is due to the thermal drying of newsprint inks. This drying leads to increased ink fragmentation (higher ERIC's) and ink re-attachment (ink that cannot be separated from the fiber by chemical or flotation mechanics). Ink Fragmentation increases as the ambient temperature goes up. The summer effect issue occurs due to the drying process of newsprint inks. The rapid aging of newsprint inks in recovered paper is due to elevated storage temperatures. The aging promotes fragmentation of the ink particle during pulping, which increases ERIC values. The smaller ink fragments are harder to remove by flotation, and if fragmented into specks below 1 micron in diameter they tend to lodge inside of the fiber, which irreversibly lowers the brightness of that fiber. The deinking performance was improved by

optimizing the process, chemicals and furnish mix during summer. Enzymatic (Cellulase) De-inking is not suitable in ONP & OMG mixture in the summer which will decrease ink particle size resulting in lower brightness by 1.5 units (% ISO).Switchover from enzymatic to conventional Deinking(by increasing caustic 0.15% & 0.5% silicate up to normal dose) and shorter pulping time(6-7min.)are effective solution to compensate the summer effect. Use of enzyme in Deinking plant is the regular practice since Jan.2012.When enzyme is used caustic & silicate are reduced in Pulper 0.15% & 0.5% respectively.During summer with the enzyme Deinking suddenly brightness drop faced across the deinking plant.By changeover the enzyme deinking to conventional deinking,low brightness gain problem is sorted out. The plant trial results for seven days at Emami are given in Table-6 &7.

Another process variable that can impact ERIC is the ratio of ONP to OMG (old magazines).A higher percentage of OMG is used to compensate. The addition of more ONP increased the ERIC values during the spring to summer months. Higher ERIC in the pulp adversely affects the hydrogen peroxide bleaching also.

6. Stickies

Generally, the term "stickies" refers to sticky material in the recovered paper. The most common sources of stickies are adhesives used in attaching labels, advertisements, CD's and any other additional material in newspapers and magazines, for binding catalogues, for envelope sealings, stamps, and many more. The other sources of stickies are ink binders and coating binders. Stickies are one of the biggest technical challenges in using recycled fiber in papermaking. Stickies cause product quality problems, such as holes and specks in paper, which may lead to higher paper rejection or to customer reclamations, runnability problems, such as sheet breaks, occur both at the paper machine and at printing houses. Generally; stickies may be divided into macro, micro and secondary stickies. Macro stickies refer to tacky particles that retain on a laboratory screen of 100 or 150 μm. The size comes from the usual slot size of

Table-6. Br. % gain from pulper to storage tower & Reduction in ERIC (ppm) with enzyme

Brightness gain & reduction in ERIC from Pulper to Final Tower with Enzyme						
Day	Pulper Br., % ISO	Pulper ERIC, ppm	Final Tower Br., % ISO	Final Tower ERIC, ppm	Br. gain from Pulper to Final Tower, % ISO	Reduction in ERIC from Pulper to Final Tower, ppm
28th May,12	43.6	1095	57.4	425	13.8	670
29th May,12	44.0	1062	57.5	433	13.5	629
30th May,12	43.9	1071	57.5	434	13.6	637
31st May,12	43.7	1100	57.5	426	13.8	674
1st June,12	43.9	1087	57.3	432	13.4	655
2nd June,12	44.0	1076	57.3	469	13.3	607
3rd June, 12	44.0	1069	57.2	448	13.2	621

The results are given below after stopping the enzyme.

Table-7. Br. % gain from pulper to storage tower & Reduction in ERIC (ppm) without enzyme

Brightness gain & reduction in ERIC from Pulper to Final Tower without Enzyme						
Day	Pulper Br., % ISO	Pulper ERIC, ppm	Final Tower Br., % ISO	Final Tower ERIC, ppm	Br.gain from Pulper to Final Tower, % ISO	Reduction in ERIC from Pulper to Final Tower, ppm
5th June,12	43.7	1088	58.5	364	14.8	724
6th June,12	43.9	1078	59.0	335	15.1	743
7th June,12	43.9	1093	58.9	340	15.0	753
8th June,12	43.7	1091	58.8	343	15.1	748
9th June,12	44.0	1084	59.0	333	15.0	751
10th June,12	43.8	1087	59.3	325	15.5	762
11th June, 12	43.6	1105	59.2	328	15.6	777

fine screening. Stickies smaller than 100 or 150 μm, but bigger than 1-5 μm are called micro stickies. Dissolved and colloidal stickies smaller than micro stickies are called secondary or potential secondary. The secondary stickies are thought to become harmful after the sudden changes in temperature, pH, or chemical environment.

7. Control of stickies

The control of stickies may be roughly divided into two possibilities: Removal of stickies and prevention of the remaining stickies to deposit. Removal of stickies is usually the primary goal, and deposit control is performed to minimize the detrimental effects of the stickies that cannot be removed.

7.1 Removal of stickies

7.1.1 The effect of pulper chemistry

Deinking chemistry is important for stickies removal in a deinking mill. The stickies are detached from their substrate in the pulper for the first time, and thus the conditions in the pulper are very important for the performance of the subsequent unit processes. The effect of repulping at a lower pH with surfactants was noticed to have three main effects on stickies. The first was that stickies do not break up into as small particles as with alkaline soap chemistry. The second effect of reduced alkaline surfactant chemistry was the lower deposit formation tendency of the pulp the third effect was the better removal of stickies in flotation. It is important to add the surfactants into the pulper. If the surfactants are added just before flotation, they make the surfaces of the stickies more hydrophilic, which is not desired if they are to be removed in flotation.

7.1.2 Removal of stickies in screening and cleaning

Removal of macro stickies is the main purpose of fine screens in deinking plant, although the removal of other big contaminants is also a target. Screening has been reported to remove macro stickies very well found that even if screens remove 99% of macro stickies, only 10-20% of all stickies are removed. Higher pulping temperature produces smaller stickies, which leads to poorer screening efficiency of stickies.

7.1.3 Removal of stickies in flotation

Deinking flotation is designed for ink removal, but it has also been noticed to be good for stickies removal. Deinking flotation is especially good for micro stickies removal due to the optimal size range for flotation. The flotation gave the most consistent results in good stickies removal compared to the other unit processes. Based on the optimal size range for flotation, it would seem rational that micro stickies were removed better than macro stickies in flotation. Stickies were removed in flotation faster or at the same rate as ink, most likely due to the same mechanism, by which ink was removed. However, it can be said that the stickies have a higher affinity for removal in flotation than ash. That is most likely due to the more hydrophobic character of stickies.

7.1.4 Internal water treatment

The purpose of internal water treatment is to prevent accumulation of contaminants in the water loops and thus lower the contaminant load. Internal water treatment is most commonly done by dissolved air flotation (DAF), which treats a part of the water in the water loop. In the DAF the micro bubbles produced when the dissolved air is released to the water followed by a pressure drop which creates very small bubbles. These micros bubbles usually collect everything possible and carry it to the froth, like a comb leaving just the water behind. The stickies removal was to some extent dependent on the suspended solids removal.

Table -8. Reduction of suspended solid in DAF

DAF inlet suspended solid(ppm)	DAF outlet suspended solid(ppm)
350-400	10-15

The Mill DAF result shows in Table 8. that suspended solids is being removed up to 97.0%.

7.2 Prevention of the deposition of the stickies

Preventing the deposition of remaining stickies is usually very difficult, because the reason for the deposition is not always clear. Changes in temperature, pH, and various chemical parameters, such as conductivity, charge or zeta potential might also be dangerous. In drying section and calenders, the temperature plays a very important role in where the deposits form.

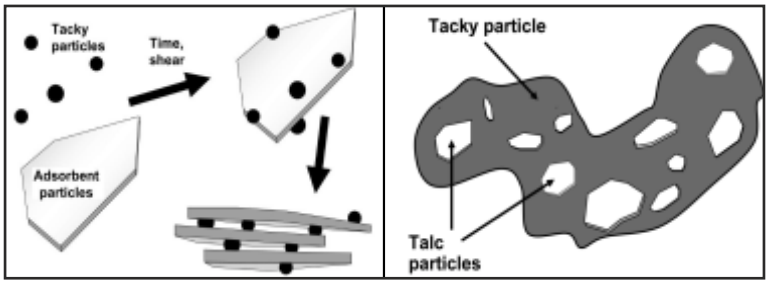
7.2.1 Fixing and retention

Selection of the appropriate wet end chemicals may reduce the stickies deposition, if the stickies are small enough and trapped inside the paper sheet, or if the chemicals form a protective layer around the stickies preventing deposition. The higher retention of stickies also prevents the accumulation of stickies in the white water, and makes the stickies exit the system with the paper. Thinking globally, this will introduce the stickies again to a papermaking system if the produced paper is again recycle Fixing of detrimental substances with high-charge, low molecular weight organic polymers on the fiber may be thought as the first step of retention.

7.2.2 Fillers and talc

Inorganic particles are often mentioned in literature as adsorbing on the surface of the stickies and thus making the stickies more rigid and thus not so tacky anymore. Talc is the most known inorganic particle used to reduce the problems due to stickies. Talc is hydrated magnesium silicate and has plate-like crystalline structure as shown in Fig-1. It is added to the flotation loop in the deinking plant or in the wet end of a paper machine. Talc has higher affinity to adsorb micro stickies than GCC (ground calcium carbonate) or bentonite. Talc works

Fig. - Model of talc as an adsorbent and detackifier.



mainly with micro stickies, and not with macro stickies.

The overall macro stickies removal in our deinking plant is 98% which has given in Table -9.

Table -9. Reduction in macro stickies count hole screen inlet to final tower inlet.

		tower inlet (mm^2/Kg)
PM		

When the stickies problem faced in the paper machine, the following steps are being taken at Emami Paper mills Ltd.

- The furnish mix is checked & the sticky material is sorted out.
- The pH level of the pulper is reduced & enzymatic deinking is started to control the stickies.
- The pulping time is reduced in Pulper cycle.
- The disperser gap is reduced.
- The rejection rate of flotation cell is increased.
- The Soap Stone powder is added in flotation.

8. Limited Life Cycle

Unlike some other materials that can be recycled an infinite number of times, paper can only can be recycled somewhere between five and seven times. The fibers in the paper get shorter each time they are recycled, eventually becoming too short to be made into new paper. Each time the paper is recycled, some new fibers must be added in to replace the unusable fibers, so new materials must still go into the manufacture of recycled paper.

To introduce new fibre, 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 recycled fiber.

Result & discussion

Various remedial measures are being taken as discussed earlier to minimize the adverse effect of furnish variation, aging, summer and rainy season by optimizing the ratio of coated & uncoated magazine, storage in the covered godown, first come first use, some times by increasing the OMG ratio and by changing the chemical composition to maintain the final quality (optical properties) of paper throughout the year as shown in Table 10.Optical properties was checked by L & W Elrepho spectrophotometer.

Conclusion

1. Deinking of uncoated paper is difficult compared to the coated paper. To maintain the required hardness level, either GCC/$Cacl_2$ is used in Pulper/flotation or furnish is optimized.
2. Flexo ink is difficult to remove in flotation deinking. It is segregated & used in a regulated way (Max.-2.0%).
3. To minimize the effect of aging ONP & OMG are used on the basis of first come first use.
4. To minimize the summer effect in ONP & OMG mixture, conventional deinking (Increase dose of caustic-0.15% & silicate-0.5% up to previous level) and shorter pulping time (6-7min) have been used in the plant.
5. Out door uncovered storage & wet aging are most harmful for deinking of ONP & OMG.

Table- 10. Emami standard news print paper optical properties for the year 2010 & 2011.

For the year 2010							For the year 2011						
Month	Brightness, % (ISO)	ERIC, ppm	Opacity,%	L*	a*	b*	Month	Brightness, % (ISO)	ERIC, ppm	Opacity,%	L*	a*	b*
Jan'10	58.9	358	92.5	83.1	-0.7	3.5	Jan'11	58.8	334	92.6	82.7	-0.7	2.9
Feb'10	58.8	360	92.6	82.9	-0.8	3.5	Feb'11	58.1	358	92.6	82.3	-0.8	2.9
Mar'10	58.7	351	92.5	82.8	-0.7	3.8	Mar'11	58.6	340	92.5	82.6	-0.7	2.9
Apr'10	58.7	359	92.5	82.8	-0.7	3.5	Apr'11	58.5	357	92.6	82.5	-0.7	2.9
May'10	58.6	360	92.4	82.7	-0.7	3.4	May'11	58.1	355	92.8	82.3	-0.8	2.9
June'10	58.4	365	92.7	82.6	-0.8	3.4	June'11	58.0	362	92.8	82.2	-0.8	3.1
July'10	58.0	366	92.7	82.5	-0.7	3.5	July'11	57.3	398	92.9	81.9	-0.8	2.9
Aug'10	57.2	390	92.9	82.1	-0.7	3.5	Aug'11	57.2	389	93.0	81.8	-0.8	3.3
Sept'10	57.6	384	92.9	82.2	-0.8	3.5	Sept'11	57.4	387	93.0	82.3	-0.8	3.6
Oct'10	57.2	399	93.0	82.0	-0.7	3.4	Oct'11	57.4	386	93.1	82.1	-0.8	3.6
Nov'10	57.8	376	92.8	82.4	-0.7	3.5	Nov,11	57.7	381	92.9	82.2	-0.8	3.6
Dec'10	58.5	347	92.7	82.7	-0.7	3.2	Dec'11	58.0	374	92.8	82.5	-0.7	3.6

6. A covered shed has been constructed to eliminate negative impact on brightness, ERIC & yield. During wet aging 4-5% OMG was increased in the furnish.
7. DAF technique is employed for back water clarification by removing suspended solids up to 97% which reduces micro stickies substantially.
8. To minimize stickies problem, enzyme is used with lesser dose of caustic & silicate. However in summer enzyme is not effective due to lower brightness gain.
8. Talc is used in Flotation inlet to remove of micro stickies for the smooth running of paper machine.

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