Dusting and Lint Reduction in AKD Sized Agro-based Paper - An Experience

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Abstract

A conversion to Alkaline paper making with AKD size offers the Paper Maker an opportunity for improving the Product quality and system cleanliness, however we have experienced Dusting & Linting during offset printing on non-surface sized Wheat Straw-based Paper. The effect on surface strength of AKD sized paper may be due to more retention of fines & fillers with the use of high molecular weight low charge density Retention Aid polymer which is foremost requirement in AKD sizing as regards to retention of AKD is concerned. The present paper highlights the reduction in Dusting and Linting during offset printing in AKD Sized Paper by utilizing the concept of wet-end chemistry in choosing the correct wet-end chemical and its optimization. Based on feedback received from customer regarding the dusting, we studied the changes and trials were taken with Cationic Starch, DSR of improved cationicity & crosslinking agent in starch. Printing trials were taken on same sheet & web fed printing machine and found significant improvement in printability of paper. Number of prints were increased from 2500 to 6000 impressions in sheet fed and 5000 to 10000 impressions in web offset printing machine before cleaning the blanket. Printability, in regards to dusting, improved further on changing the bleaching sequence from conventional CE_pHH to ECF bleaching, $OD_0E_{OP}D_1$ i.e. 8000 in Sheet-fed & 12000 in web-fed. It was also experienced that residual Chlorine & high conductivity in pulp and hardness & TDS of water have detrimental effect on printability with respect to Dusting & Linting due to increase in Cationic demand.

INTRODUCTION

During the offset printing process, the paper surface is subjected to both mechanical and chemical treatments. Mechanically, the paper surface is forced against the printing blanket. During this ink transfer step, slippage between the blanket and paper occurs, resulting in abrasion to the paper surface. Any abraded material removed from the sheet will remain with the printing blanket. As the ink is transferred, it "splits" between the paper surface and the printing blanket. This separation exerts shear forces such that the paper surface may be disrupted. Any components of the paper not firmly attached at the surface will be removed and, again, deposit on the blanket (1).

While subjected to these mechanical forces, both an aqueous fountain solution and oil containing ink are being applied to the sheet's surface. With this treatment, components of the sheet may dissolve into the fountain solution. Some may remain with the printing blanket in the non-image areas containing the fountain solution. The organic solvents present in the ink will also interact with the components of the paper. Along with the shear forces and chemical involvement, the length of time in which the printing blanket, ink, and aqueous fountain solution are in contact with the paper surface will also have an impact on the print job. The nature of an acceptable offset sheet, then, must be such that it will readily accept the mechanical and chemical treatments typical of offset printing. With increased use of fillers for increased optical properties and reduced fiber content, an on-press, blanket contamination problem referred to as "piling" arises with greater frequency. Piling is the accumulation of pigments and fillers from paper, ink, or of fibers or dust from the paper.

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Dusting

Pigment dusting is one form of piling. Dusting results from the removal of loosely bonded pigments or fillers from an uncoated paper. These undesirable dust particles will be present on the blanket in both image and non-image areas. Dusting inhibits the development of the desired tone density. Technicians stop the press and perform a wash-up/cleaning.

Linting

Fiber linting is another type of piling. It results when loose fiber on the surface of the paper accumulates on the printing blanket. Linting is a deposit of mainly paper debris on the blanket. Such material will also interfere with the uniform transfer of ink. Linting can make for poor uniformity in solid tones. As with dusting, excessive linting requires the pressman to stop the print job and perform a wash-up/cleaning.

Inkpiling

If dust and lint accumulate on the printing blanket and remain undetected, a severe piling problem can occur. With time, a resultant build-up in the image areas takes on the color of the ink and appears as a putty-like mass. This mass, formed on the second and succeeding stations of an offset press, can become increasingly tacky, which hinders ink transfer and flow. Color development will deteriorate. It usually seen as loss of highlight dots or gradual lightening in the solid areas (2). Correction requires a halt to production with subsequent removal of the piled material.

Paper surface made of weakly & strongly bonded particles. Evaluation is usually done by Linting & Dusting tester, Wax pick and Patra type dust and lint tester under water. In addition to that some free dust also adheres to paper surface while converting paper to sheeting. The main parameters which affect dusting and lintings are

1. Amount of filler added and its particle size
2. Amount of short fiber or fines.
3. Higher amount of % Ash.
4. Residual chlorine , Conductivity & cationic charge demand in

Table-1 Fluff Causing parameters and their controlling measures

Parameter	Controlling Measures & Norms
High Calcium content in pulp	Carryover of Hypo sludge is to be avoided for controlling the Calcium less than 0.5 % in order to avoid high AKD consumption and scaling in the paper making system
Viscosity of Straw pulp	Hypo vat pH is to be maintained in the range of 7-7.3 and chlorine tower level should be maintained at <30% if the stoppage/shut exceeds 2.0 hrs to avoid higher fine generation due to degradation of fiber. Viscosity is to be maintained 6.5 cp (min).

pulp

5. High water hardness & TDS
6. Insufficient addition of DSR
7. Cationicity of DSR
8. Efficiency of ATC in neutralizing anionic charge
9. Wet-surface strength of Paper , as water is used in dampening solution for offset printing. So we have to consider surface binding strength under dry and wet condition.
10. Retention of fines and fillers
11. Sheeting operation By keeping in view the controlling parameters, ABIL took the plant trails by changing the wet-end chemicals and their addition points.

About the Mill:

M/s Abhishek Industries Ltd., (ABIL) is an integrated pulp and paper mill situated at Dhaula, District Barnala, Punjab. It is a part of Trident group of companies. The mill produces Eco-friendly paper varieties using wheat straw, an agro based residue. The paper division of ABIL was established at Dhaula, Punjab in the year 1993 with an installed capacity of Paper 75 tpd. After 1993, Division upgraded its paper mill to expand the capacity towards continuous growth & development and commissioned Soda Recovery Plant with an installed capacity of 165 tpd of black liquor solids in the year 1998. Presently the mill produces 116 tpd at PM#1 and 275 tpd at PM#2 of Printing and Writing paper grades utilizing the Continuous digester pulp of uniform quality. Recently, division has commissioned the New Environment friendly Fibre line supplied by the world leader Metso Sundsval AB., Sweden, with an ECF bleaching sequence of $OD_1E(OP)D_2$ to get bleached Wheat Straw pulp of 85+%ISO Brightness, 400 tpd black liquor firing capacity of new recovery boiler and Power Plant of 40 MWH capacity. Further expansion plan includes, Two stage Causticization Plant of TAA about 100 tpd with Lime-mud reburning kiln of capacity 140 tpd and Conversion of current hard wood fiber line of capacity 90 tpd from CE_pHH to ECF bleaching, $OD_0E_{OP}D_1$.

PROCESS TRIAL

At ABIL, our main raw material is agro residue i.e. wheat straw and paper made with wheat straw pulp has good in bonding strength, low porosity values, low absorption coefficient and suitable for printing purpose. We have switched over from Acidic Sizing to AKD sizing since last two years and customer have faced some printing problem during the initial stage of AKD sizing regularization. Number of prints has come down necessitating them to clean their blanket frequently. We have considered customer feedback and took initiatives with all cross functions to overcome this problem. This paper highlights the various initiatives which we undertook to excel the printing requirement.

After changing to AKD sizing, we have come across various complaints from market regarding the Dust and Lint deposition on blanket cylinder during offset printing. This problem was thought to be insufficient addition of DSR as no changes was made except introduction of ATC in machine chest , AKD in PCC accept line and retention aid in Pressure screen inlet. In the first step, dose of DSR was increased from 1.0 Kg/t to 2 Kg/t and antifluffing agent dose was increased from 1.0 Kg/t to 1.5 Kg/t by keeping in mind the higher FPR 72% in AKD sizing against 62% in acidic sizing. But no improvement was noticed as per market feedback. Then a brainstorming session was conducted and outlined the parameters responsible for giving the Dusting and linting problem in printing and corrective measures to overcome the problem. Table-1 demonstrates the main Dust and Lint causing parameters and their controlling measures with action.

In addition to that it is foremost requirement of using crosslinking agent along with cationic starch in order to increase the wet surface strength for good offset printing runnability. The productivity and quality of the offset printing machine process directly depend on WSS. This can be expressed by the number of printed copies before cleaning the offset press. Offset printing is a planographic method based on the principle that oil-based printing inks and water do not mix. The image to be reproduced is printed photographically to make ink-receptive and water-repellent areas on a press plate surface (5). So, water is adsorbed on the hydrophilic areas of the printing plate, ink on the hydrophobic ones. Ink and water are transferred from the printing plate to the blanket and from the blanket to the paper. The paper goes through presses to be printed by each color on multicolor printing machine. Picking

Table-1 Fluff Causing parameters and their controlling measures

Parameter	Controlling Measures & Norms
Residual chlorine , Conductivity and Cationic Charge Demand in washed pulp	High RCl_2 and conductivity in washed pulp indicates the poor washing of pulp and it leads to higher wet-end chemicals consumption which in turn creates problem in binding the fillers and fines to the fiber. Residual Chlorine, Conductivity and cationic charge demand are required to be controlled nil, less than 1800 µS/cm and less than 200 µeq/l respectively. Use of antichlor, sodium sulphite to neutralize the chlorine.
Temperature of first dryer	Not more than 7 Deg Celsius from entering paper sheet Temp.
FPR & FPAR	For controlling higher fines in paper, FPR is to be maintained 68-70% against 72-75% and FPAR 40-42% against 45.
Starch Cooking	It is required to maintain the starch solution temperature at 90°C for 30 min to enhance its binding properties. B.F Viscosity of 25 gpl is to be maintained at 30-40 cps at 60°C & 50 rpm.
Wax Pick	11A/12A Wax pick is to be maintained by varying the doses of DSR & Starch. Following action is to taken to maintain the required Wax Pick- ✓ Use of cationic starch in place of Amphoteric starch as to gain good starch retention on paper making fibers in order to increase the bonding between the fibers & fines. Cationization imparts high dispersability (3) and ideal suitable for AKD sizing. ✓ Use of Higher DSR of Cationicity
Hardness of fresh water	High back water hardness as $CaCO_3$ (650-690 ppm) is detrimental to AKD sizing and due to this; it has negative impact on knife blunting and abrasive action against blanket during offset printing. Use of canal water, that is having low hardness and conductivity, is required to be mixed with tubewell water in order to reduce the water hardness and it is to be reduced to 300 ppm.
Fluff measurement	Dusting & surface contamination gauge is to be procured from R.A Emerson & Company for monitoring the dusting in Paper(4).

occurs when the ink film is split between the paper and the rubber blanket. If the paper is weakened by water on the previous press, piling occurs on second press. To avoid this, paper surface is required to be strengthened with respect to wetting. Crosslinking chemical help in improving the wet surface strength of paper by reducing the water sensitivity of starch. By keeping in mind the process of offset printing and feedback of deposition of dust on second color unit, a cross linking agent (Reactive Polyhydroxyls based resin) was added after starch cooking at 60°C in the starch cooker itself. The properties are given in table-2.

RESULTS AND DISCUSSION

a. Complaint analysis before taking action

Month wise complaint details of dusting & linting with respect to month of manufacturing are given in Table-3 and

Table-2 Properties of Cross linker (Polyhydroxyl Resin)

Particular	Unit	Results
Appearance	-	Golden Aqueous liquid
Ionic Character	-	Neutral
Dry Content	%	40
Density	cc/g	1.25 at 20°C
Viscosity	cp	130 at 20°C
pH		5.0

graphical trend for the Month of paper manufacturing with respect to customer Fig-1 indicates that maximum no. of complaint is related to paper manufactured in Oct-07. Based on customer feedback, Doses of DSR, amphoteric starch and antifluffing agent was increased in the month of Nov-07. It has resulted the reduction of complaint from 6 to 1 in the month of Dec-07, however complaint again increased in the month of Jan-08 & Feb-08 (Table-3). It clearly indicates that increase in the doses of DSR, amphoteric starch and antifluffing agent are not sufficient measures to control the dusting. Then, we start analyzing the pulp cleanliness characteristics with respect to Ca content, Viscosity, RCl2, conductivity and Cationic charge demand, Water hardness, FPR, FPAR, wax pick and dusting measurement after implementation of controlled measures described in table-1. Pulp Characteristics, water and Stock data are given in table-4.

Water, Stock and Dust deposition data are given in table-5. Dust deposition is tested at pope reel by placing a swatch of standardized black felt on to the surface of paper. Then, gauge test cup is placed directly onto the swatch, press down and hold at the red line of the spring loaded central shaft of the gauge for 30sec. duration. Collection of paper surface contamination or dust deposited on black felt is weighed and reported in mg/km length of paper as given under-

Dust Deposition = (Wt in mg. X 2000) / M/C Speed in m/min., mg/km

The main reason of increasing complaint in the month of Jan & Feb-08 was due to the poor cleanliness of pulp in regards to high conductivity 3120 and high cationic charge demand 350 meq/l. In these conditions, retention of amphoteric starch and low cationic DSR is poor due to having more negative charge in the paper making system and less cationic charge available is utilized in neutralizing the charge. Fig-2 & 3. Shows the trend of conductivity & cationic charge demand -

Trend of conductivity and cationic charge demand clearly indicates that the improvement from mar-08 onwards. We replaced the amphoteric starch with cationic starch of DS 0.025, low cationic DSR with high cationic DSR, mixing of canal water with borewell water and 2% reduction FPR in the month of Mar-08. The trend of back water hardness is given in Fig-4.

Back water hardness reduced drastically after Mar-08. It is due to the less carry over of calcium hypo from wheat straw pulp and mixing of canal water with bore well water. Hardness of borewell

Table-3 Monthwise Dusting & Linting complaint received from Customer

Month	No. of Complaint	Month of Paper Mfg.
Sep-07	1	Aug-07
Oct-07	1 + 2	Sep-07 + Oct-07
Nov-07	3 + 3	Sep-07 + Oct-07
Dec-07	1	Oct-07
Jan-08	3 + 1	Dec-07 + Jan-08
Feb-08	2 + 1 + 1	Oct-07 + Dec-07 + Jan-08
Mar-08	3	Feb-08
Apr-08	1 + 1	Feb-08 + Mar-08
May-08	1 + 1	Feb-08 + Mar-08
June-08	0	-
July-08	0	-
Aug-08	0	-

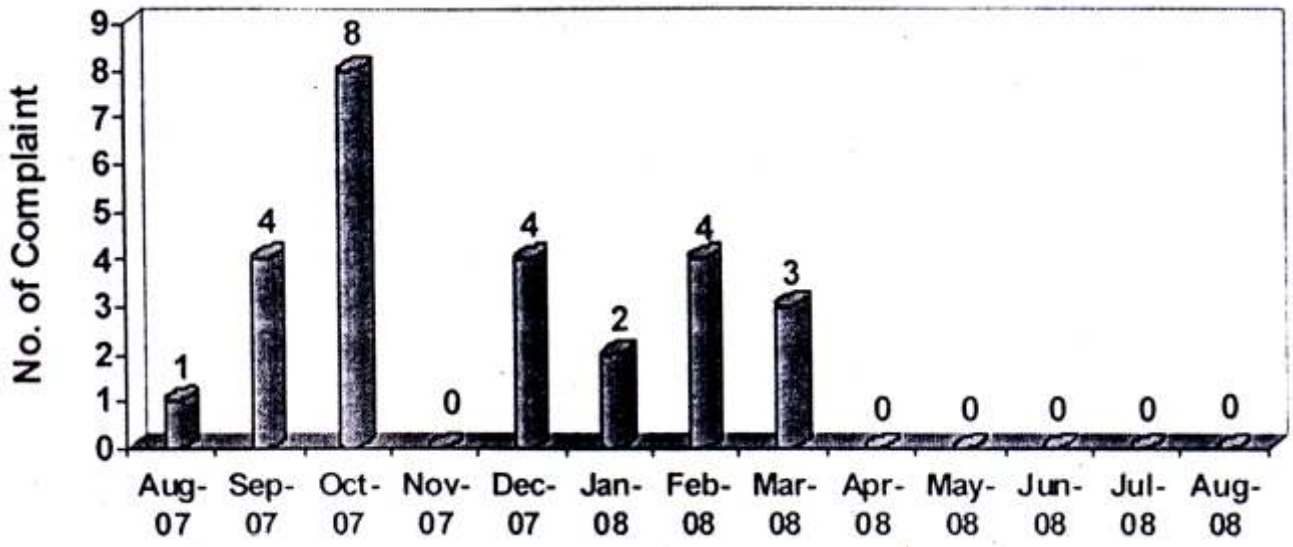

Fig.1 : Manufactured Month Vs Customer complaint of dusting

Table-4 Monthwise Analysis of Pulp Characteristics

Month	RCl_2	Conductivity	Calcium content	Viscosity	Charge Demand	Tear Factor
UOM	ppm	µS /cm	ppm as Ca	cp	µeq/l	
Aug-07	109	2900	1	6.0	350	41.7
Sep-07	76	2880	0.9	5.5	335	40.8
Oct-07	64	3080	1.2	5.5	380	40.7
Nov-07	13.3	2500	0.9	6.2	210	41.7
Dec-07	32	3120	0.8	6.0	350	41.1
Jan-08	12.2	2200	0.8	6.8	195	42.6
Feb-08	6.4	2300	0.6	7.2	217	46.6
Mar-08	6.4	1600	0.7	7.3	189	47.2
Apr-08	6.9	1970	0.7	7.5	152	46.3
May-08	11	1700	0.3	10.8	212	56.7
Jun-08	10	1280	0.3	11.3	364	58.2
Jul-08	01	1700	0.2	11.4	278	58.2
Aug-08	02	1900	0.2	12.2	401	59.1
Sep-08	02	1990	0.2	12.6	348	59.3

water is 400-450 ppm, while hardness of canal water varied from 95-105ppm as $CaCO_3$. Although we received three complaint in paper manufactured in the month of Mar-08, but the no. of prints before blanket cleaning increased from 2500 to 4000 on sheet fed printing machine. In this complaint maximum dust deposition was noticed at second unit. It indicates the poor wet surface strength, and then we start the addition of crosslinking agent in cationic starch. After Mar-08, we have not received any complaint from market. Reduction in dust deposition is noticed inspite of increasing the conductivity after July-08 & charge demand after June-08 due to processing of wheat straw pulp

Table-5 Monthwise data of Water , Stock & Paper Characteristics

Month	Total Hardness of raw water	Total Hardness of back water	FPR	FPAR	Dust deposition
UOM	ppm as $CaCO_3$	ppm as $CaCO_3$	%	%	mg/km
Aug-07	420	671	72.5	45.9	-
Sep-07	400	668	72.5	48.7	-
Oct-07	450	696	72.9	45.9	-
Nov-07	390	614	72.1	49.9	-
Dec-07	341	564	71.4	49	-
Jan-08	314	429	72.8	49.3	-
Feb-08	325	453	72	48	-
Mar-08	204	346	68.8	41	207
Apr-08	219	300	68.6	39.3	270
May-08	261	285	69.2	39.7	150
Jun-08	346	286	70.2	38.9	130
Jul-08	370	310	69.7	41.1	82
Aug-08	385	317	70.2	38.1	82
Sep-08	352	324	69.6	36.9	75

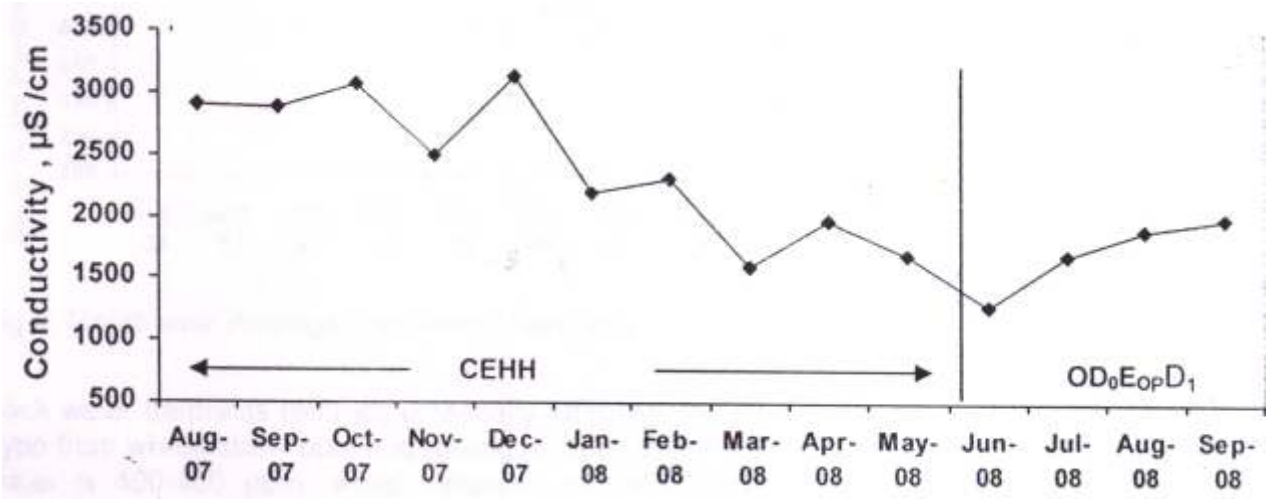

Fig.2 : Month wise Avearge Wheat Straw Pulp Conductivity

through new fiber line which is based on ECF bleaching. Increased tear factor in ECF pulp clearly indicates less fines and longer fiber pulp than CEHH pulp. If we compare the fines %, i.e. -200 mesh fractions, average fines reduced from avg. 30% to 23% in bleached pulp on technological change from CEHH bleaching to ECF bleaching.

Fig-7 & 8 shows the trend of increasing the Number of prints from 2500 to 8000 in sheet fed and 5000 to 12000 in web fed printing machine before cleaning the blanket.

CONCLUSION

A concrete study of Wet-end Chemistry is required for conversion into alkaline sizing with AKD from Alum-Rosin sizing in Agro based furnish with respect to offset printability. Use of cationic starch, cationic DSR and cross linking

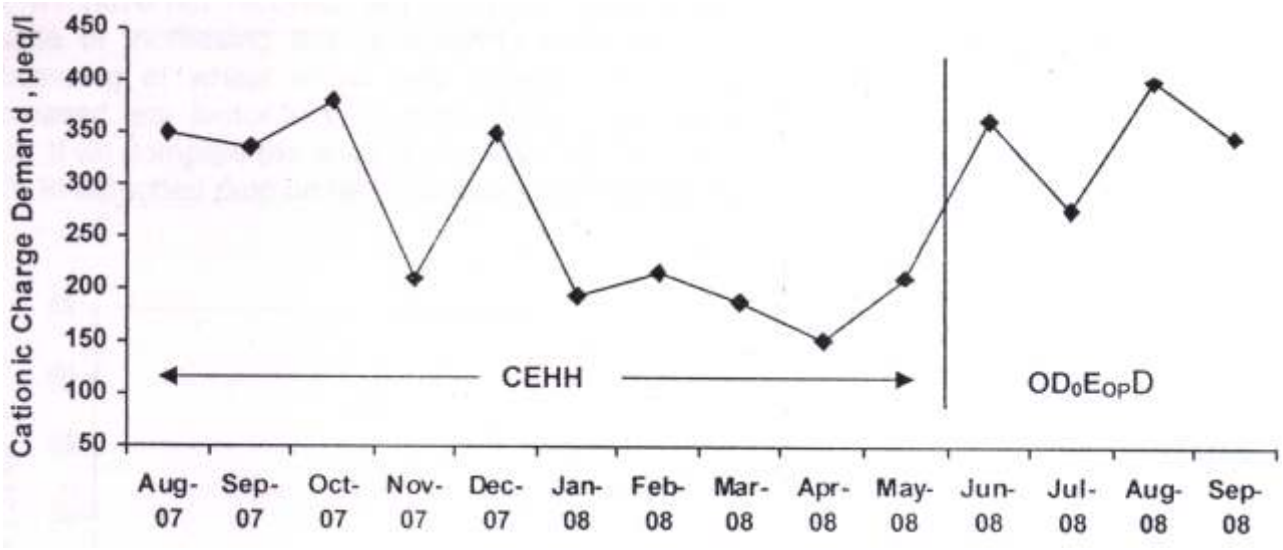

Fig.3 : Month wise Avearge Wheat Straw Catonic Charge Demand

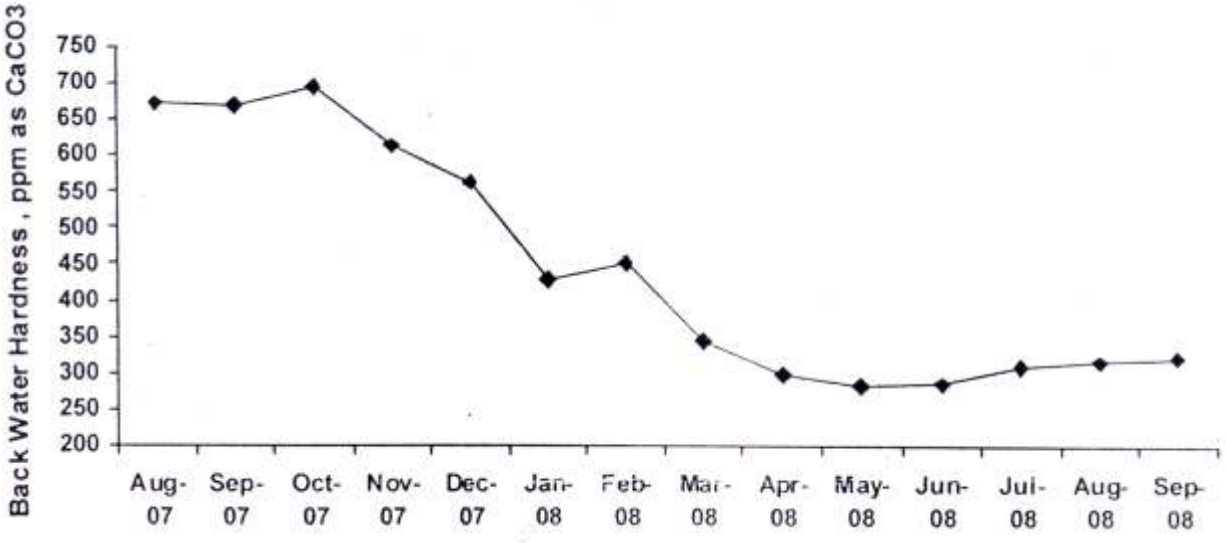

Fig.4 : Month wise Avearge Back-water hardness

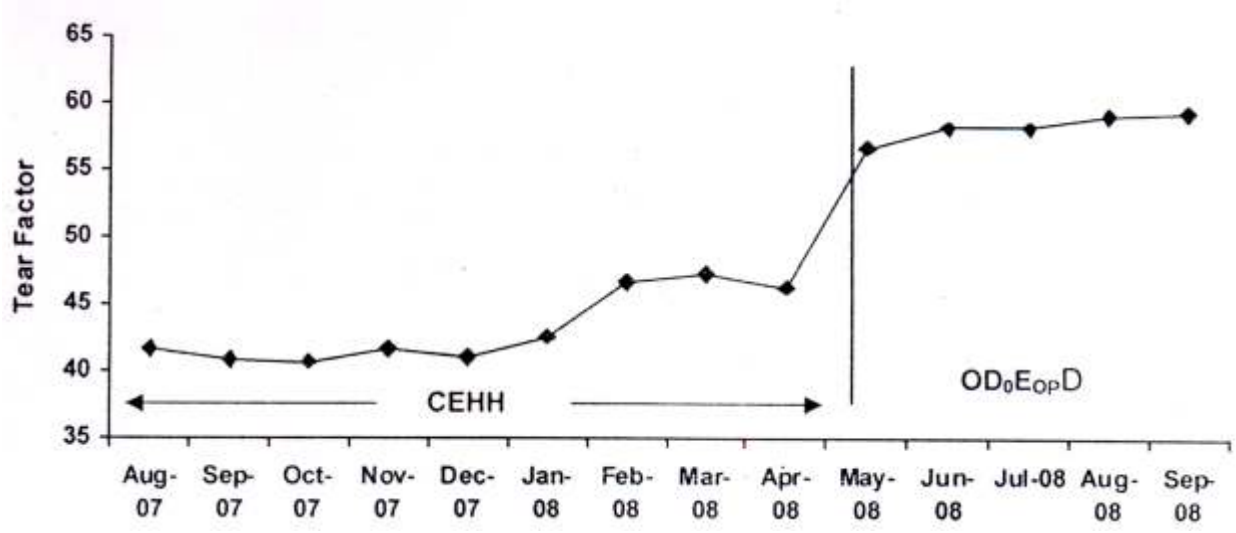

Fig.5 : Month wise Avearge Tear Factor of Wheat Straw pulp

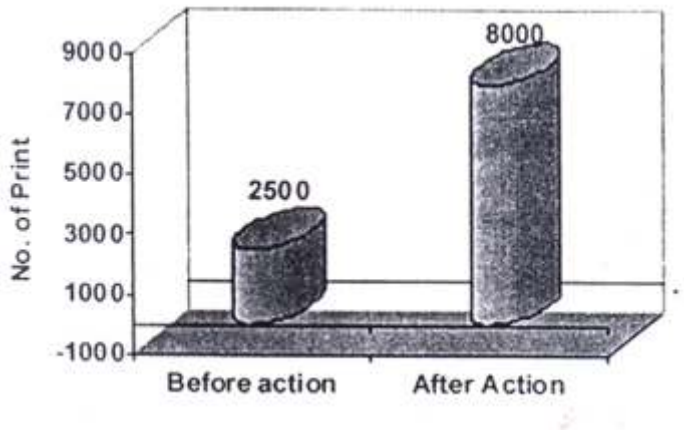

Fig.6 :No. of Print in Sheet-Fed

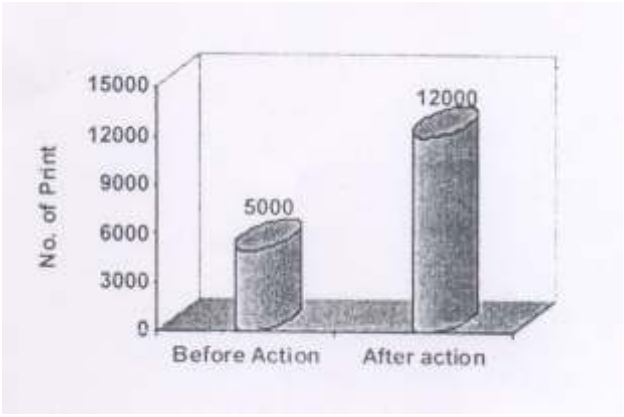

Fig.7 :No. of Print in Web-Fed

chemical in starch are beneficial to improve the printability of paper in regards to dusting and linting in offset printing. Along with suitable DSR and crosslinking chemical, it is very much necessary to maintain the good pulp quality of lesser fines and pulp cleanliness in regards to less conductivity, nil residual chlorine and less cationic demand for good retention of DSR and other wet-end chemicals. Bleaching technological change from conventional CEHH to ECF bleaching have a major impact on good quality of pulp with regards to less fines generation due to reduced degradation of cellulosic fiber. Quality of good water with respect to total hardness is of paramount importance as it helps in lower chemical consumption that in turns resulted in less interference in bonding of fines and fibers.

ACKNOWLEDGEMENT

The authors acknowledge their sincere thanks to the management of Abhishek Industries Limited for granting permission to present this paper in IPPTA workshop on "Paper Quality and Printing Process" at Saharanpur in 23rd and 24th October, 2008. We are also thankful to Quality Control and Paper machine staff for their contribution.

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