Effect of Broke Quality and Chemical Additives on Paper Cleanliness

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Paper cleanliness has assumed greater importance particularly for high bright papers used in quality printing segment. Along with other quality parameters, cleanliness plays important role for improving machine runnability by reducing machine breaks. Improved cleanliness also results in higher productivity during converting process at the customers end. Attention is to be focused on quality of various inputs and interaction of wet end additives as they may create problems by deposit formation which appears as holes/ spots when subjected to heat and pressure during subsequent operation. Understanding of wet end chemistry and its control is crucial. On the basis of analysis of spots with FTIR spectroscopy and other analytical techniques, the mill has implemented high density broke cleaning system along with slotted screens to remove heavier particles as well as light impurities like plastic pieces from straps, tapes, pouches, core plug etc to get the desired cleanliness of broke. All these efforts have improved cleanliness level in paper by about 80-85%.

INTRODUCTION

Paper cleanliness is an important quality parameter along with the basic functional properties of paper sheet particularly for high bright printing papers. It has assumed greater importance in view of rapid changes in printing technology as well as end use of paper in many converting operations. It is therefore, vital to understand the role of wet end chemistry in paper making as well as handling of in-house generated wet broke from paper machine and dry broke from rewinder, cutter and finishing house to avoid contamination in the system.

Papermaker tries to keep the papermaking system balanced in terms of chemical addition, charge balance of the system to avoid excessive interactions at the molecular and colloidal level like flocculation, coagulation, hydrolysis, precipitation and microbiological activity to avoid quality defects in paper and improve machine runnability is good.

To achieve this, storage, handling and preparation of various chemicals and additives play an important role. Also, broke generated during various operations need special attention as the main goal of a broke system is to return fiber back to the process with no disruption to the uniformity and quality of the stock flowing to the paper machine.

This paper will discuss our experience with broke handling and cleaning system, which made significant improvement in cleanliness of paper after implementation of this system as well as optimization of wet end chemicals.

Overview of broke generation and utilization

Ours is an integrated pulp and paper manufacturing unit producing average 310MT /day bleached pulp and 340MT/day finished paper with 4 MF and 2 MG machines.

The average broke generation per day from all these paper machines is about 40 MT/day. Out of this, about 20MT/day broke is consumed by MF machine running at a speed of 480m/min producing surface sized quality offset printing paper. The entire production of this machine (PM-3) is automated from pope reel to the dispatch via rewinder, syncro cutter, wrapmatic and shrink bundling machine. However, there are still paper converting equipments for about 60% production where dry broke is generated.

During these operations, there are possibilities of broke contamination with non-cellulosic foreign material used during paper finishing stage like BOPP tape, hot melt glue, plastic core plugs, plastic straps responsible for deteriorating cleanliness of final paper sheet.

To remove major contamination, we were earlier

cleaning broke through centrisorter having basket of 3mm hole.

Study on Nature and Origin of Spots in Paper

Mills was receiving complaints of different types of spots in paper. These spots were other than the dirt and shives having an average diameter of 3-4 mm. The frequency of these spots was 20-25 spots/100m2 of area. It was difficult and also not reliable to evaluate cleanliness of paper with light contrast equipments used for the analysis of dirt and shives. We devised an internal method for rating of cleanliness of paper as follows.

One full wire length sample drawn from the jumbo was guillotined to size of 58.5cm x 91.0cm. The spots were checked and manually counted in 250 sheets. The results were reported as No of spots/250sheets and No of spots/100m2.

Table 1 : Initial Status of Paper Cleanliness

Nature of Spots	No of spots/ 250 sheets	No of spots/ 100m2
Waxy Translucent	5-7	3-4
Brown Translucent	2-4	2-3
Green/ Blue color spots	8-10	6-8
Black Spots	2-3	2-3
Oil/ Grease	2-3	2-3

During the analysis, different types of spots were observed. These spots were classified depending on their physical appearance, color and feel. The frequency is given in Table-1.

A detailed study was carried out systematically to understand the nature, type and origin of spots in paper in order to identify the root cause.

The normal practice of tracking backward was followed and about hundred samples of different types of spots appearing in the final paper sheet were collected during a long run.

Analysis and Source of Waxy Spots

To examine the nature of waxy spots, these spots were subjected to FTIR Spectroscopy. The resulting IR Spectra was having picks related to Fatty acid/ Resins. The first impression was that of wood resin/ pitch or fatty acid from other inputs used during pulp and paper manufacturing. Since the spots were precipitates and insoluble in water, they were also examined for copper, calcium and iron. It was found that these spots were calcium rich fatty acid agglomerates.

The question then was to find out the source of these fatty acids entering the system. Different sources of fatty acids like wood resins, rosin size emulsion, defoamer used at different stages of pulp and papermaking were analyzed in detail with modern analytical techniques like partition thin layer chromatography using silica gel as supporting material and then subjecting to FTIR spectroscopy to identify the contributing component.

It was found that the nature of fatty acids observed in paper spots was matching with the characteristics of the fatty acids present in defoamer used both at pulp mill and paper machine. The defoamer used at papermachine contains about 23-24% fatty acid and rosin dispersion used for paper sizing contains 6-7% fatty acids.

After detailed experimentation in laboratory, it was found that the defoamer used at unbleached pulp decker gets chlorinated in bleaching forming waxy agglomerate, which get contaminated with calcium in calcium hypochlorite bleaching stage. These materials are carried over with pulp to papermachine creating spots in paper after calendaring under the application of heat and pressure.

Table 2 : Constituent of different type of spots

Nature of Spots	No of spots/100m2	Constituents
Waxy Translucent	3-4	Chlorinated fatty acid from defoamer, rich in calcium
Brown Translucent	2-3	Starch agglomeration
Green/ Blue color spots	6-8	Aliphatic hydrocarbons basically Polyethylene/Polypropylene.
Black Spots	2-3	Low Molecular weight Polyethylene.

These spots were reduced significantly by optimizing the defoamer consumption at unbleached pulp decker through metered addition and creating awareness among the shop floor people regarding these problems. But this action solved the problem to the extent of 15-20% only.

Analysis and Source of colored spots

Microscopic analysis as well as analysis with FTIR spectroscopy reveals that these spots in paper were colored and flexible in nature. The physical appearance was like plastic. The comparison of FTIR spectra of these spots and blank paper shows that these are basically polypropylene, polyethylene compounds.

Table 2. shows the outcome of the analysis of different

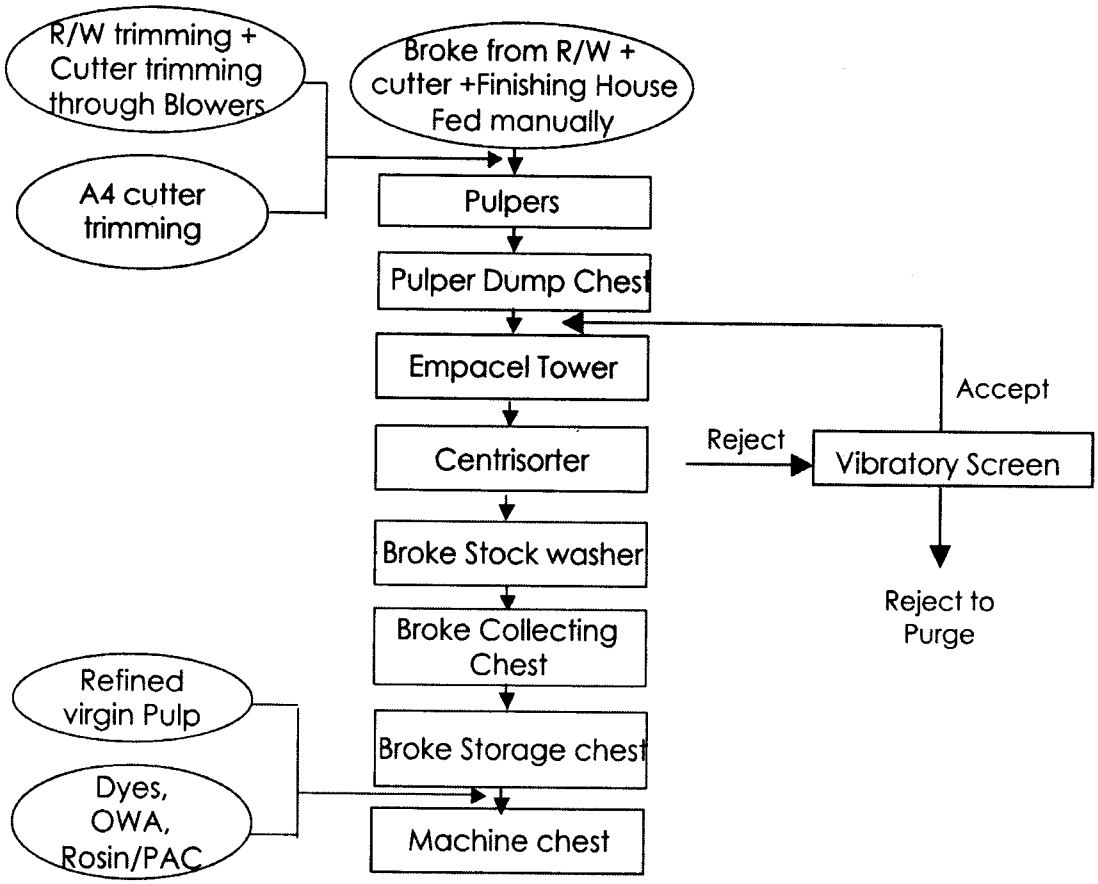
types of spots by FTIR spectroscopy.

In the papermaking system, nothing is used having these compounds and there was no possibility of formation of any such product through interaction of different papermaking inputs. The papermaking system was analyzed by screening the pulp stock of different stages from final bleached pulp to papermachine approach flow system through Sommer-Ville screen in laboratory for separation of any foreign material in the stock.

through screen are added. Sample from this stage was found contaminated with green/ blue colored material looking like plastic pieces. Similarly, slushed broke was analyzed and similar nature of material with green/ blue color was observed.

This study suggested that the spots in papers are basically through contamination of broke with shop floor materials like BOPP tape, plastic core plugs, plastic straps which gets reduced to small pieces during

Figure 1 : Old Broke Handling and treatment



OBSERVATIONS

Major contraries observed in final bleached pulp were partially bleached and bleached shives, grits and calcium hypo scales. But these were not the part of major spots appearing in paper. Therefore, contamination due to final bleached pulp to paper machine was ruled out. Also in refined pulp, foreign material observed was similar to that of final bleached pulp. It indicates that the system was clean up to stock preparation refiners.

At machine chest, refined pulp and broke get mixed and other chemicals like tinting dyes, OWA, sizing material

slushing of broke and pumping operation etc. These small pieces are difficult to separate during screening and create spots after calendaring.

It means that the remaining 60-65% problem of paper cleanliness was related to broke. It was thus decided to focus broke cleaning system.

Figure 1 shows old broke handling and flow till machine chest.

Old Method of Broke cleaning with Centrisorter

Figure I shows the detailed scheme of handling of self-

generated broke and cleaning to remove contraries and foreign particles.

The amount of broke fed manually to pulper is approximately 75% of total in-house generated broke where chances of broke contamination are more. In order to remove the contraries single stage centrisorter with basket of 3mm hole diameter was in use. The basic problem with the centrisorter was the requirement of over dilution at feed, which resulted into diluted, accepts broke pulp, which is to be thicken on thickener. The reject through this system was basically contrararies like plastic tape, pieces, different plastic material and lot of useful fiber. To recover the useful fiber, reject from centrisorter was sent to vibrating screen having 3mm hole. To improve the cleanliness further 1.8mm hole basket in centrisorter was tried but it did not give the desired throughput. So, we reverted back to the original system which was having poor cleaning efficiency.

It was then decided to install high-density broke cleaning system capable of removing all these contraries and manufacture acceptable quality of paper.

New High Density broke cleaning system

Figure 2 shows the basic component of new high density broke cleaning system with process flow. The new broke cleaning system is provided with High Density Cleaner followed by two-stage pressure screens with PLC control. The high density cleaner removes heavier particles and pressure screen having slotted basket of 0.25mm removes lighter particles like plastic pieces, strings etc.

High Density Cleaner and its Operation

The basic function of high density cleaner is to remove heavy impurities. It continuously removes coarse impurities like grits, stones etc which have the higher

Figure 2 : New Broke Cleaning System: High Density Cleaner & Screens

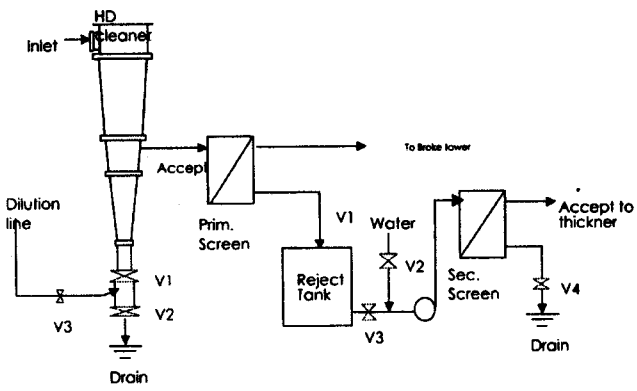


Table 3 : Conditions for optimum performance of High density cleaner

Particulars	Requirement
Pressure drop across High Density cleaner	0.6-0.8 kg/cm2 (min)
Feed pressure to high density cleaner	2.3-2.5 kg/cm2
Pressure at accept of HD cleaner	1.5-1.8 kg/cm2
Flushing water pressure	3.3-3.5 kg/cm2

specific gravity than the suspension. But it is not suitable to remove lighter particles such as plastics, wooden specks or bulky impurities such as strings, wires that cause plugging of machine equipments.

Table 3 gives the basic requirements for optimum operation of high density cleaner.

The fresh water pressure in the flushing water line at dirt tank is to be kept at least more than 1 bar than the stock pressure at the purifier inlet. If the pressure difference is less, good fibers will not be returned from the dirt trap increasing fiber loss.

Pressure drop across high density cleaner should be minimum 0.6-0.8 Kg/cm2 and accept of high density cleaner which is fed directly to Primary Screen of broke cleaning system should be at 1.5-1.8 kg/cm2. It means that minimum feed pressure to high density cleaner should be about 2.3-2.5 kg/cm2 to have proper operation. Flushing water pressure should be at least 1.0kg/cm2 more than the feed pressure and thus minimum flushing water pressure should be maintained at 3.3Kg/cm2.

In high density cleaner, stock enters tangentially which is rotated rapidly by the rotor. The impurities are thrown by centrifugal force against the wall of the separating zone. The rejects are purged out from the system after a set interval from dirt tank by switching off the flushing water.

The cleaned stock is discharged from the middle of cleaner through discharge branch and fed to screening system.

Three control valves of high density cleaner as indicated in the figure-II have interlocks. The purging valve V2 of dirt trap for draining the reject operates after every 30minutes and simultaneously high-density cleaner discharge valve (V1) and flushing line valve (V3) closes. This interlock facility avoids unnecessary fiber loss. Similarly during reverse action, flush valve (V3) opens first followed by closing of dirt trap valve (V2) and opening of discharge valve (V1) of high density cleaner.

Two Stage Screening Systems

The basic purpose of screening system is to remove lighter particles which were not removed by high density cleaner.

Screening system basically has two screens in series having baskets of 0.25mm slots in both the screens. Accept of high density cleaner is fed to primary screen. The accept of primary screen goes to broke chest while reject of primary feed goes to secondary screen and secondary screen rejects are purged out from the system. The accept of secondary screen remains in recirculation.

The stock to be screened out is sent to the inlet chamber radially and flows from there into the gap between rotor casing and screen basket. The accepts flow centrifugally through the screen basket openings. Dirt particles and fiber flakes are transported with the assistance of the rotor from the screen inner side of the basket to the drive side and discharged through the rejects outlet branch.

To operate the screen without any problem for improved efficiency, the operating pressure of screen inlet is kept at 1.5-2.0 kg/cm2 and maximum allowable pressure is 3.0 kg/cm2. The reject of screen is continuously discharged with normal opening of reject valve at 30% and after every 15 minutes, reject valve opens fully where reject of primary screen gets discharged at reject tank.

The feed valve (V3) of reject tank to secondary screen opens for every 3minutes during this period, flushing valve (V2) gets simultaneously closed. As soon as V3 closes V2 opens for 1.5 min and simultaneously secondary screen reject valve (V4) opens for 5 sec. Flushing valve (V2) gets closed after closing the V4 valve.

Accept of screening system having consistency of 3.0-3.5% is directly feed to the broke storage system for blending with the papermaking stock.

Benefits with broke cleaning system

- The implementation of high density cleaner helped to remove heavy particles from the system.
- Most of the plastic and other lighter particles, which were affecting paper cleanliness could be removed from the system with slotted screen having slot size of 0.25mm.
- The cleaned broke from broke cleaning system helped us to utilize more broke from other machines in papermaking furnish of PM-3.
- The major advantage of installing broke cleaning system was elimination of blotches and spots caused by thermo plastic material. Cleanliness data is given in Table 4.

CONCLUSION

Paper cleanliness along with functional properties of paper has assumed greater importance particularly for high bright papers used in quality printing segment. This helps in improving machine runnability and, therefore, productivity during converting process at the customers end by reducing conversion losses. Attention is to be focused on quality of various inputs and interaction of wet end additives which may create problems. Understanding of wet end chemistry and its control is crucial.

On the basis of analysis of spots with FTIR spectroscopy and other analytical techniques, the mill has implemented high density broke cleaner along with slotted screens to remove heavier particles as well as light impurities like plastic pieces from straps, tapes, pouches, core plug etc to get the desired cleanliness. The visual appearance of the sheet improved significantly with reduced machine breaks and thus improvement in machine runnability. The downgrading and rejection on account of cleanliness/ dirt reduced significantly.

Table 4 : Cleanliness in Paper achieved after installation

Nature of Spots	Frequency (No of spots/100m2)	
	With old System	After installation of broke cleaning system
Waxy Translucent	3-4	1-2
Brown Translucent	2-3	1-2
Green/ Blue color spots	6-8	2-3
Black Spots	2-3	1-2
Oil/ Grease	2-3	1-2
Total	**15-20**	**3-4**