Alkaline Sizing for Fine Paper : An Experience

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ABSTRACT

Alkaline Sizing offers many benefits to the papermakers in terms of quality and cost. For this purpose in paper industry, AKD and ASA is the established alkaline sizing agent for stock pH up to 8.5. In today's scenario, alkaline sizing becomes necessity for the papermaker to have an edge over the competition in terms of product quality which facilitates use of GCC/PCC in system along with other benefits in terms of cost, quality and productivity.

As both the product have certain limitations as well as advantages, selection of suitable sizing agent among ASA and AKD for alkaline sizing depends on the individual mill and paper machine conditions. A particular mill has to select a suitable chemistry for successful implementation based on the available process conditions and resources like furnish , process water quality, steam availability in dryer section, design of press section, size press design, nature of final product to be manufactured etc.

Mill under consideration have gained sufficient experience for both alkaline sizing agent in recent past and based on the available system, ASA has been selected as an alkaline sizing agent for fine paper making. In initial phases, mill has faced lot of issues with ASA sizing technology. But the issues have been sorted out with complete analysis and understanding the necessary chemistry. Now mill is ready for change over to ASA sizing system.

INTRODUCTION

With the development of technology in paper industry and global competition, mills are under pressure to improve bottom line and papermakers are constantly striving for manufacturing better quality of paper at lower cost. This is forcing the mills to focus on the process chemicals for quality improvement and cost reduction rather than solving and preventing problems.
To get maximum benefit, mills are adopting following basic criteria for the new technology.

- Reduced contaminant in paper making system.
- Improvement in quality of paper product.
- Reduced cost of application.
- Reduced deposits in system.
- Minimum environment related impact.
- Cleanliness of papermaking fabrics.
- Synergy of wet end chemistry program components.

Wet end chemicals are also no exception to this phenomenon and environment impact of changes becomes more relevant in today scenario along with quality and cost factor. To tackle this issue, papermaker expects restricted drainage of water from system.

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In terms of quantity of inputs required for papermaking, sizing chemical has a significant contribution after water, pulp and filler. Now papermaker has convinced the benefits of alkaline sizing system against sizing with rosin and PAC/ Alum in acidic and neutral pH.

Traditionally sizing of paper is carried out with rosin and alum in acidic pH, but later on to avoid the formation of calcium sulphate precipitation in system; alum is replaced with PAC and system pH increased from acidic to pseudo neutral. Now to get the quality benefits of GCC/ PCC in optical properties of paper and better recyclability of paper machine back water, mills are moving towards alkaline sizing system, although the soap stone is available in India abundantly at comparatively lower cost.

This paper will share the experience of our efforts for the conversion of paper making system from neutral to alkaline sizing system.

Brief of Manufacturing Process at Bilt- BPU

Bilt Ballarpur is an integrated pulp and paper manufacturing unit based on bamboo and mix hardwood as a raw material species. The major products are fine quality paper for offset printing like Maplitho, super printing, bond paper and MG posters like TD loaded poster, AR poster, AF poster for industrial applications. These products are manufactured on 4 MF machines and 2 MG machines with a production capacity of 360MT per day.

The sizing system as on today is dispersed rosin- PAC sizing system at neutral pH for all the paper machines. As usual in Indian paper making scenario, paper filling material is high bright soap stone with Bentonite macro-particle system as retention aid system. The broke handling is through a common cleaning system and paper machine back water handling and recycling is through a common clarification system.

With a basic objective of improving quality of paper in terms of opacity of paper through use of GCC/ PCC in system along with below mentioned benefits, mill is keenly focusing on conversion of sizing system to alkaline pH.

Why alkaline Sizing

- Facilitates use of GCC- PCC to enhance optical properties of paper.
- Reduced cost of chemicals.
- Reduced chlorides build up in system and hence reduced corrosion.

- Reduced TDS build up in water system, Better recyclability.
- Reduced fluff in pre dryer and enhanced cleanliness of paper.
- Better stability of product due to less reversion rate.

Although in Indian industry scenario cost of GCC- PCC is prohibitive compared to abundantly available good quality soap stone for loading the paper, industries are going for alkaline sizing system because of above mentioned benefits.

Bilt Ballarpur is working on establishing alkaline sizing system like AKD, ASA on the paper machines from late 90's. Initially efforts were made on AKD based systems on a paper machine having conventional size press. But due to already stretched for the production rate, different limitations experienced in terms of available resources against the requirement of system. Later on the efforts were concentrated on ASA based system to meet the requirement of system with available technology and resources.

A step by step approach of the mill for the conversion to alkaline sizing system and the experience gained has been summarised below.

Previous experience with AKD based alkaline Sizing System

After the initial efforts in 1995-98, in 2002 mill has tried AKD emulsion once again for alkaline sizing along with Bentonite based retention aid system on a paper machine with production rate of 60MT per day manufacturing hi bright offset printing paper with conventional pond type size press. The summary of the experience is given below.

Pre Trial Preparation

- A complete boil out of the machine was taken up.
- All the felt and press rolls washed with caustic to remove any traces of rosin residue.
- Bentonite cationic polymer based retention aid program was already established on machine.
- A desired quality defoamer and Bronopol type slimicide used for the alkaline pH.

Details of chemical addition point and typical chemical consumption during AKD run are given in Table-1.

Table-1

Chemicals	Addition Point	Typical addition level
Soda ash	Blending chest	To get the pH of pulp at 7.0-7.5
Tinting dye & OBA	Mixing chest	As per normal practice
Cationic Starch	SR box Leg	3.8 Kg/T
AKD emulsion	SR box leg after starch	10 Kg/T
PAC	Back water channel	3-4 Kg/T
Filler	Centricleaner accept	To maintain ash level of 15%
PAM	Pressure screen inlet	195 g/T
Bentonite	Pressure Screen Outlet	2.5 Kg/T
Defoamer	Backwater channel	500 g/T
Slimicide- (Bronopol)	Back water channel	100 g/T
Slimicide	Broke Chest	40 g/T

Table-2

	Before Refiner	After Refiner	SR Box	Head Box	Back Water
pH	6.6-6.8	7.5-8.0	7.4-7.6	7.5-7.7	7.5-7.7
Charge (eq/lit)	-48		-19	-20	-24

Wet end parameters of importance maintained during the run is given in Table-2

First Pass Retention : 80-82%
First Pass ash Retention : 50-52%
Back water alkalinity : 100-110 ppm as CaCO3

The major experiences during AKD run are summarised below

Positive observations

- Desired level of Sizing was achieved with 10kg/MT of AKD emulsion consumption with 2-3 kg/T of PAC in system and 4kg/T of cationic starch before AKD addition.
- Fluff at pre dyer section completely eliminated.
- Better surface strength of paper in terms of wax pick due to higher size press starch pick up due to insufficient cobb development in paper before size press.
- No changes in slime activity in the papermaking system as monitored with TBC of the system.

But the system could not be established at paper machine due to following shortcomings

Spots in Paper

With AKD as a sizing chemical, there was an issue of spots in paper. These spots were attributed to the uneven pick up of size press starch due to insufficient development of sizing and creating spots in paper at the calendar stage.

Paper Machine runnability and roll Building

During AKD run on paper machine, an issue of variation in on-machine Cobb value at pope reel observed, which may be related to variation in before size press Cobb. Due to this variation, there was variation in size press starch pick up which affected the paper machine runnability, although the cured Cobb was acceptable.

This variation in starch pick up resulted in calliper and smoothness variation of paper and resulted into poor pope reel building.

Conclusion on AKD as a sizing material

Past experience with AKD as a sizing chemical and experience of this AKD run, it has been concluded that pre dryer section steam limitation is the major constraint for conversion of Rosin-PAC based sizing system to AKD based alkaline sizing system. Due to this factor, minimum required sizing before size press was not able to achieve and creating the issue at conventional pond type size press in terms of paper machine runnability.

Considering the limitations with the system, it has been decided to go for ASA based sizing system where sizing development is quick on machine itself, although it is more sensitive and dedicated systems are required for emulsification and monitoring for ASA.

Brief Introduction of ASA sizing system

ASA sizing system has a long history in paper industry since 1970 and during early introduction it is blamed for issues like sheet defects, press picking & poor machine runnability. But in later stages, it has been developed in stages as a useful technology alternative to AKD sizing system which can run to a wide pH range from acidic to alkaline. During improvement stages, system has undergone through many changes in emulsification systems as well as emulsification media and purity of ASA itself.

Today ASA sizing system is a proven technology for paper industry with certain limitation like on site emulsification system which requires minimum machine capacity to justify the investment in emulsification system.

Initially Bilt- Ballarpur conducted some small runs with ASA and faced different issues pertaining to process problem & machine runnability. There are several variables particularly furnish composition, sizing chemical, additives, fillers, white water loop, hardware of paper machine, dosage level and application point, preparation of sizing emulsion can influence the sizing efficiency in a significant way due to change in process conditions like pH, alkalinity and first-pass retention.

Based on the experiences of short runs, available technical literatures and success stories in concerned sister papermaking units, a detailed study has been carried out for the actual system requirement and available conditions as well as resources for ASA sizing system at unit. The same has been discussed below point by point.

Defoamer usage in Papermaking

With rosin alum sizing system, defoamer is a part of papermaking auxiliaries to take care of foam in system. It becomes of importance when the back water loop get tightened. But the defoamer has an adverse impact on the sizing of paper and in turn sizing chemical performance. Interestingly the impact of defoamer is much more at size press compared to wet end when used in excess.

Before our efforts for conversion to alkaline sizing system, a complete review of the defoamer usages has been conducted on all paper machines. Mill was using oil based defoamer with rosin PAC sizing system and consumption was abnormally as high as 3-4 kg/MT of paper when back water loop has been closed to maximum possible extent.

A decision has been taken to establish good quality defoamer at all paper machines before conversion to alkaline system. A water based defoamer has been established on all the paper machines for wet end application.

This has helped to reduce sizing chemical consumption. Otherwise once the dosages on ASA increases beyond the control limit, the issues like hydrolysis of ASA, press picking and machine runnability come into picture. Establishing and optimisation of ASA sizing system was one of the important steps to have a check on ASA sizing consumption.

Media for emulsification

On site emulsification of ASA is a prerequisite for ASA application. In the emulsification process, emulsification unit as well as emulsification media play an important role for successful change over to alkaline sizing.

Basically emulsification media should fulfil the basic criteria

1. Stable under available paper making condition.
2. Uniform and stable viscosity of media
3. Should not be prone to any type of degradation.

Conventionally cationic starch is used as an emulsification media for ASA but due to certain constraint like dedicated starch cooking and storage facility, facility to reduce the temperature of cooked starch, batch to batch variation in solid concentration and extra labour cost, ready to use cationic polymer is more preferred with uniform emulsification quality.

But as reported in the literature elsewhere, cationic polymer is used in mill manufacturing container board, cartons and news print. Use of cationic polymer in fine writing, printing paper experiences excessive deposits and issues like press picking and roll coating starts. In fine paper manufacturing, cationic starch with proper viscosity is a proven option.

Based on the previous experience of cationic starch based liquid polymer as well as Bentonite for emulsification of ASA, mill has decided to go with cationic starch. The same formulation is running successfully in one of our sister unit for past 3 years.

Point of addition of ASA

There are two philosophies for adding ASA emulsion to a papermaking system.

1. Addition of ASA in thick stock- At Stuff box accept line:

This philosophy is applicable when the filler is going in the thin stock. In this situation if ASA is added in thick stock near the fan pump dilution, the majority of ASA will be deposited on the cellulose fiber and not on the filler fines and fines recycled through back water. This will reduce the potential hydrolysis of ASA due to recirculation of fines through back water system. The addition of ASA emulsion near to fan pump dilution also eliminates the chances of hydrolysis of ASA as time interval between addition of emulsion and formation of web is too small.

This method is applicable particularly when retention levels are not consistent and at a desired level.

2. Addition of ASA emulsion near head box in thin stock:

It is a general perception that ASA to be added as near to head box as possible to avoid the hydrolysis chances of ASA. This approach is also valid in case of papermaking system when stock temperatures are high (>50°C) and/ or filler addition is in thick stock. But main prerequisite is that retention level (FPR and FPAR) must be adequately high to avoid the recirculation of fines in system.

Considering the high ash level in paper (15-18%) and retention level at the machines, mill has taken a decision to add ASA emulsion in the thick stock (accept line of Stuff box) to fix the maximum possible ASA on the fiber and avoid the recirculation of ASA in back water system in the form of hydrolysed product which are the main responsible species to affect the paper machine runnability.

Retention Level

In alkaline Sizing (AKD or ASA), retention levels are of paramount

importance compared to rosin- PAC sizing system. Different kinds of retention aid systems are available from dual polymer to microparticsle to nano particle retention aid system. Today, paper maker has a wide choice to use proper retention aid system suitable for the paper machine and furnish used for papermaking.

Based on the experience of the successfully converted alkaline sized paper machines, the optimum retention values of FPR and FPAR are 78-80% and 47-50% The proper retention values ensure the check on the consumption level of ASA as well as minimises the chances of hydrolysis of ASA through reduced circulation of fines in the paper making system.

In mill, a Bentonite based macro particle retention aid program is established on all the paper machines with an acceptable level of retention levels for alkaline sizing. Hence it has been decided to forward with the established system.

Deposit control measures

ASA is mainly blamed for the deposit formation at different papermaking hardware like press roll, foils, paper machine wire etc. As per the study carried out at different places and reported in different literatures, now it is a well known fact that the deposits are mainly due to formation of sticky salt by hydrolysed ASA with calcium ion present in different sources in papermaking system like process water, cationic starch used for papermaking etc. The deposit control measures are basically focused on reducing the chances of hydrolysed ASA and treating the calcium ion present through different available chemistry.

Hydrolysis of ASA cannot be eliminated 100%. Some amount of hydrolysis of ASA will takes place in the system during ASA emulsification, dosing in papermaking stock, recirculation of fines in the back water system, temperature of stock as well as emulsion media etc. Hydrolysis of ASA can be minimised depending on the papermaking system available through different measures as discussed above.

Another route is to take care of calcium ion before it comes in contact with the hydrolysed ASA so that formation of sticky calcium salt of hydrolysed ASA can be avoided. The most common and widely recommended action is use of aluminium species like papermaking alum in the water used for emulsification before coming in contact with ASA. Use of alum/ PAC in back water to avoid the formation of calcium salt as formation of aluminium salt is preferentional reaction over the formation of calcium salt and aluminium salt is not sticky in nature and can be easily carried over with paper.

The pH of ASA emulsion also has an important role. Recommended pH of ASA emulsion is about 4.0 and normally maintained with alum and citric acid.

During short runs with ASA, mill has faced a problem of press top roll coating frequently in all the runs. From the old experience and the technical literatures available as discussed above following measures planned to take of deposit formation and costing on the press rolls.

1. Maintaining temperature of mill cooked cationic starch below 45°C.
2. Better mixing of ASA emulsion with stock through addition of emulsion near to fan pump.
3. Addition of Alum in ASA emulsion to scavenge hydrolysed ASA.
4. Start the ASA emulsion addition from lower dosages to avoid build up of hydrolysed ASA in back water system.
5. Use of Surface sizing (HSS) chemical at size press to reduce ASA consumption at wet end.

Nature and quality broke available in system

In the papermaking furnish, broke is also a major constituent. The role of broke becomes significant particularly when it is a multi paper machine location. As all the paper machines may not be converted to alkaline system in one go, the mixing of broke creates an issue and restrict to get the desired benefits of alkaline sizing system.

The mill under consideration is having MG and MF paper machines of different capacity running with rosin-PAC sizing system. Paper machine under consideration runs with 25% mixed broke in furnish. The mixed broke containing Rosin-PAC sizing leads to following Issue.

Rosin entering from the broke to papermaking system contributes to paper sizing till PAC is available in system and pH of system is in neutral stage. This checks the ASA sizing consumption also. But when the pH of the system goes up from 6.8-7.0 to 7.5-7.7, contribution of rosin in sizing process vanishes and rosin becomes a part of anionic trash and at higher pH contributes to press roll coating and felt clogging issues.

During past trials at paper machine, when pH of system increases from 6.8 to 7.5, ASA consumption increased from 0.8 kg/MT to 1.4kg/MT of paper due to above said reasons.

The un-reacted rosin from broke needs to be taken care at higher operating pH through proper fixing agents so that it can be carried over with paper without any issue.

Experience of ASA sizing system at Bilt- Ballarpur

Considering the past experience of AKD sizing system as well as short runs of ASA system of different technology at different paper machine, mill has studied systems where ASA is running successfully to benchmark the practises. Based on the experience gained and above discussed technical requirements, it has been decided to go for ASA based alkaline sizing system for a 480mpm paper machine. The details of the same is summarised in Table-3.

Table-3

Paper Machine Speed	480 mpm
Quality of Paper	Wood Free offset printing paper
GSM Range	58 to 120 g/m2
Press Section	Bi Nip Press followed by a third Press
Press Roll MOC	Granite
Size Press	Conventional Puddle Type Size Press

Table-4

Actions taken & problems faced in last trials	Proposed actions
ASA dosing Point: In thin stock just after filler addition.	ASA emulsion dosing to be shifted to fan pump inlet line in thick stock to get maximum ASA retention on cellulose.
ASA Dosage Level: In past, ASA trials started with higher dosages of ASA (about 2 kg/MT) to get the desired sizing and back water saturation at the earliest.	Lower dosages of ASA (about 0.7-0.8 kg/MT of paper) at earlier stages of run to avoid the recirculation of ASA in back water system and get hydrolysed subsequently.
Coating on Press Roll/ Hydrolysis of ASA: A coating of press roll was started immediately after starting the trial and requires frequent cleaning.	Reduce ASA addition through maintaining sizing through size press additives. Installation of efficient water jets on press roll to clean regularly and effectively. Use of alum in ASA emulsion system to avoid the formation of sticky calcium salt. Use emulsion direct dosing system without any intermittent ASA emulsion storage.
Press felt cleaning:	Use of suitable felt conditioning program to clean out the felt.

The addition points of key paper making additives

Table-5

Input chemicals	Dosing Point for dispersed rosin sizing	Dosing points for ASA sizing program
Soda Ash	Before refining	Before refining
Broke	Metering channel	Metering channel
Cationic starch	--	ASA emulsifier
High Grade Alum	--	Emulsified ASA
PAC	Machine Chest	Machine chest
Dispersed Rosin	Machine Chest	--
ASA	--	Stuff box down leg
Filler (Soap Stone)	Centricleaner accept	Centricleaner accept
Polyacrylamide	Pressure screen inlet	Pressure screen inlet
Bentonite	Pressure screen outlet	Pressure screen outlet
Defoamer	Back water Tray	Back water Tray

Figure-1: Particle size of ASA droplet, µm system

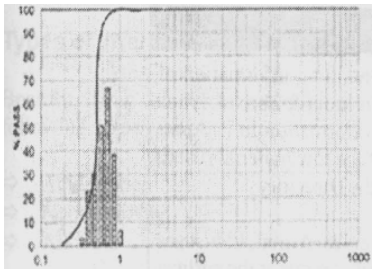

Figure-2: ASA emulsification

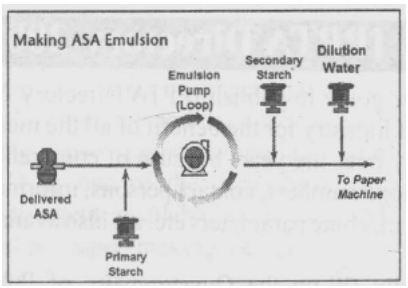

Table-4 shows the problems faced in earlier trials and possible action plan to take care of the issues faced in earlier efforts.

The Addition points of key paper making additives are given in Table-5

ASA Emulsification Details

The process of onsite emulsification used was based on cationic starch (DS = 0.035) at 3.5-4.0% solid having a viscosity of about 200 cps (brook field Spindle No: 2, Speed:60 rpm, temperature: 50°C). The ratio of ASA to Starch is maintained at 1:3.0 and pH of starch is maintained before emulsification at 4.0-4.5 with citric acid and non-ferric alum is added after emulsification to avoid formation of sticky with calcium hardness available with water.

Particle size of ASA emulsion is important for efficient sizing with ASA. With smaller particles (droplets) the distribution of ASA improves. Basically particle size of ASA droplet depends on following factors.

- Loop flow emulsification unit
- Inlet and emulsification pressure of emulsifier
- Starch flow and solids
- Viscosity and temperature of starch
- Emulsification temperature

The typical particle size distribution of ASA emulsion is given in Figure-1 and Basic conceptual representation of ASA emulsification unit is given in Figure-2.

Observations

Initial Change over

A change over from dispersed rosin to ASA was taken over by introducing ASA in increment and simultaneously reducing dispersed rosin without changing any other parameter at same PAC dosages of 9 kg/MT with back water pH of 6.4-6.6.

During the change over, paper quality parameters were normal and machine was running without any issue.

ASA at higher backwater pH of 7.1-7.3

After three days of change over when the system was running smoothly, the attempt was made to reduce PAC to increase the pH to alkaline side. Slowly the PAC reduced from 9.0 kg/T to about 5.0 kg/T and simultaneously soda ash increased from 1.25 kg/T to 2.5 kg/T to maintain the backwater in the range of 7.1-7.3. Machine was allowed to run at alkaline pH of 7.1-7.3 for about 25 days.

When backwater pH increased to 7.1-7.3 by reducing PAC and adding soda ash in pulp, the Cobb value at pope reel increased slowly which has forced to increase the ASA dosages from 0.85 kg/MT to 1.2 kg/MT to maintain Cobb value at 25 gsm.

The reason for fluctuation in Cobb value in paper at alkaline backwater pH may be the rosin entering into the system via common broke cleaning system. At lower pH this rosin may be contributing to sizing which is not effective at alkaline pH.

Table-6: Typical Cost Details of ASA sizing system

Particulars	Dispersed rosin sizing, Rs/MT	ASA at 7.0-7.2 pH, Rs/MT	ASA at 6.6-6.8 pH, Rs/MT
ASA	0	236.21	193.27
Cat Starch	0	115.14	96.96
PAC	80.26	40.95	73.72
Non ferric Alum	0	1.40	1.40
Defoamer	89.45	37.25	37.25
Soda Ash	15.51	31.02	18.61
Rosin	255.26	0	0
Total	440.48	462.00	421.21
Cost Increase Rs/MT		**+21.52**	**-19.27**

During the run at higher pH, many times the issue was tackled successfully by reducing the pH to 6.9-7.0.

Issue Faced with ASA sizing

There was a tendency of increasing first press felt vacuum from 360-380 to 410 - 420mm of Hg and felt cleaning was required at regular intervals otherwise it was creating problems of moisture belts in paper and breaks at paper machine due to crushing of paper.

This issue was studied in detail through plant trials of different felt conditioning program as well as on line felt washing systems. Finally it is concluded that felt conditioning program with lower pH along with higher pressure in felt cleaning shower to a level of 15 kg/cm2 help to keep the felt in desired condition.

Unit is now ready to switch over to alkaline sizing system on continuous basis.

CONCLUSIONS

Alkaline Sizing offers many benefits to the papermakers in terms of quality and cost. Some of these benefits are immediately evident and other may take some time to visualise and requires optimisation of system to its full potential. The selection of ASA and AKD as a sizing agent depends on the individual mill and paper machine conditions as the requirement of both products are different. But once the chemistry is understood along with the available process conditions and resources, alkaline sizing system can be successfully implemented.

Both the products have certain limitations as well as advantages. But for fine paper making, ASA is gaining popularity. The system can be implemented successfully with complete study of the system including furnish, process water quality, felt conditioning, ASA emulsion quality, retention levels etc.

In the initial phases, mill has faced lot of problems particularly at press section related to press roll coating, felt clogging. But as discussed above, a detail analysis of each and every parameter can eliminate the potential issues. With ASA, particularly hydrolysis of ASA has to be taken care of with best possible means and suitable treatment to be given for papermaking fabrics based on the requirement of system.

After a lot of efforts and production runs, mill is completely ready for change over to ASA sizing system.

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