Alkaline Sizing for Manufacture of Coloured Papers

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Alkaline sizing offers several advantages over the acid sizing process. While usage of alkaline sizing is very common for white varieties of paper, its usage for coloured varieties is a challenge particularly in India where the market demands many colours and within that many shades. This paper deals with our experience at SPB to implement alkaline sizing process with special reference to the manufacture of coloured varieties of paper.

INTRODUCTION

The Indian paper industry is rather unique. The paper machines are still small in size and the varieties made in each machine are many. Coloured varieties still constitute a major percentage in the product mix in many Indian paper mills and Acid sizing continues to be the main sizing process in most mills. While Neutral or Alkaline sizing process is well established and is generally adopted in mills outside India, most Indian mills till recently were not looking at alkaline sizing possibly due to lack of awareness of the benefits of alkaline sizing and it's high cost. Today, however, many paper mills in India including the smaller mills have switched over to alkaline sizing process. This has become possible due to commencement of manufacture of this chemical in India. In addition paper mills based on waste paper which inherently have $CaCO_3$ as filler, find the usage of alkaline sizing advantageous to reduce generation of foam during manufacture and to increase ash in paper.

Acid vs. Alkaline sizing process

As the name suggests acid sizing is done at acidic pH while alkaline sizing is done at alkaline pH. The primary difference between acid sizing and alkaline sizing process is that in the former case it is rosin and aluminium that are ionically bonded to each other and it is this precipitate that renders the fibres "hydrophobic".

In alkaline sizing process, the reactive sizes, namely Alkyl Ketene Dimer (AKD) or Alkenyl Succinic Anhydride (ASA) form a covalent bond between the hydrophobic molecule present in it and the cellulose of pulp fibre. Another difference is in the chemical structure of the hydrophobic part. This is in the form of fused aromatic ring in rosin sizing, whereas with reactive sizes, it is typically a long hydrocarbon chain of aliphatic origin.

Alkaline sizing offers many advantages like:

- Reduced corrosion
- Improved strength of paper
- Reduced fluff in paper
- Good smooth feeling on paper surface
- Stability of shade on aging
- Improved machine runnability
- Possibility to increase ash in paper
- Possibility to use $CaCO_3$

Trials at SPB

In SPB, the first alkaline sizing trial was done in the year 2000 in paper machine no.1 during manufacture of white variety. During the trial, the fibre furnish was 75% bagasse pulp and 25% hardwood pulp. Two problems were faced during this trial. One was the wide difference (6 to 7 gsm) of cobb sizing between top and bottom side of paper. Another was the poor fixation of blue dyes on paper as a result of which the desired shade of paper could not be maintained even after addition of more blue dye. The trial had to be suspended due to these problems.

Again in the year 2001, alkaline sizing trial was done in paper machine no.5. This trial was also done on white variety and the machine speed was nearly 800 mpm. The back water system in this machine is almost closed. The pulp furnish was 70% bagasse pulp and balance

Table 1 : Following is a comparison of acid and alkaline sizing chemical:

Parameter	Acid size	Alkaline Size (AKD)
Physical state at room temp.	Liquid emulsion	Liquid waxy emulsion
Purity	50%	6-15%
Shelf life at 90°F	6 months	3 months
pH requirement	4-5.5	Dependent (7-9)
Deposit potential	Medium/High	Low
Addition level	2-10kg/t	6-10 kg/t
Cure	Immediate	Slow
Slip	Increases friction	Yes at high dose
Foam	High	Low
Lactic acid resistance	No	Yes
Hot liquid resistance	Yes	No
Particle size of emulsion	-	1 micron
Size reversion	No	Will occur

was hard wood pulp. Because of poor machine runnability this was also abandoned.

Subsequently, several alkaline sizing trials were conducted in paper machine no.5 with AKD from different chemical suppliers. The problems generally faced were:

- Poor machine runnability
- Low and inconsistent one pass retention and ash retention values
- Poor drainability of stock
- Poor binding of fibre and filler fines with sheet
- High fluff generation of dryers

Very detailed discussions were held among ourselves and also with the suppliers. After extensive deliberations it was concluded that the problem is basically to select a suitable retention aid which will be compatible for our pulp funish as well as for the sizing chemical.

After several bench scale studies in our laboratory and also at the chemical manufacturer's research centres, a suitable retention aid was identified. Since then, this process is being used continuously in paper machine-5.

Importance of retention aid :

Retention aids are chemical substances that react, via a coagulation and/or flocculation mechanism with the paper machine stock fed to the paper machine to increase the retention of fibre, fibre fines, filler or pigments and other stock components to the paper web.

The coagulants are chemicals that prossess the ability to neutralize nagative charges (anionic) of various stocks ingredients. In acid sizing, alum acts as a coagulant, whereas, in alkaline sizing, retention aid chemicals like polyamines or Poly di-allyl dimethyl ammonium chloride (Poly-DADMAC) is used as a coagulant. Flocculants are soluble synthetic polymers. The main purpose of flocculants in the papermaking wet end is to agglomerate stock ingredients in a homogenous fashion, by a bridging mechanism.

Attention needed during Retention aid solution preparation and addition

- The retention aid addition must be as "constant" as possible.
- The quality of water used to make down the retention aid must be monitored and controlled. Polymers are rich in nitrogen and are a possible food for source of bugs.
- Flow and pressure of water used for making solution of retention aid must be kept under control.
- Management of 'Charge' is important for better retention results.

Environmental issues

From the environment point of view, the Chemical Oxygen Demand of machine back water was studied and found that, there is no adverse impact of this sizing process over normal acid and neutral sizing process. The same can be seen from the table given below:

Manufacturing of coloured paper at SPB with alkaline sizing process

Once alkaline sizing process was implemented in two of our machines successfully on white varieties, the operating crew developed confidence and it was decided to try on coloured papers.

While implementing alkaline sizing in white varieties offered fewer challanges, there was hesitation to try the same for coloured varieties. The fear was basically how the pH will affect the shade for which the customers are already used to Prior to taking the trial on the machine, discussions were held with several dye manufacturers and few bench scale trials were done at their laboratories as well as in our laboratories. From discussions and preliminary bench scale studies, it was concluded that, except yellow coloured and orange coloured paper, all other coloured varieties of paper (blue, green and pink) can be made with almost the same dye combination. The dosage also can be more or less same to obtain same shade.

In case of yellow and orange coloured paper, paper yellow (basic dye) and acid orange (acid dye) respectively are normally used in acid process, which are very sensitive to pH of the system. For these dyes, dye manufacturers recommended different alternate direct dyes. The cost of the alternate direct dyes, especially for matching yellow shade of paper however worked out to be very high compared to that cost of dyes being used in acid process. Moreover, in place of single dye (paper yellow), two direct dyes are to be used and at very high dose. Due to very high cost of dyes required for the manufacture of yellow coloured paper in alkaline sizing process, the same was not tried on the machine. Alkaline sizing has also not been tried in Orange coloured paper.

Observations of the Study

- Normally, the AKD sizing chemical is milky white in colour with a pH of 3.2 - 3.5 and total solids in the range of 16 to 20%.
- pH of wire water during the study was in range of 7.5-8.0.
- Cobb sizing of all paper roll samples were determined after curing in oven at 105°C for 5 minutes. Cobb sizing of all roll samples were in the range of 20-24 gsm. On machine (without curing in oven) the cobb sizing of paper was in the range of 50-60 gsm, which after 48 hours of atmospheric curing was found to be 22-24 gsm. No abnormalities were experienced with respect to sizing of paper.
- In alkaline sizing process, one-pass retention values have shown improvement compared to acid process. In case of ash, the improvement in one pass retention was significant.
- Following are the one pass retention values in alkaline and acid process for same grammage of paper
- Consumption of various dyes for manufacturing

Table 2 : Observations of the Study

Sizing Process	COD of machine back water, ppm
Acid sizing process	220-288
Neutral sizing process	240-280
Alkaline sizing process	220-296

Table 3 : Point of addition of various wet end chemicals during alkaline sizing

Chemical Name	Point of addition
Soap stone powder	Blending chest
Cationic Scavenger	Machine chest
Alkaline sizing (AKD) chemical	Fan pump inlet
Dyes	Blending chest
Retention aid chemical	Selectifier screen outlet

Flow diagram of acid sizing process (prior to conversion of alkaline sizing process) and alkaline sizing process (being followed at present) are presented below:

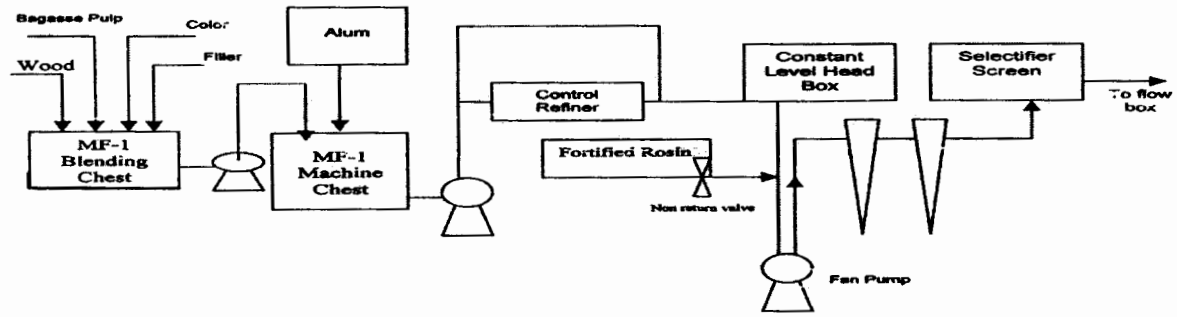

Fig.1 : Flow Diagram of Acid Sizing Process

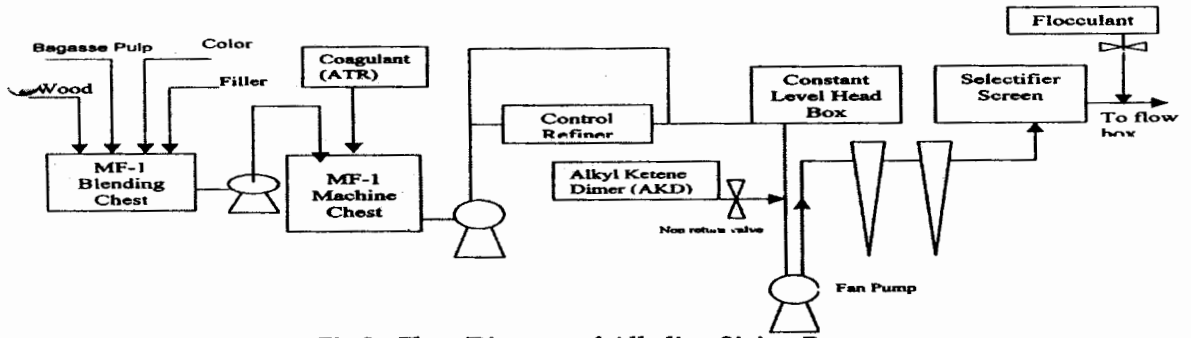

Fig.2 : Flow Diagram of Alkaline Sizing Process

different paper grades in alkaline sizing (AKD) process and acid process are given below:

The dye consumption data clearly shows that, there is no major difference in consumption of dyes between acid and alkaline sizing process.

- Following are the data of colour co-ordinate values obtained in various coloured varieties of paper manufactured in acid and alkaline sizing process:

As can be seen from the shade data, no problem is experienced in maintaining the shade of coloured varieties of paper in alkaline sizing process. Rejection due to shade variation in alkaline sizing process was comparable to that obtained during acid sizing process.

- In alkaline sizing process, in most of the cases, ash content in paper could be increased.
- Even with high ash content of paper, all physical strength properties of paper could be maintained at the normal level.
- Surface strength of paper (was pick value) increased in most of the cases by one unit with the alkaline process compared to acid process.
- Machine runnability and production rate during the study was found to be very normal.
- The study on pollution load in machine back water, revealed that, there is no adverse impact on environment with alkaline sizing process compared to acid sizing process.

Table 4 : Retention properties

one pass retention%	45 gsm paper		60 gsm paper		70 gsm paper	
	Acid Process	Alkaline Process	Acid Process	Alkaline Process	Acid Process	Alkaline Process
Solids	61-63	69-77	70-76	77-79	80-84	85-87
Ash	24-25	33-39	34-37	42-47	44-49	52-54

Table 5 : Consumption of dyes per tonne of paper

Dyesused	Acid sizing process	AKD sizing process
(A) Ledger paper (blue)		
Violet dye	300 g	275 g
Blue dye	250 g	250 g
(B) Colour Ptg (blue)		
Blue dye - 1	1.4 kg	1.4 kg
Blue dye - 2	0.8 kg	1.0 kg
(C) Colour Ptg (Green)		
Green dye	2.0 kg	2.0 kg
Auromine	20 kg	20 kg
(D) Azure laid (Green)		
Blue dye	35 g	35 g
Auromine	60 g	60 g
(E) Colour Ptg (Pink)		
Red dye	1.2 kg	1.2 kg

Table 6

Particulars	Acid sizing process			Alkaline sizing process		
	L-value	a-value	b-value	L-value	a-value	b-value
Ledger paper (blue)	85.64to80.04	-1.93to-2.50	-2.54to-3.86	85.69	-2.12to-2.45	-1.98to-2.52
Colour Ptg. (blue)	79.15to80.04	-5.51to-6.53	-9.80to-10.97	79.98to80.96	-6.74 to -7.32	-9.50to -11.01
Colour Ptg. (Green)	84.88to85.21	-19.30to19.21	-1.52to-1.88	84.54to85.34	-18.69to-19.55	-1.41to-1.98
Azure laid (Green)	90.56to90.81	-9.68to-9.99	-7.91to-8.59	89.88to90.04	-9.36to-9.67	-8.36to-8.61
Colour Ptg.	76.61to83.11	22.46to32.67	-0.57to-2.52	75.41to82.94	22.20to33.21	-0.64to-2.26

- We face the following problems with AKD sizing process:
  - whenever sheets are stacked on a pallet. they tend to slip.
  - Occasionally customers complain that more than one sheet is picked (due to sticking of sheets) during sheet fed printing.
  - Moisture in sheet is very high off size press and paper breaks are experienced when compared to acid sizing.

In General

The cost of alkaline sizing including the cost of retention aid is comparable to acid sizing cost, thanks to improved retention and increased ash in paper.

CONCLUSION

At SPB, we have implemented alkaline sizing for manufacture of most of the coloured varieties on a regular basis. The key seems to be the identification of a retention aid compatible for the pulp furnish and sizing chemical and working closely with dye manufacturers to identify the right dye combination and fixation of dosage. There are several advantages in using alkaline sizing as detailed in the article.