Experiences in Alkaline Sizing of Paper

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ABSTRACT

In an effort to achieve improvement in optical properties especially brightness and whiteness required to meet the growing demands of domestic and global markets with the high bright pulp available, APPM took up trials with Alkaline and Neutral sizing chemicals. It has been the first mill in India to dedicate one machine for the production of different grades of writing and printing papers in Alkaline sizing from the year 2000 onwards. Since then trials for other sizing systems are continuing. Some of those experiences are presented in this paper.

INTRODUCTION

Alkaline sizing of paper is adopted to improve the brightness, strength properties and permanence of paper compared to acid sizing. In rosin sizing fortified rosin and alum / Poly aluminum chloride (PAC) are used to impart the water repellency to paper and the paper is made at a pH of 4.0-4.5. The acidic nature of aluminum compounds used in rosin sizing and the lower pH maintained during papermaking generate acidity in paper. On prolonged storage, this residual acidity will gradually increase due to reaction of acidic compounds in paper with atmospheric moisture and adversely affect the appearance and permanence of paper. To avoid this deterioration on storage, Neutral sizing (a sizing process with dispersed rosin and reduced alum usage) or Alkaline sizing (cellulose reactive sizing without / with slight alum usage) have become of importance.

Besides eliminating / reducing usage of aluminum compounds, use of calcium carbonate as filler is possible in alkaline sizing which will not only help in improving the brightness of paper due to high brightness of calcium carbonate compared to talcum but also buffer the acidity generated on storage of paper and hence will improve permanence of paper.

For the first time in the country, APPM in the quest to make higher brightness and whiteness papers has taken trials and regularized AKD sizing in writing and printing papers since the year 2000. Trials with other sizing systems were also taken up. This paper will present those experiences.

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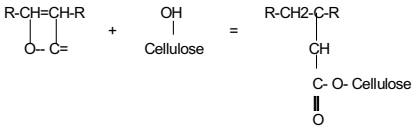
Alkaline sizing with Alkyl Ketene Dimer (AKD):

Alkaline sizing with AKD and ASA differ in the basic chemistry of the additive but both are cellulose reactive additives. AKD is basically a Ketene dimer with substitution of alkyl groups of carbon number C14-C16. The basic chemistry of the AKD with cellulose molecule is given hereunder.



The unsaturated bond in AKD forms a covalent bond with cellulose and hence is known as reactive size. In AKD sizing besides AKD, Fixing agent, Retention aid are also used.

Unlike alum rosin bond which forms in the wet end itself and cures in the drier of machine, the reaction of AKD and cellulose will take place in the paper machine drier section. Also the sizing continues to develop after paper is made and full sizing is obtained only after 8-24 hours depending on the nature of the AKD and the machine conditions. Retention aid serves the purpose of retaining the AKD in pulp and fixing the same on to furnish components till it reaches the drier part. It will also minimize the AKD required for sizing. In some instances depending on the type of pulp (which may be highly anionic due to anionic trash associated with the pulp) a cationic fixing agent is also used to neutralize the anionic charge of the pulp and improve fixing of AKD on to fiber. The strong covalent bond formed by AKD will help in hard sizing.

Due to slow curing of AKD in paper making, to monitor the chemical doses to get required sizing and Cobb, accelerated curing of the paper is done before testing. For this paper sized with AKD is to be cured in an air oven at 105 ° C for about 15-20 minutes and then conditioned before testing for sizing.

Emulsion stability-AKD is supplied as ready to use aqueous emulsion which is in general of 15% solids and will have limited shelf life (about 3 months) depending on the temperature of storage and emulsifier used in the preparation.

System pH above 6.5 is sufficient but good sizing is achieved at 8.5. Alkalinity of back water system increases sizing efficiency. When calcium carbonate is filler it acts as buffer and pH will be in the range of 7.5-8.5.

General advantages of AKD sizing are-

a) Less corrosion due to elimination of alum
b) Clean machine once the dosing and additive levels are optimized.
c) Possibility of improved recycling of machine backwater due to less concentration of sizing chemicals compared to rosin sizing.
d) Improvement in brightness and strength properties

In consultation with suppliers technical team and after studying the sizing and paper making system the following points were considered for AKD conversion trials by APPM :

1. Addition of a fixing agent to the pulp of highly anionic charge to reduce the charge

AKD sizing additives and some of their dosing points:

Additive	Solids,%	Shelf life	Nature	Preferable dosing point
Fixing agent (Optional)	Powder /Liquid	12/ 6 months	Cationic, High charge	Refined pulp
AKD	15	3 months	Cationic	SR Box accepts / Pressure screen inlet
Retention aid	Powder/ Liquid	12 /6 months	Low charge, Medium molecular weight	Pressure screen inlet / outlet
Size press additive	Liquid	3-6 months	Anionic Styrene Acrylic copolymer/ SMA	Size press

2. Addition of AKD as late as possible nearer to Head box e.g.: SR Box accepts (thick stock) or PCC accepts (thin stock) but before filler addition to avoid excess consumption by filler which have more surface area than fibers
3. Addition of retention aid to retain the fines, fillers and AKD along with pulp till the sheet reaches the drier and forms bond
4. Proper slimicide program to prevent biological slime growth which will enhance the deposit problem
5. Use of surface sizing agents to reduce the requirement of wet end AKD to achieve the desired Cobb and sizing.
6. Use of filler levels to suit the sheet strength and avoid the excessive filler levels in white water by maintaining suitable first pass retention.

However, these addition points differ from machine to machine and are to be fine-tuned. Use of fixing agent is optional depending on the anionic charge of the incoming pulp.
Experiences in AKD conversion:

1) Sticky deposits on the machine elements like head box, suction boxes and press rolls due to hydrolysis of excess AKD in white water resulting paper breaks and affected machine runability. To overcome the problem periodic inspection of drainage elements, press section etc was done to identify deposit buildup before problem aggravates. Excess dose of AKD to correct the disturbance in Cobb some times made paper slippery. Use of size press additive and reduction in wet end AKD usage helped to overcome this problem.

2) Nature of slime to find out their source viz., chemical slime or biological slime and presence of fillers with sizing chemicals in slime deposits were addressed by adjusting slimicide dosages to reduce biological slime. Combined studies with the help of suppliers of AKD and slimicides helped to identify the problem and fine-tune the dosing of required additives.

3) More number of boilouts compared to acid sizing. When GCC/ PCC is used as regular filler one acid boilout is required to remove the carbonate deposits for every three alkali boil outs. In APPM talcum is used as regular filler and use of GCC is in certain grades only which reduced the acid boilout requirement.

4) Additional steam requirement in higher substance papers for drying after size press due to higher pick up of size solution as the on machine size development is not there with AKD.

5) Suitable retention aids were identified for each AKD system to arrive at optimum first pass retention and first pass ash retention levels for good runability. However, the retention values are machine, filler and grade dependant.

6) Higher consumption of AKD sizing chemicals in highly filled papers and in papers with surface sizing pigments compared to Unpigmented papers.

Factors that helped for good runnability in AKD -

1. Boilout at frequent intervals
2. On line filters before additive dosing pumps and periodical cleaning of the dosing systems to avoid additive deposits

Benefits achieved with AKD sizing

1. Improvement in optical properties by about 2.5 - 3.5 units with accompanying improvement in whiteness
2. Use of GCC as filler in certain grades
3. Improved efficiency of Optical brighteners in improving whiteness and tint and reduction in OWA consumption
4. Improved printing performance of paper especially Inkjet printability
5. Sizing cost reduction: Initially the AKD sizing is costlier compared to rosin sizing due to more number of sizing chemicals and non availability of those additives indigenously. However, over a period of time, the cost reduced due to the availability of the sizing chemicals indigenously at lower prices.
6. Reduction in defoamer usage due to less foam generation compared to rosin sizing.

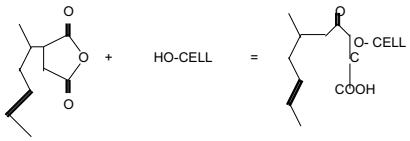
Adverse effects due to AKD sizing

1. Increase in boilout frequency (from 45-50 days in acid sizing to 25-30 days with AKD)
2. Increase in slimicide program cost due to more slimicide usage
3. Increase in steam consumption in higher grammage
4. Limitation to run size press where pre sizepress moisture is more (machine specific) and not suitable for required size solution pickup.

Alkaline sizing with Alkenyl Succinic Anhydride (ASA)

ASA, another cellulose reactive size was tried due to it's on machine curing property which is advantageous for size press operation resulting in less steam requirement in post size press drying compared to AKD. Also shelf life of ASA is higher compared ready to use AKD emulsion.

The reaction of ASA with cellulose is as below



APPM has taken trials to establish the benefits vis a vis AKD being used and the initial mill trials have shown that -

1) Unlike in AKD sizing, small quantity of alum / PAC is to be used in ASA to avoid the stickiness of ASA . This reduced the improvement in brightness compared to AKD

Additive	Active matter, %	Shelf life	Nature	Preferable dosing point
Fixing agent (Optional)	Liquid /Powder	12 /6 months	Cationic, High charge	Refined pulp
ASA	100	Unlimited	Liquid, Sp.Gr. 0.94-0.98	Fan pump inlet (thick stock before filler)
Emulsifier	20±1	3-6 months	Cationic, High charge product	
Retention aid	Powder/ Liquid	12 /6 months	Low charge, Medium molecular weight	Pressure screen inlet / outlet
Alum	Liquid	--	Acidic	Backwater channel
Dry Strength Resin	Liquid		Amphoteric charge	Machine chest as per requirement
Size press additive	Liquid	3-6 months	Anionic Styrene Acrylic copolymer/ SMA	Size press

2) Onsite preparation and dosing of ASA emulsion due it's less shelf life (less than 4 hours)
3) Requirement of costly and sophisticated emulsification equipment which requires more care and skill in preparation and handling of emulsion
4) Excessive dosing of ASA to correct sizing loss results in hydrolysis and deposits of ASA which is more severe than AKD
5) Press picking /deposits on press rolls is a serious problem with ASA. This requires frequent cleaning of press rolls or continuous cleaning of roll surface by providing flow of suitable chemicals for good runability.
6) Runability problems are more in lower gsm papers compared to higher gsm(>70)
7) Expected 100% cure of sizing on machine could not be achieved.
8) Economics of ASA sizing are yet to be confirmed.
9) Efficiency of OWA is lower with ASA compared to AKD.

In ASA sizing alum is used to prevent the stickiness of hydrolyzed ASA in back water and slight amount is used in ASA emulsification also to improve emulsion stability. DSR is used only if the cationic charge of the system is higher after the additives and in some cases it may help in improving the strength of the paper. Use of size press additive may help in reducing the wet end ASA requirement to get the target cobb and also reduce deposit problem but the same was not yet tried. Use of fixing agent is optional depending on the anionic charge of the incoming pulp.

Different additive used in ASA sizing and the dosing points tried are given above. However, these addition points differ from machine to machine and are to be fine-tuned.

CONCLUSION

With AKD sizing in comparison to rosin sizing, there is an improvement in brightness by about 2.5-3.5 units for different grades of papers with corresponding increase in whiteness. Also the effectiveness of Optical brighteners increased due to absence of alum.

With ASA compared to AKD, improvement in optical properties is less which may be due to the presence of alum in ASA system. Also fine tuning of the preparation and dosing of the ASA emulsion and addressing of runability problems by proper adjustment of machine parameters is required.

In a nutshell, APPM's experience in Alkaline sizing with AKD and ASA shows that among the two, AKD is more easy to adopt and suitable for writing and printing papers compared to ASA. In case of ASA more care is required in the onsite preparation of ASA emulsion.

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