Alkaline Sizing- A Case Study

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ABSTRACT

To sustain in the competitive market, it is inevitable to up-date the quality of product on a continual basis. In this direction, APPM has introduced alkaline sizing in one of its machines # 3, in 1999. During the change over from acidic paper making to alkaline paper making system, APPM has to encounter many operational problems but, with the constant encouragement from the management, technical support rendered by chemical suppliers and the dedicated spirit of the technical team, APPM was able to solve the problems through experience and guidance from different sources. This paper deals with some of the major problems encountered and the solutions enolved for murmounting the same.

INTRODUCTION

Internal sizing is an important step in the wet end operation of the paper machines. The purpose of the sizing is to modify the surface of paper to control water penetration as the fibres in the paper are very hydrophilic (water loving). Sizing is done either to limit the pick up at the size press and coaters or to render the final product water, ink and other aqueous liquids resistant. The sizing agent inhibits or controls the penetration of liquids (aqueous). The liquids can penetrate paper in two ways. Interfibre penetration is fluid penetration through the pores or spaces between the paper fibres and intrafibre penetration is fluid penetration through the fibres themselves. The sizing agent inhibits this penetration by providing a low surface energy layer on the paper fibers, which tends to repel the high surface energy liquids. In order to effect in this function, the molecules of the sizing agent must be well distributed throughout the paper structure and firmly anchored to the fibre surface. Also the sizing process must be controllable.

Types of internal sizing

Basically internal sizing can be categorized into three types based on the pH of sizing system operation, viz., Acid sizing, Neutral sizing, Alkaline sizing.

Acid sizing

In acid sizing, rosin is by far the most widely used internal sizing agent. In the past, mills used to prepare their own rosin size. But of late, ready made fortified rosin either in powder or liquid form are availabe for use. In acid sizing, the alum chemistry plays a very important and critical role in imparting sizing property to the paper/board. At low pH (< 4.0), the aluminum exists as a soluble ionic species, but as the pH is raised, a colloidal hydroxylated alum floc forms. At higher pH values (> 7.0), the alum flocs tend to redissolve and soluble aluminate is formed. As alum floc is a cationic material, it has affinity for anions such as anionic rosin particles, and fibre, fines, and fillers. Thus, alum serves as a precipitating and anchoring agent for the size and also serves as a retention aid for fines fillers, and dyes, improves drainate etc. Best sizing is generally achieved in 4.0-5.0 pH range. However, this depends upon indiviual mill operational conditions and furnish etc.

Neutral sizing

Now sizing systems are available which are rosin based and still effective in the pH range of 6-7. The hydrophobic ingredient in the neutral sizing is inherently non-ionic that is they hold no charge, and hence would not be greatly attracted to the cellulose fibres. By incorporating sepcially desigend polymers into the sizing chemical, it is rendered non-ionic. This helps to use chalk (calcium carbonate) with rosin sizing and levels of alum gives the paper makers some of the benefits of alkaline paper making i.e., higher filler loadings, reduced fibre costs, greater permanence and less corrosion. Because of alum usage, reduced press picking and better drainage, helps the productivity. However, greater attention has to be paid to the wet end and its chemistry in order to optimize the chemical consumption and overall economics. Though, polyaluminium chloride (PAC) is another source of aluminium species, its usage is still not widely accepted.

Alkalien sizing (Cellulose reactive or synthetic sizing agents)

In the mid eighties, alkyl ketene dimer (AKD) emerged as the promising reactive sizie for alkaline paper making. However, by nineties, another size, alkenyl succinic anhydride (ASA) also started competing with AKD as one of the major synthetic sizing agent, available for neutral and alkaline paper making i.e., in 6-9 pH range.

AKD VS ASA

AKD

AKD is derived from the waxy fatty acid. The AKD is known to be reactive to cellulose and hence slow in size development. Further, AKD is less tolerant to the presence of alum. Though AKD scores the benefit of simplicity of handling, it is known for certain shortcomings viz., slippage and higher static current in final product and difficulty in assessing the sizing off the machine, unless do the heat curing test.

ASA

ASA is a petroleum based oil. Because of its high reactivity, the diluted emulsion shelf life is very short, i.e., for few hours, while concentrated undiluted shelf life is unlimited, if properly sealed and preserved. During emulsification, a cationic carrier, usually, cationic starch or any compatible synthetic cationic polymer is added to ASA. This facilitates quick size development and lower chemical consumption. However, the chemical consumption depends upon individual mills fibre furnish, anionic trash content, wet end configuration etc. With ASA, the main disadvantages are requirement of on-site emulsification and short shelf of ASA. Both the synthetic sizing agents react chemically with cellulose to form a hydrophiobic or water resistacne substrate. The cellulose-sizng bond is highly resistant to hydrolysis.

The efficacy of the chemical depends upon how efficiently it is distributed and retained in the wet web. Hence, naturally a retention aid is a compulsory requirement. Size development occurs in the forward drier section. Poor retention or poor sheet formation will lead to carry over of the back water system and thereby size deposits and poor sizing and specific consumption figures.

Why APPM preffered AKD sizing?

In tune with the changing demands of the customers for high bright papers with more whitness and fluorescence (glow), after few initial trials, with rosin based neutral sizing chemicals, APPM has taken a pragmatic decision of converting one of its paper machines i.e., #3 (ANUJA) to alkaline system of paper making from conventional acid sizing system in 1999. As AKD is easily adoptable compared to ASA as detailed in the earlier part, APPM opted to AKD for alkaline sizing. Before taking up of plant scale trials, number of lab scale experiments were conducted to identify suitable retention and fixing agent and sequence of chemical addition and also to get an idea about chemical consumption to work out preliminary techno-economic feasibility. In consultation with the AKD suppliers, APPM has worked out the sequence and point of addition of chemicals and finally evolved the system as depicted in Fig. 1.

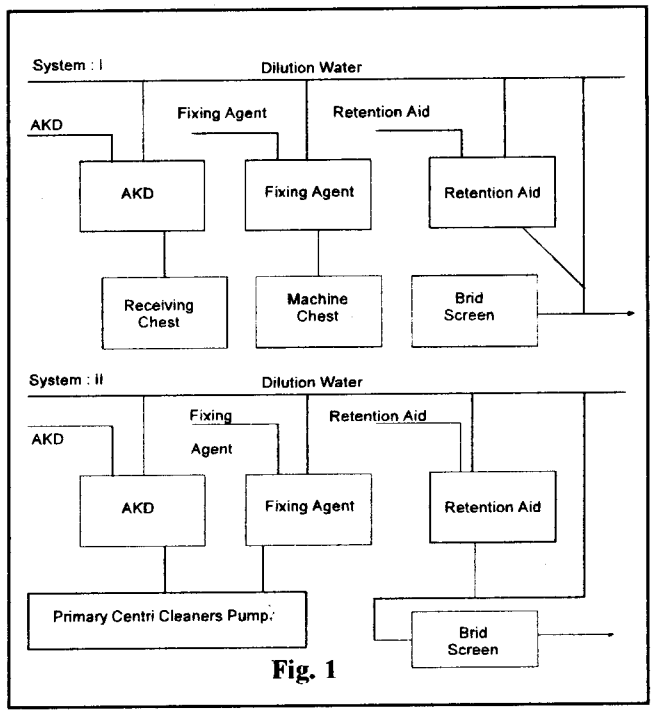

Fig. 1

Problems encountered

As any new process introduction brings in certain teething troubles, and the chemical suppliers too new to the Indian fibrous furnish and paper making systems, naturally, APPm has to face certain operational problems like -

- Paper surface defects like spots and tiny holes
- Paper breaks at press part after a couple of months continuous usage of AKD chemicals.
- Increased slime growth.
- Non-suitability of conventional basic and direct dyes, especially in coloured paper manufacturing.
- Handling and mointoring of three component sizing system in place of conventional two component sizing system.

Problems Solved

Paper Defects and Breaks

After through analysis and testing of the spots in In-House

R&D and at reputed external laboratories, the spots were traced to be retention aid.

To overcome this problem, the frequency of system cleaning (boil out) was increased from once in a month to thrice in month and also introduced slime deposit control program suitable for alkaline system. But, as the problem of paper breaks continued and causing serious concern, finally elimination process was adopted by stopping the identified problematic retention aid.

Though the machine runnablity could be brought to the normal level of operation, stoppage of retention aid resulted in higher AKD consumption and thereby the over all sizing cost escalated by about 6%. However, we could be able to contain the overall chemicals cost by stopping the slime deposit control program, which is no more required.

Slime growth

By regular mointoring of total bacterial count once in a month and detailed discussions with reputed slime control chemicals suppliers, APPM has evolved a slime control program compatible to APPM alkaline paper making process.

Non-suitability of Conventional Dyes

As most of the basic as well as direct dyes are pH sensitive w.r.t. hue and tint, In-House R&D studies were conducted prior to change over of the system to alkaline. The studies revealed that to manufacture deep coloured papers in alkaline medium is not economically viable, as the special dyes suitable for alkaline medium are very prohibitively expensive and to be imported. Hence, it was decided not to manufacture deep coloured papers with AKD sizing.

Change over from Alkaline to Acid and vice Versa

In spite of initial apprehension regarding the intermittent change over from acid to alkaline and vice versa, no serious problems were experienced, if the change over is from acidic to alkaline after through boil and out and alkaline to acidic even with out boil out.

Handling and monitoring

To make dosing system more user friendly and minimize the unnoticed stoppages of individual chemical dosing pumps, a foll proof dosing system with slarms for failure of any pump and also with required chemicals filtering and on-dilution facilities were provided in consultation with the respective chemical suppliers.

Broke handling

As the broke having GCC as filler is not very high, no serious problems were encountered in broke handling system.

Training

To make the operating crew competent enough to handle the new chemicals dosing system including the safety aspects all the concerned were trained with the help of the respective chemical suppliers. Internal shop floor training sessions were conducted to make the operating crew conversant with the process variables in new alkaline system (Paper making).

Sizing testing

As the development of sizing property found to take place only after a minimum period of 24 hrs., to have a quick check on sizing property, quick heat curing method of testing (curing at 115 + /- 5 ^{0}C for 10 minutes) was introduced, by providing an air oven on the shop floor.

Benefits Derived

Though, the overall sizing chemicals cost has increased by about two fold over conventional rosin-alum sizing chemicals cost, APPM could achieve the following quality improvements, which helped APPM to sustain in the current competitive market.

- Higher brightness with more whiteness and glow lesser brightness reversion. APPM could achieve paper brightness to a level of 90-92% (ISO).
- Utilization of calcium carbonate (GCC) as filler in some of the premium products, which helped to meet the required end use functional properties.

CONCLUSION

Choosing a right type of retention aid and suitable points of addition of different chemicals and close monitoring of overall retention (fibre and filler) will help to optimize the overall alkaline sizing chemicals consumption with cost effectiveness. Difinitely, alkaline paper making helps to improve the optical properties of paper. The optical properties are one of the vital criteria besides the competitive price for product (paper/board) selection by the customer. Change over from acidic to alkaline system should be a systmatic approach with lots of ground work, lest it may create new operational problems.

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