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"Charge Neutralization for Deposit Control"

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ABSTRACT

As the paper market becomes more and more competitive, more mills will want to switch to alkaline papermaking to take advantage of the growing demand. Many papermakers have tried to do this without success in the past, much like the American papermakers did in the late 1970's. The problem is that runnability problems occur, drainage slows, presses pick, drying becomes more difficult, and sheet quality suffers as a result. Sheet holes and breaks occur, and runnability becomes a real operating problem. Converting to alkaline papermaking is not as simple as turning off the alum. We must be aware of the numerous functions that alum served at acid pH, and provide alkaline alternatives. It is the purpose of this paper to discuss methods of deposit control via charge neutralization and system control at alkaline pH. This article explains the concept as well as the measurement and control. The resultant benefits are seen in runnability, quality and profitability for the papermaker.

KEYWORDS

Coagulation, charge measurement, charge neutralization, cationization, colloidal impurities.

INTRODUCTION

Competition in the Korean fine paper market is increasing every day, and the papermaker needs to provide his customer alkaline paper with quality as good or better than the old acid grades. Even newsprint manufacturers are aware of the advantages of neutral paper manufacture and ash loading, but have not been comfortable with the operating difficulties they experience when attempting to supply this high quality market segment.

A recent article in the TAPPI Journal [Schneider, 7] indicates that fears of a paperless society resulting from the phenomenal growth of computer sales here and elsewhere are largely groundless. The major change resulting from this growth has been the contribution of tons of instruction books and carton material as well. Any reductions in the use of writing paper have been far overcome by increases in the use of PPC paper for home and office printers and modern PPC fax machines. The TAPPI author expresses the same views about the European marketplace. He feels that print and electronic media will be working together in a symbiotic relationship, enhancing the business of both groups.

PRODUCTION vs. WET END CHEMISTRY

Korea's papermakers will soon be looking to run their machines faster, and without the holes and breaks normally associated with greater speed. Literature written by Asian papermaking experts [1,2] have recently begun emphasizing the need for charge neutralization at the paper machine wet end in order to increase first pass fiber and ash retention without the usual effects of poor formation, sheet crushing, and sheet defects, holes and breaks. To those manufacturing paper at acidic pH, this is not as much of a problem, because alum is in use as a coagulant/charge neutralizer. But as the global paper marketplace continues its alkaline conversion, more customers of Korean papermakers will be demanding alkaline paper. Alum is not soluble at neutral pH, nor is it cationic. In excessive quantities, aluminum hydroxide deposits form on the paper machine and in the wet felts. Recycled papermakers purchasing their raw materials from outside Korea are also finding acidic papermaking more and more difficult with the increasing incidence of $CaCO_3$ in that fiber. Alum reacts with $CaCO_3$, evolving CO_2 and causing large quantities of foam. The remaining reactant is the somewhat soluble $CaSO_4$, which is unpredictable at best. Deposits occur throughout the paper system, and machines run with holes and breaks until they are forced to shut down for a boilout. Something must be found to replace alum that actually works at neutral to alkaline pH.

OPERATING DIFFICULTIES

As more paper is manufactured at neutral to alkaline pH, operating problems increase, because not enough attention has been paid to the function that alum served at acidic pH.

1. Machines have difficulty operating at design speeds because drainage slows and dewatering is more troublesome.
2. Increasing the ash content in the sheet is an option that was evaluated, but retention was difficult, and deposits occurred.
3. Running at higher headbox consistencies is attempted, but sheet formation is not acceptable, and more deposits occur on the machinery and in the paper.
4. Increasing the press loading causes sheet crushing and felt filling.
5. Drying, the most expensive part of the dewatering process, is also more demanding.

Many papermakers around the world have returned to acidic papermaking as a result of these difficulties.

All neutral to alkaline papermaking materials not otherwise modified tend to be anionic, whether naturally or only on their outer surfaces. Anionically charged materials are surrounded by electrical fields which are larger or smaller dependent on the level of the charge. The fields are naturally repulsive to one another, just like identical magnetic poles. The fields also occupy space, meaning particles cannot approach one another for convenience in small particle (colloidal) retention in particular. The space is filled with "bound water", water which does not normally drain away on a paper machine or even in the press section. It must be evaporated: hence the drying problems reported above.

The proper and judicious addition of synthetic coagulant reduces the size of these fields, releasing their bound water and allowing the particles to more closely approach one another, where Van Der Wahl's and other attractive forces can begin to operate. Please see the graphic explanation in **Figure** 1. Colloids are now able to attach to fiber surfaces, promoting better distribution throughout the formed sheet, enhancing final quality and reducing operating problems. **Figure** 2 is a graphic representation of the effect of colloidal size on fine particle retention. This concept has been proved in many applications, notably pitch control and coated broke processing.

CHARGE NEUTRALIZATION

While the non-neutralized system is well dispersed, retention is more difficult because fibers and other particles repel one another. Even paper machines assisted by synthetic retention aids cannot properly retain anionic impurities and other colloids in the furnish except by the filter pad retention mechanism, which causes two-sidedness, so white water solids increase. Dispersed particles circulate throughout the system, and agglomerate at points of shear and other shocks, causing deposition throughout the system, followed by sheet defects and breaks.

Every papermachine retention program should include coagulation in the process, or the flocculant will very probably never be optimal. In acidic papermaking, alum provided the cationic charge to neutralize and coagulate the furnish for good retention. These high surface area systems provide ideal conditions for microbiological growth as well, so bacteria are rampant. The time between washups and boilouts is naturally decreased. As the papermaker realizes the importance of neutralizing these charges, he wants to be able to measure them for routine control of the papermaking process. This is not as easy as it sounds.

CHARGE MEASUREMENT

Gratton and Pruszynski [3] have explained the intricacies of the process in their presentation before the Canadian Pulp & Paper Association last year. In general, though, they explained that zeta potential has the drawback of measuring only particulate charge in the system, different particles will give different results and no effect of soluble charge is determined or noted. The results are variable as a result, and are operator and technique dependent. The CTR Technique, currently used in many Korean mills, can provide very helpful information, but does not take into account the rate of charge decay with time, nor can it overcome the problem with endpoint determination in colored stocks. The method, though, does allow for measurement of total and soluble charge. The newest and most generally applicable method uses the PCD unit from Mutek, but still has the drawback of not differentiating between different components in a mixed stock. It is important NOT to use the initial potential reading (mV), as it is dependent on too many external influences. All samples should still be titrated, just like those in the CTR method, but the instrument removes a lot of the human problems with the CTR method.

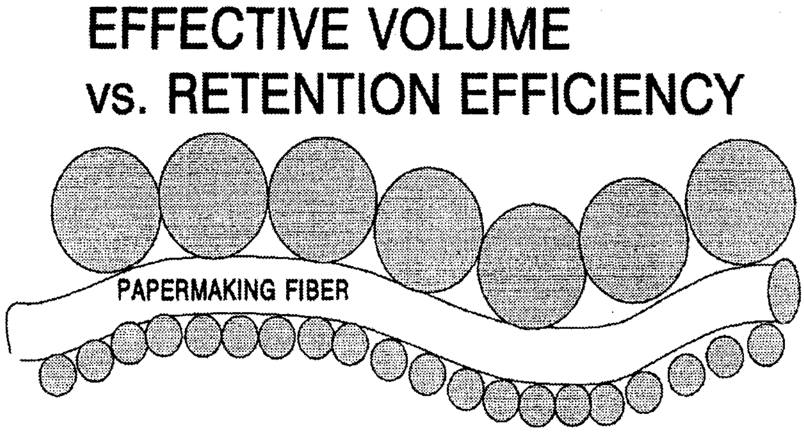

Figure 2. Colloidal particles that are closer to the fiber have a greater force of attraction and a better chance of being retained in the final sheet.

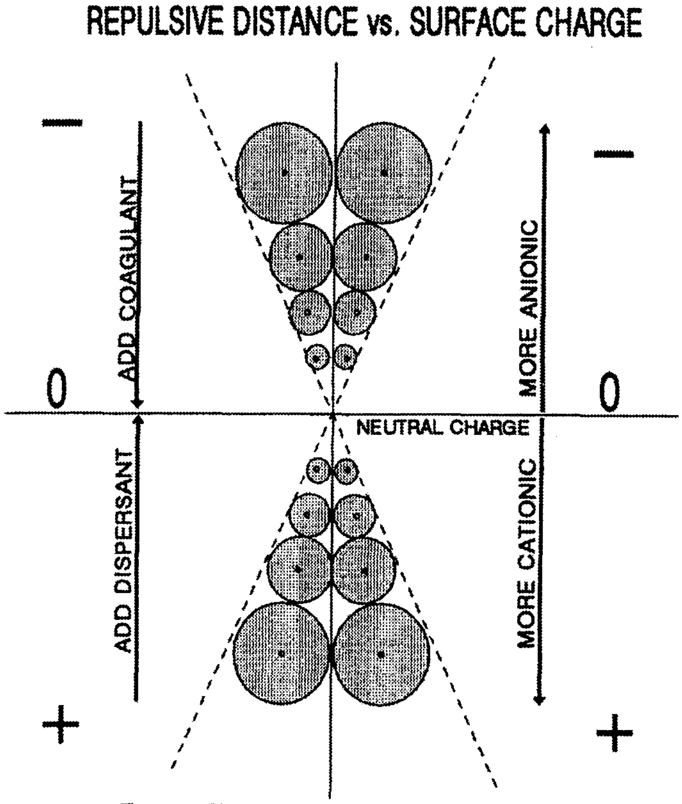

Figure 1. Higher charged particles have a larger effective volume, keeping particles farther apart.

CONTROLLING THE SYSTEM

There are many different anions in the papermaking system, depending on the grade of paper being manufactured, the closure of the system, the extent of recycled and mechanical fiber in the furnish, and the level and type of additives used to provide end-use properties to the paper. It is best to prepare a system charge demand map during a period of good running, so that comparisons can be made when poor running occurs. Beginning at the pulper or the individual furnish stock, both total and soluble charges should be run all the way through the system to the headbox and whitewater. This map will show the larger anionic influences on the papermaking system, and the effects of various additives on that charge as well. Experience shows that the best papermachine performance is usually experienced when the charge at the headbox is neutral to very slightly anionic, though the ultimate measure is the runnability of the paper machine and the cleanliness of the wet press. Usually, the best way to gain charge control is to provide the system with a high charge density cationic material that performs the function alum used to have in acid papermaking.

The feed point(s) and rate(s) will depend on the system in question. Cantrell and LeFevre [4] explained the technology and reasoning behind the selection process. Since anionic materials in the system could come as a result of pulp mill carryover, natural pitch, recycled contaminants, components of broke, or even raw water contaminants, there will be various and perhaps multiple ways to achieve consistent control over the headbox charge of the system, and should be the object of a comprehensive and thorough study.

EXAMPLES

Coated broke is a negative influence on the manufacture of grades like Art Base, LWC, and other coated grades. An American coated paper manufacturer utilized charge control concepts in his coated broke system with a Nalco coagulant, and increased his net profits by $US 280,000 per year without changing quality through reducing down-time for machine cleanups. He also found that he dramatically reduced his machine down-time to clean the wet press, and got better sizing efficiency in the sheet. Please see the graphic explanation in **Figure 3**.

A light weight coated (LWC) papermill was experiencing latex deposition on the paper machine wire and drainage foils. Different types and levels of dispersant materials were tried without benefit. Even talc was unable to provide any help, because the system was too highly anionic from the ash, dispersants, coating starch and latex, and fiber fines in the system. The addition of a Nalco coagulant to the primary source of the anionic charge, coated broke, greatly reduced deposition on the paper machine and enhanced first pass retention (FPR) and first pass ash retention (FPAR). Down-time for cleaning was reduced from 4% of running time to only 0.5%, increasing machine productivity as well. This is real deposit control.

A Canadian newsprint manufacturer removed pitch dispersant from his paper machine and enhanced quality and runnability by using a high charge density cationic solution polymer from Nalco to reduce the anionic charge in his groundwood system and allow attachment of pitch to the fiber fines while they are still colloidal. The result in the final sheet was better printability due to a 20% increase in natural sizing.

FIGURE 3

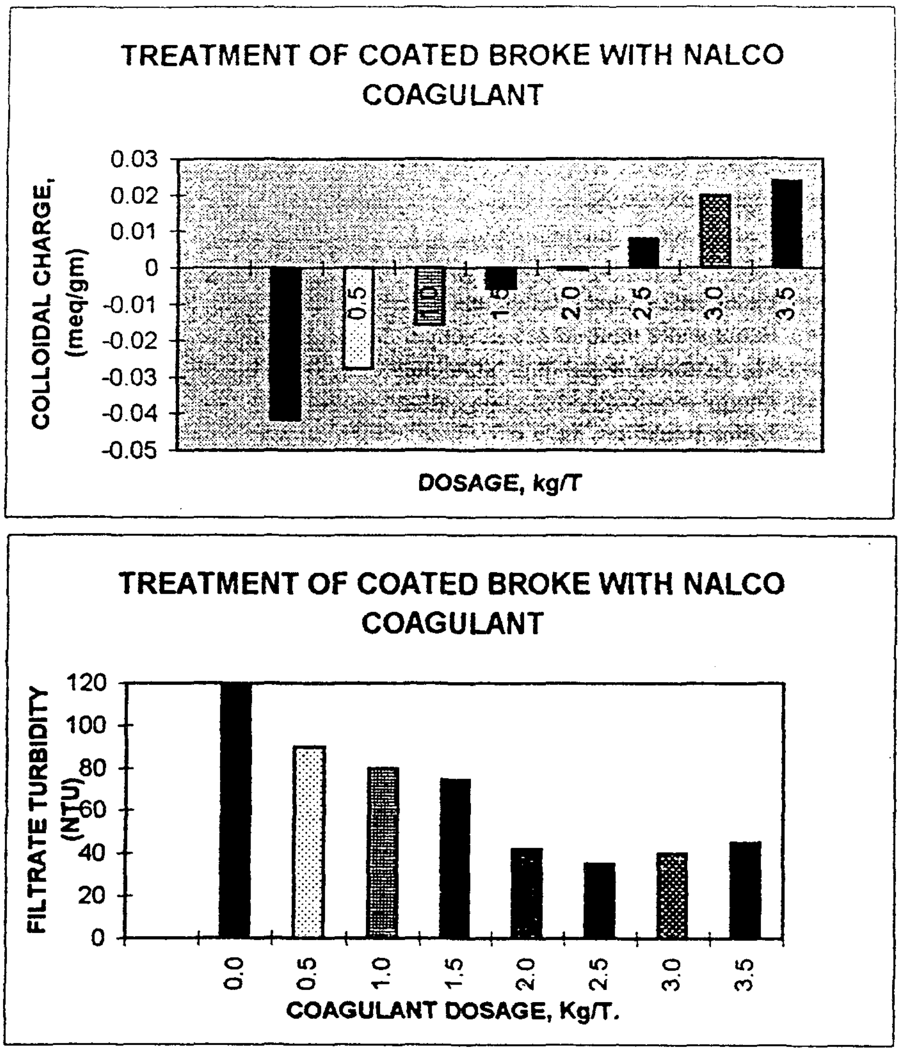

FIGURE 3. A sample of coated broke is treated with Nalco coagulant, reducing anionic charge and filtrate turbidity.

The proper and judicious addition of synthetic coagulant reduces the size of these fields, releasing their bound water and allowing the particles to more closely approach one another, where Van Der Wahl's and other attractive forces can begin to operate. Please see the graphic explanation in **Figure 1**. Colloids are now able to attach to fiber surfaces, promoting better distribution throughout the formed sheet, enhancing final quality and reducing operating problems. **Figure 2** is a graphic representation of the effect of colloidal size on fine particle retention. This concept has been proved in many applications, notably pitch control and coated broke processing.

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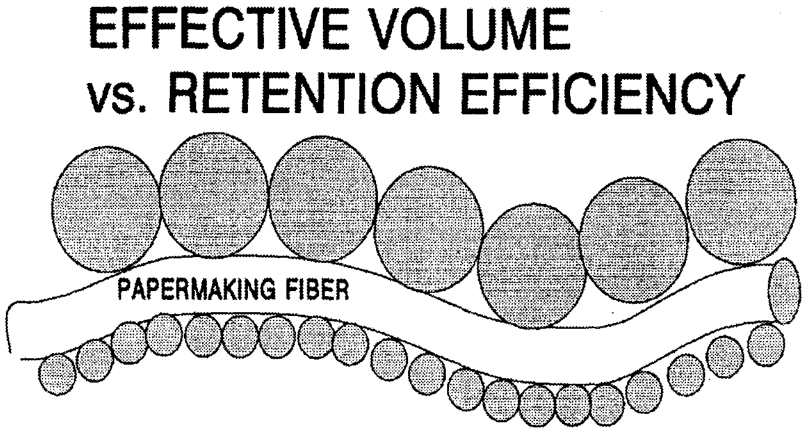

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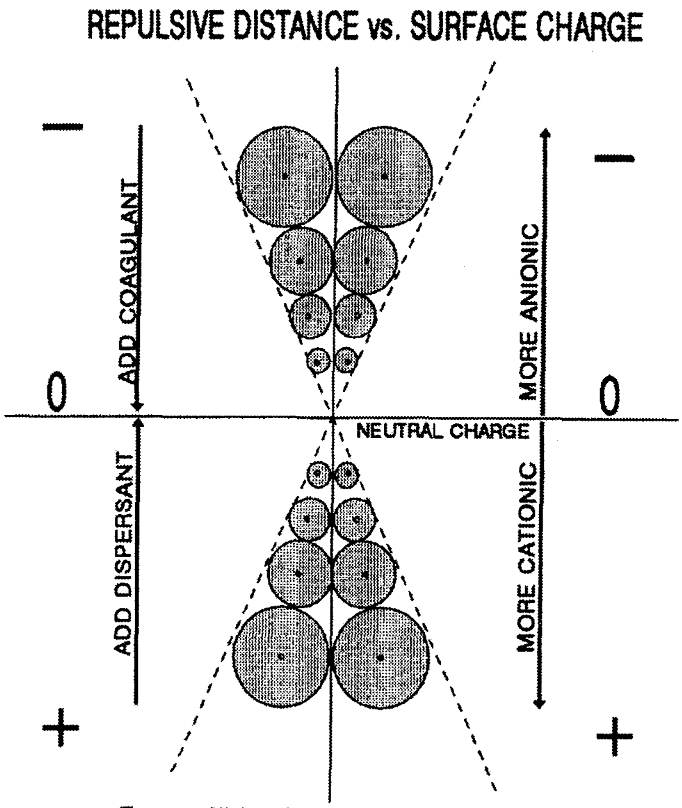

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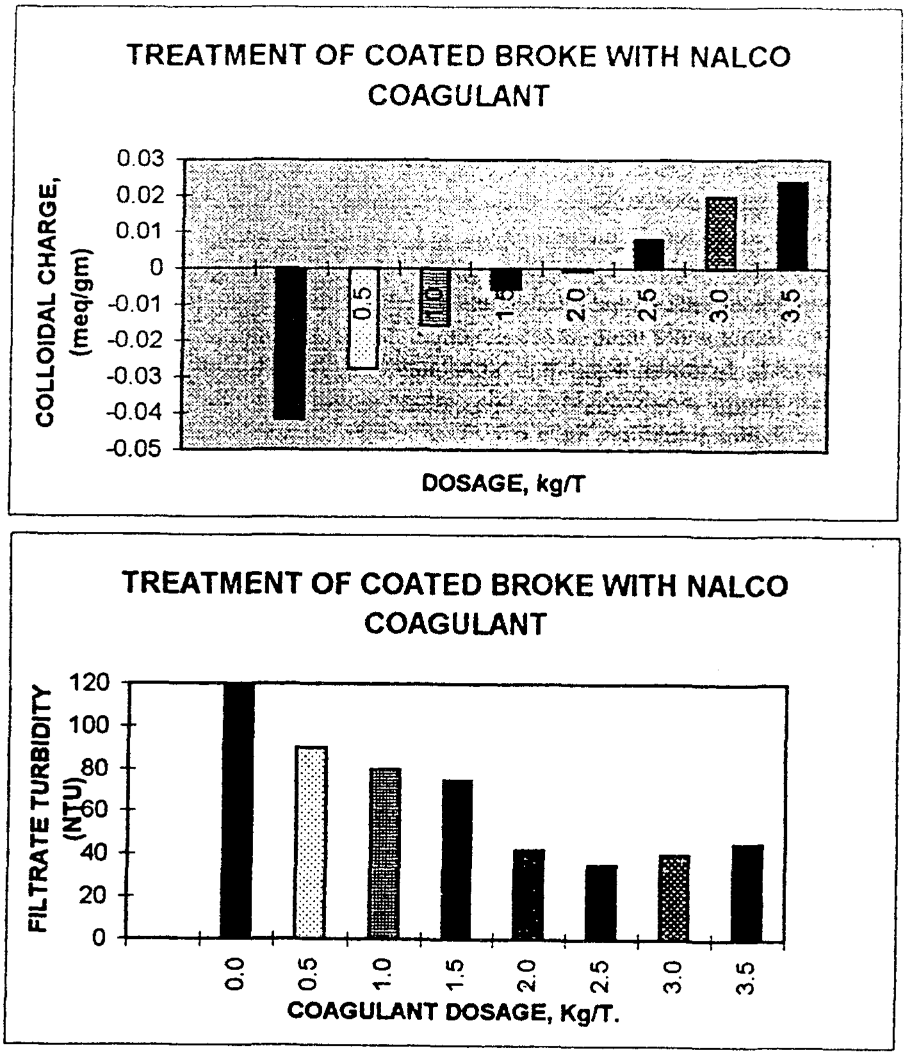

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Another American mill using TiO_2 for opacity and brightness employed a dual polymer retention program to provide a raw material savings of SUS 132 per ton. He was able to achieve all desired final sheet properties without using excessive quantities of TiO_2 in his furnish.

BENEFITS

Benefits to the papermaker will be among the following:

- Better ash retention.
- Better sheet formation.
- Better drainage in the forming zone.
- Cleaner white water; fewer machine deposits.
- Better water removal in the wet press; less deposition.
- More running time between boilouts.
- Energy reduction in the dryer section.
- Better overall productivity.

As competition increases throughout the Korean paper market, better paper machine runnability will become extremely important. The market will continue to demand the quality they are accustomed to, but it will demand higher quantities. It is a good idea to get ready for the change.

SUMMARY

The market for publication papers continues to grow worldwide, despite fears of the electronic "paper-free" communications age. As demand grows, papermakers around the world, and also in Korea, will wish to increase the productivity of their paper machines. Since running faster usually causes sheet quality and machine runnability problems, many will begin thinking about capital investments to increase capacity. In many cases, this will not be necessary, as Korean papermakers will find that careful wet end chemical control will assist them in meeting the demands of their increasing market. Many tools and much experience is available through working with Nalco, whose business style involves working with the papermaker to analyze and solve his wet end chemical problems.

ABOUT THE AUTHOR

Mr. Buikema has been associated with the paper industry in various ways since 1962. He has served the industry with Nalco Chemical Company for twenty-six years, in research, technical sales, marketing and applications engineering functions. He is currently a Market Development Manager for Nalco Pacific, focusing on the Korean paper industry.

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