Advanced Control of Hydrophobic Contaminants in the Paper Machine Wet End

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ABSTRACT

The increased use of secondary fiber, coated broke and mechanical pulp in the papermaking process contributes to the accumulation of organic contaminants. These contaminants can form deposits that affect machine runnability and final product quality. Control of the contaminants is typically managed through chemical fixation, and its effectiveness is therefore dependent on the ability to determine the proper program and application. Historically, a common method used to assess program performance has been filtrate turbidity reduction. This method, however, is not entirely adequate because it often yields an incomplete picture of the furnish demands from hydrophobic particles. More recently, flow cytometry has been used in the industry for monitoring hydrophobic contaminants. Disadvantages of this method are that it is both labor and capital intensive. Nalco Company recently developed a fluorescence technique to monitor the relative concentration of hydrophobic materials throughout the paper machine wet end. This technique, which is both easy to use and inexpensive, can also act as a screening tool for contaminant treatments in order to evaluate efficacy and dosage. Results of machine surveys and the impact of contaminant control agents will be discussed in this paper.

INTRODUCTION

Increased use of secondary fiber, coated broke and mechanical pulp contributes to the accumulation of organic contaminants in the papermaking process. Organic contaminants, such as natural pitch (fatty acids, fatty esters, rosin acids), stickies, tackies and white pitch (adhesives and coating binders such as styrene butadiene rubber, ethylene vinyl acetate, polyvinyl acrylate, polyvinyl butyral, polybutadiene) are contributors to poor machine runnability. Components of printing ink such as wax, alkyd resins and polyol acrylates, are also potentially troublesome. These materials, when liberated during a papermaking process, can become both undesirable components of papermaking furnishes and troublesome to the mill equipment. They prevent proper operation of mechanical parts when depositing on paper and tissue machine clothing, cylinders, or rolls. There is a clear difference in the chemical structure and, consequently, behavior in the papermaking process between natural wood pitch and synthetic additives constituting stickies or white pitch. Chemical composition, as well as size, pH and temperature, all affect the tackiness of stickies. The commonality among these contaminants, though, is that they are, to varying degrees, hydrophobic in nature.

Control of contaminants can be managed through mechanical means such as washing, or chemical means such as dispersion, detackification, or fixation. Chemical fixation of organic contaminants will be the aspect considered in this paper. The effectiveness of chemical fixation is dependent on the ability to determine the proper program and application. Historically, a common method used to assess program performance has been filtrate turbidity reduction. While the use of turbidity measurements is well known to indicate the consistency in a suspension, this method is not entirely adequate because it often yields an incomplete picture of the furnish demands from hydrophobic particles. Different types of particles, not all hydrophobic in nature, with different sizes, shapes and surface properties will scatter light differently, leading to different turbidities for the same concentration. Particle size distribution will also play an important role as samples with the same concentration, but different distributions will have different turbidities.

More recently, flow cytometry has been used in the industry for monitoring hydrophobic contaminants. Flow cytometry is a technique used mainly in biology and medical diagnostics to count cells and sort them in sub-populations based on their size and shape and their ability to emit fluorescent light. The intensity of light scattered in the forward direction gives an approximate indication of the size of the particle. Accurate output requires adjustment of the dilution factor for the sample, the voltage settings for the detector, amplification of linear parameters, and sample flow rate. In another application of this method, particle size is inferred directly by fluorescence intensity. There are limitations, however, to measuring particle size with forward scatter or small angle scatter, or use of a fluorescence channel. Even for uniform particles, forward scatter amplitude will not be a monotonic function of particle size. It is also not possible to derive precise particle size information from the intensity of fluorescence signal since the binding affinity of the stain and quantum yield will vary based on the nature of the particles. These approaches are both labor and capital intensive as well.
A rapid and accurate method of measuring the organic contaminants in a papermaking process was desired. Nalco Company recently developed a fluorescence technique to monitor the relative concentration of hydrophobic materials throughout the paper machine wet end. This technique, which is both easy to use and inexpensive, can also act as a screening tool for contaminant treatments in order to evaluate efficacy and dosage.

RESULTS AND DISCUSSION

Method
The method developed involves the addition of a fluorescent dye to a sample of interest from the thick stock or wet end of the paper machine. The dye fluoresces in the presence of hydrophobic materials and the relative fluorescence intensity, or hydrophobicity, of the sample is recorded using a hand held fluorometer. The turbidity of the samples is measured before dye addition to provide complementary information about components that do not have a strong affinity for the fluorescent dye. By monitoring samples across the paper machine, problem areas are identified and a proper treatment program can then be evaluated and applied.

Paper Machine Surveys
Pulp and water samples were collected from the various locations across the wet end of a tissue machine using deinked pulp as the main fiber source. The long fibers were removed from the sample by filtering it through a 150-micron sieve. The filtrate turbidity was measured and a fluorescent dye was then added to the filtrate; the resulting fluorescence was recorded. The results in Figure 1 indicate that turbidity and hydrophobicity, or contaminant presence, do not necessarily track each other. In some cases there is an increase in turbidity while the hydrophobicity remained the same.

The next example, Figure 2, indicates the colloidal contaminant mapping across a machine producing coated magazine paper. In this survey, the turbidity is low in the pulp lines and the hydrophobicity is relatively high. With the broke lines, there is a reduction in the turbidity and hydrophobicity after fixative usage. Finally, in the stock approach system, there is no reduction in hydrophobicity and the turbidity is relatively low, and there is a marked increase in the hydrophobicity and turbidity in the headbox and white water.
Fixative Evaluations

The remaining figures demonstrate the use of this technique for evaluating fixative programs for applications that include groundwood mechanical pulp, deinked pulp and coated broke. Figure 3 illustrates the application of the fluorescence technique in a system containing natural hydrophobic contaminants. Programs A and B, a crosslinked and linear EPI-DMA, respectively, have activity comparable to the reference program. However, a reduction in the hydrophobicity near 80 percent can be achieved with the use of chemical program C, a co-polymer of DADMAC. It is more effective than the other fixatives in this pulp under the doses examined.

The next example is the comparison of various fixative programs and their impact on hydrophobicity and turbidity in a deinked furnish. All of the fixatives in Figure 4 have an impact on the turbidity and hydrophobicity to varying degrees. Compared to the reference, fixative B, an EPI-DMA based polymer, is able to reduce the hydrophobicity of the sample to a greater extent, but at half the dosage. A linear EPI-DMA, fixative A, and a DADMAC, fixative C, at 0.5 kg/ton, are not able to match the performance of 0.5 kg/ton of fixative B.

Finally, various chemical treatment programs were evaluated in a coated broke, containing synthetic hydrophobic materials, from a paper mill. The data in Figure 5 demonstrates that the different fixative programs respond to the hydrophobicity in the coated broke differently. Fixative A is an EPI-DMA- based polymer, fixative B is a DADMAC-based polymer, and fixative C is a DADMAC co-polymer. Although the different fixatives can achieve the same turbidity level, the hydrophobicity varies greatly among the samples.
CONCLUSIONS

A fluorescence technique was developed by Nalco to monitor the relative concentration of hydrophobic materials throughout the paper machine wet end. Machine survey results indicate that hydrophobicity and turbidity do not necessarily track each other, demonstrating that this technique is complementary to turbidity reduction measurements, which provides further insight into locating and controlling hydrophobic contaminants on the machine. The method can also be used as a screening tool for contaminant control agents in order to evaluate efficacy and optimal dosage. Other benefits of this technique are that it is rapid, easy to use and inexpensive.

REFERENCES


