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FUNDAMENTAL STRATEGY FOR CONTROL OF RETENTION AND DRAINAGE ON A MODERN PAPER MACHINE

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ABSTRACT

Government controls on effluent, accompanied by attractive cost savings, have moved the paper industry toward ever increasing degrees of system closure and white water reuse. As a result, dissolved organic and inorganic contaminants build up in the recycled white water, and anionic organic moieties compete with filler and fibrous additives for adsorption of costly cationic chemicals.

An instrument-based retention control strategy to detect and maintain control over these contaminants is discussed. Some of the sensors needed to implement this strategy still await development, such as good devices to monitor total charge in the system and slurry ash and fines. Investigations that will lead to a device to monitor total charge in the papermaking system have been carried out (1).

The conductivity is useful to measure the total level of inorganic contaminants in a papermaking system. The level of organic contaminants can be monitored nonselectively by use of total organic carbon measurements. The paper industry needs to make significant strides in order to achieve good process control over its papermaking process.

INTRODUCTION

The control of retention and drainage is accomplished through a combination of machine design and chemical addition. The best approach seems to be first to optimize the mechanical factors on the machine such as table design (including foil numbers, type and placement, vacuum foils, and suction box vacuum profile) and headbox conditions and then to use chemical additives to adjust the colloidal conditions in order to achieve the best first pass retention compatible with maximum drainage and paper dryness leaving the couch. At Miami University for a number of years we have been studying the

effects of process water system closure on paper machine operations (2) with particular attention to retention (3,4,5). From this base of experience we have concluded that it is not sufficient just to mechanically optimize the machine and then select the most advantageous retention polymer or polymer combination, and run at a fixed level of polymer addition. The papermaking system is a dynamic, changing chemical environment and addition levels must be adjusted to compensate for this ever-changing environment.

In order to detect changes in wet-end chemistry, new online sensors will need to be developed and those which are available used more effectively. A recent survey conducted by Scott (6) revealed that we are in our infancy in this field. The survey revealed that the most-needed capability was a reliable way to monitor the state of charge or zeta potential of the system. This will be discussed more in depth later, but it is important to realize that knowing the state of charge of the system is a necessary condition but not a sufficient condition to control retention and drainage. The lack of recognition of this fact is partly responsible for the very poor results people have experienced in trying to apply zeta potential sensors in the paper mill.

RETENTION AND DRAINAGE CONTROL STRATEGY

In order to adequately control retention and drainage, an instrument based strategy must be developed. The background data which produced this conclusion and the development of the specific strategy have been previously reported in the literature (3,4,5,7). The strategy is illustrated in Figure 1. This strategy presupposes that a good pH control program is already implemented in the mill.

The strategy would continuously monitor the level of contaminants and key system responses and automatically adjust addition control agents appropriately.

Utilization of such a strategy would likely result in significant raw material savings and increased productivity while including such benefits as:

1. Reduced loss of high cost materials such as titanium dioxide, synthetic size, etc.
2. Increased dewatering on the paper machine leading to a lower water content sheet to the press section (lesser energy requirement in the dryer section).
3. Potential increased machine speeds due to increased drainage rate.

4. Improved paper machine runnability and properties.
5. Increased water reuse potential which can result in energy and raw material savings.

Lindstrom and coworkers (8) also have proposed a retention control strategy model.

Three major generalizations can be drawn from the extensive amount of research aimed at elucidating wet-end chemistry mechanisms and fundamental knowledge (5). These serve as the major basis of a first-pass retention control strategy:

1. The wet-end chemistry performance of most additives and components is highly dependent on the level of first-pass retention achieved.
2. On medium to high speed paper machines, retention aid addition is necessary to achieve acceptable first-pass retention levels.
3. The effectiveness of cationic additives is greatly impaired due to interference by dissolved and colloidal anionic substances in the wet-end.

The proposed retention and drainage control strategy (Figure 1) consists of three main control loops. The first loop measures and neutralizes the organic derived contaminants on the thick-stock side of the stock preparation area. Total organic carbon measurements serve as a measure of the cationic demand of the system (9). Based on the levels detected, a cationic charge neutralizing additive of low molecular weight and high charge density is added to counteract the detrimental organic effects. This amount will be slightly affected by the level of dissolved inorganic material present since these cationic species will react with the negatively charged organics. Specific conductance measurements serve to quantify the level of dissolved inorganics (9). In theory, as the furnish exits the stock preparation area, the total charge of the system is checked to determine if the organics are sufficiently neutralized.

In the second loop, the first-pass retention performance is measured, and the high molecular weight retention aid addition rate is adjusted if a change in retention is necessary to achieve a targeted uniform retention level. A retention value that correlates with first-pass retention can be derived with the M/K and Chemtronics retention meters.

The adjustment of drainage rates and couch dryness levels would be controlled by this additive, also. Information about the mass of incoming fine solids (filler, pulp, and broke fines) from the stock preparation area is also known and fed forward to this loop.

The third loop illustrated in the diagram monitors the level of filler retention in both the final sheet and in the recycled broke recovery system. This information is fed back so as to adjust the flow rates of mineral fillers, such as clay and TiO₂, accordingly in the stock prep area.

Not illustrated in the diagram, but quite necessary, is a feedback loop which relays information concerning such properties as the optical and strength characteristics of the paper to some type of process control computer. This information would include measurements of opacity, brightness, ash content, strength, etc., so that product specifications would remain acceptable.

In short, a first-pass retention and drainage control strategy could be implemented with relatively few online sensors. However, sensors which are currently unavailable are those which measure total charge of the system, process stream fines levels, and wet ash levels in the system. Given the future demands required in the paper machine wet end from alkaline papermaking and the increased filler loading levels, higher machine speeds, lower basis weights, white water recycle, etc., the industry needs to take a stronger approach toward this type of online process control strategy. If the needed sensors can be developed and are sufficiently dependable, it appears possible to control retention and drainage using the described strategy.

We have begun to work on a reliable technique to monitor total charge in the papermaking system, since the industry survey (6) indicated this was of top priority. The measurements to characterize fine solids and wet ash still need to be developed. Instruments to monitor retention are under development and some commercial installations exist. The sensors to monitor sheet ash by components exist and are readily available. They are becoming part of many instrument package systems for the paper machine.

The inorganic levels in the system are best detected by conductivity and we have conducted studies to investigate the usefulness of the measurement. Good flow through conductivity meters exist so the main questions to be answered deal with the limitations of the measurement. A more detailed discussion can be found in reference 9.

Disclaimer:

The use of trade firms and product names is for convenience of the reader and does not constitute an endorsement to the exclusion of others that may be suitable.

CONCLUSIONS

1. The basic concepts of an instrument based retention and drainage control strategy were presented.
2. Not all of the instruments necessary to implement the strategy are developed. What is missing are a wet ash sensor, a fine solids sensor, and a technique to monitor total charge in a papermaking system. The latter is under development at Miami University.
3. Conductivity is a good sensor to monitor the level of inorganics in the papermaking system provided consistency, temperature and pH are compensated for.
4. Total organic carbon is a good nonselective measure of the colloidal and dissolved organic matter in a papermaking system. Total organic carbon is a function of pH and consistency.

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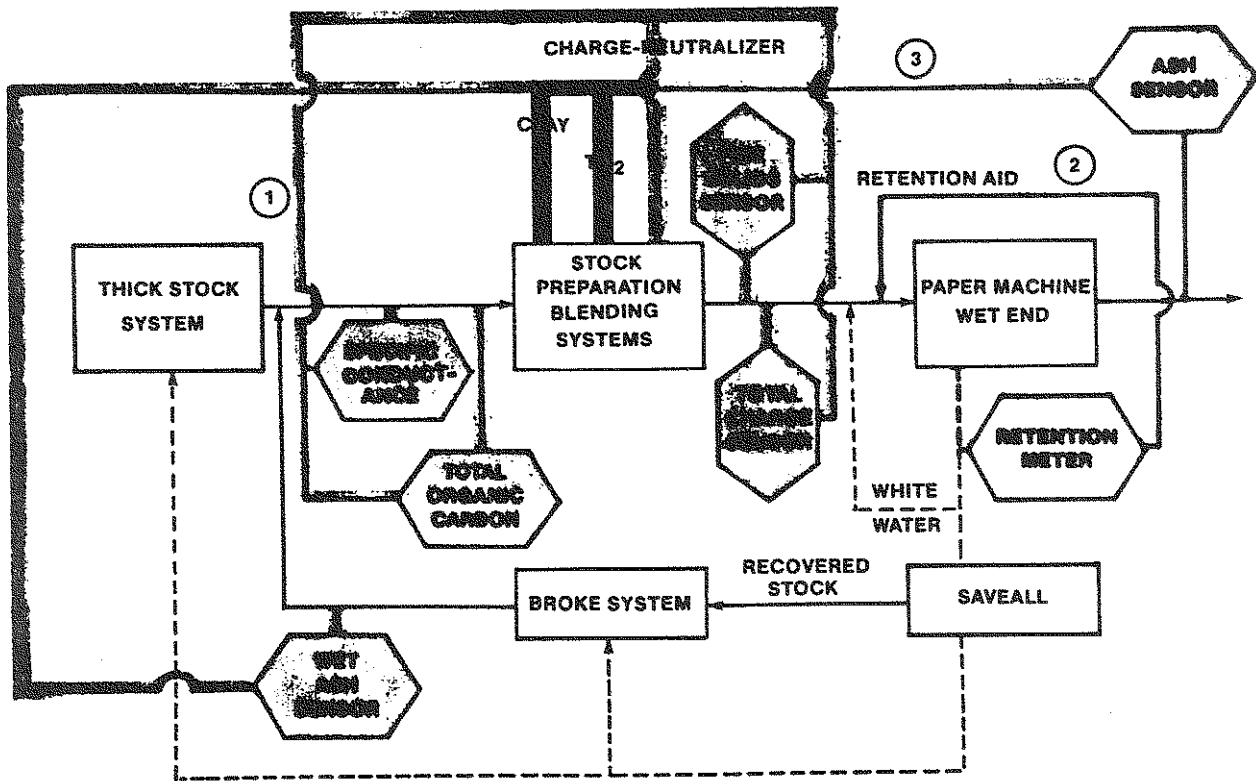


FIGURE 1: MIAMI UNIVERSITY RETENTION AND DRAINAGE CONTROL STRATEGY DIAGRAM