Modern Solutions to Improve Paper Making Efficiency

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ABSTRACT

Papermakers have three prevailing objectives: quality, runnability and overall performance. Today the overall performance means aiming to the best possible efficiency of the whole production line and maintaining stable quality of the produced paper at target level. To meet this, it is vital to stabilize consistency, ash content, charge and chemistry at start-ups, in normal run and after grade changes. It's best done by measuring and controlling the wet end as comprehensively as possible.

This paper introduces two lately launched tools for wet end management: modular analyser to wet end chemistry and consistency sensor for wet end applications. The new analyser is first in the world that provides papermakers all the relevant wet end chemistry measurements.

The consistency sensor is stand-alone device that performs continuous measurements from one sample point. It is ideal for applications that require continuous consistency measurement from the wet end and for automatic retention control.

Retention is controlled by stabilizing white water consistency by changing retention polymer flow. This is the cornerstone for stabilising wet end. Efficiency of this control is shown by real mill examples. The performance of retention control can be improved by sustaining optimum chemical environment for retention polymers. This optimum chemical environment can be created by measuring and controlling charge in different parts of the process.

INTRODUCTION

Analyzers used in mill experiments and control solutions

For charge control experiments kajaaniWEM™ analyser was used. This analyser combines all the relevant wet end variables for the total wet end management. It has four modules for charge, chemistry (pH, temperature, conductivity and redox), consistency (total and ash consistency, flocculation), and turbidity. There are six sample points from which kajaaniWEM provides online wet end measurements. For thick stock sampling it has sampler available. Since all the measurement modules are in one cabinet, the installation costs are lower compared to the cases where the same measurements are provided as separate units.

For retention control experiments we used kajaaniRM3™. It is a new retention sensor for paper machine wet end and stock preparation and designed to meet the new requirements in pulp and paper industry. It is based on 20 years of experience in optical consistency measurements and represents the third generation of industry-standard Kajaani™ technology. The sensor is totally redesigned utilizing modern technology including FieldCare™ based User Interface, quality mechanics, and powerful optics and light sources. All this means top performance and reliability with low investment cost. kajaaniRM3™ is suitable for all pulp types. kajaaniRM3™ fits the applications where the continuous, single line measurement of total and true ash consistencies is needed for building the solution for process monitoring and closed loop control.

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Retention measurement

The conventional way to "control" retention is based on manual sampling and consistency analyses in laboratory; but this method is far too slow to be useful for retention control in any serious sense, as it requires much time and lab work. For wet end control on modern paper machines, we need continuous, robust on-line consistency measurement that is sensitive enough to detect even quick changes taking place in the process. In figure 1 is typical installation points for modern retention measurements.

Control of White Water Total Consistency

The majority of the poorly retained material is contained in the white water

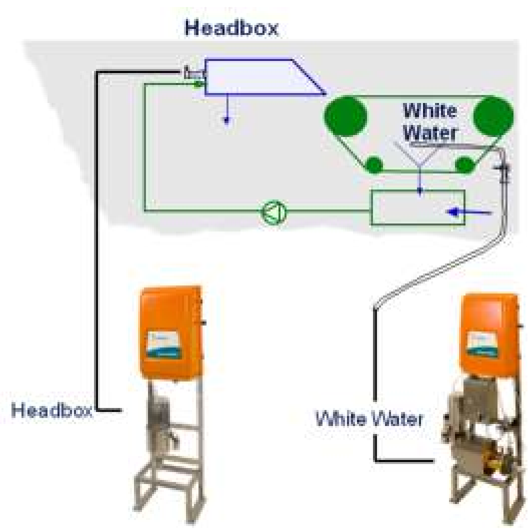

Figure 1. Typical low consistency measurement points in wet end for retention control

Table 1. Ability of different control methods to dampen the effect of a 20 % dilution in retention chemical strength.

Measurement	Controlled variable Damping and recovery time		
	Total retention (+ HB filler consistency)	Filler retention (+HB filler consistency)	White water total consistency (+HB filler and total consistency)
Total retention	76 %, 18 min	83 %, 13 min	94 %, 10 min
White water total Cs	79 %, 19 min	85 %, 13 min	89 %, 8 min

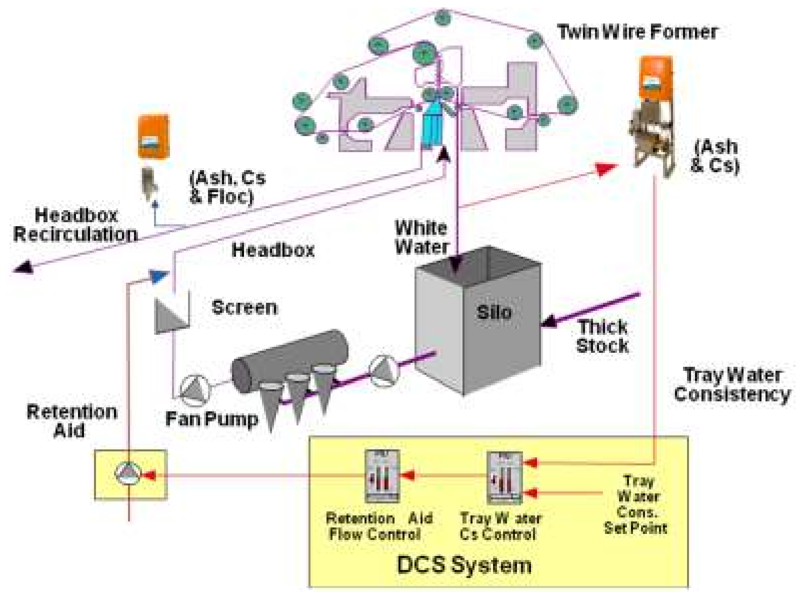

Figure 2. White water consistency control system

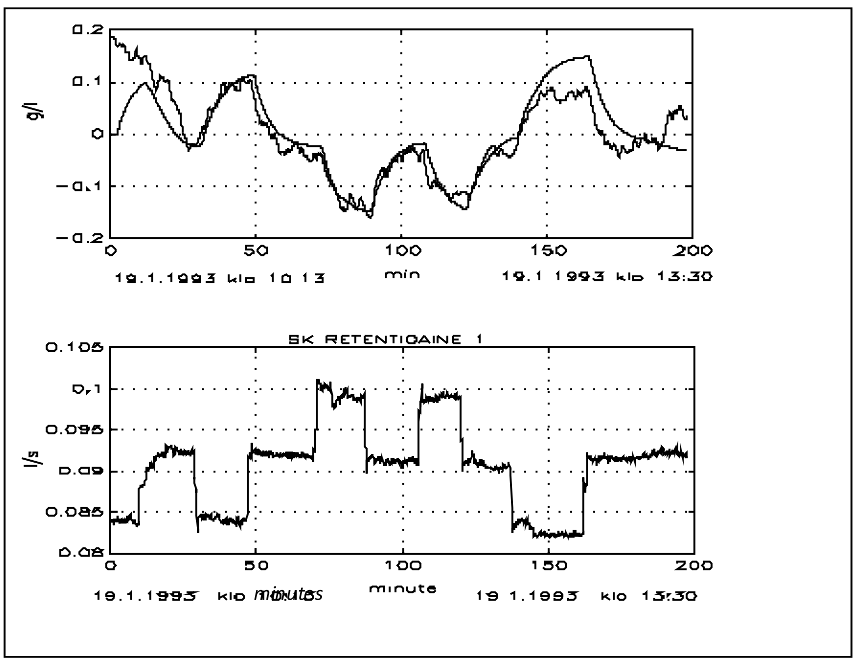

Figure 3: Example of retention aid step test

flow and returns from there to the headbox. The retention of this circulating material is improved by adding retention chemicals. Reducing total consistency variations and thus circulating material in white water will also stabilize consistencies in the entire wet end, and this in turn is reflected in a more stable retention. The most effective way to stabilize wire retention is by controlling white water consistency with the retention aid flow.

This has been proved with several control test runs in a separate project /6/. The results in table 1 show that by controlling white water consistencies the retention and whole wet end is most effectively stabilized.

Retention is controlled indirectly, through the total consistency control of the white waters; the principle is presented in figure 2. There is a cascaded control system where the inner loop is retention aid flow controller and the outer loop is consistency controller.

This control solution optimizes the retention program by using always only the necessary amount of chemicals, and by eliminating under dosing and overdosing situations. It also pinpoints potential problems in the process: retention chemical make-up and dosing system, pulp refining, mixing and broke dosing, to name but a few. It is the last watchdog before the furnish turns into paper, and it can be used to fine-tune the papermaking process.

Prerequisites of Retention Control

For truly efficient control we need an accurate, reliable, quick measurement and an efficient retention chemical. The control loop must be properly tuned. There must be also clear user interface and users must be trained to use the control loop. proper user training

kajaaniRM3 used for retention control studies proved to be accurate and quicknew result is available every 1 seconds and suited for all paper grades. In addition, the retention chemical used on the PM must have a clear effect on consistency; this is ascertained by means of step tests. Example of retention aid step test can be seen in figure 3.

Clear user interface for the operator is of vital importance in Control; figure 4. Figure 5 shows results from a PM where white water consistency control was put on automatic control. As can be seen the difference between automatic and manual run is clear. The automatic control is able to keep the white water consistency very stable and the effect of this can be also seen as a much more stable headbox consistency and total retention. So by controlling white water consistency we are able to stabilize the whole short circulation.

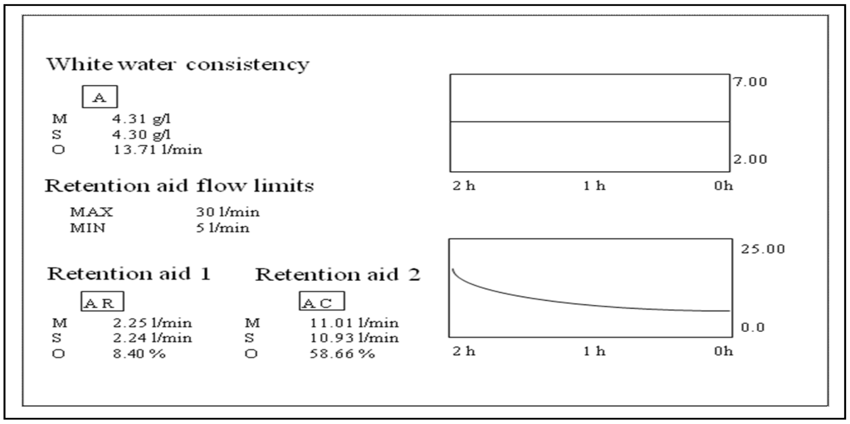

Figure 4: White water consistency user interface.

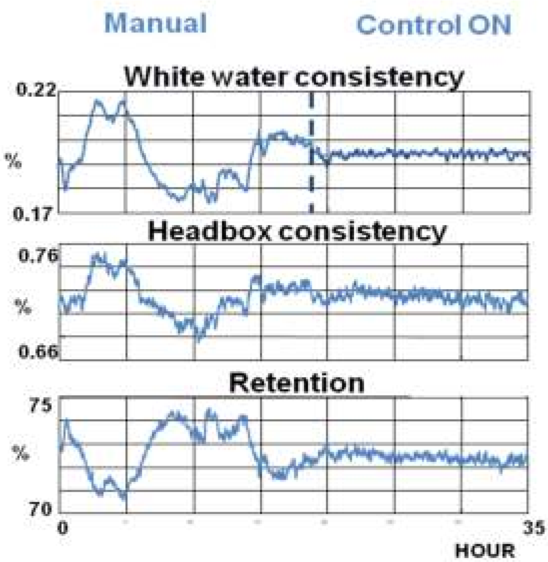

Figure 5: White water consistency on manual and control run

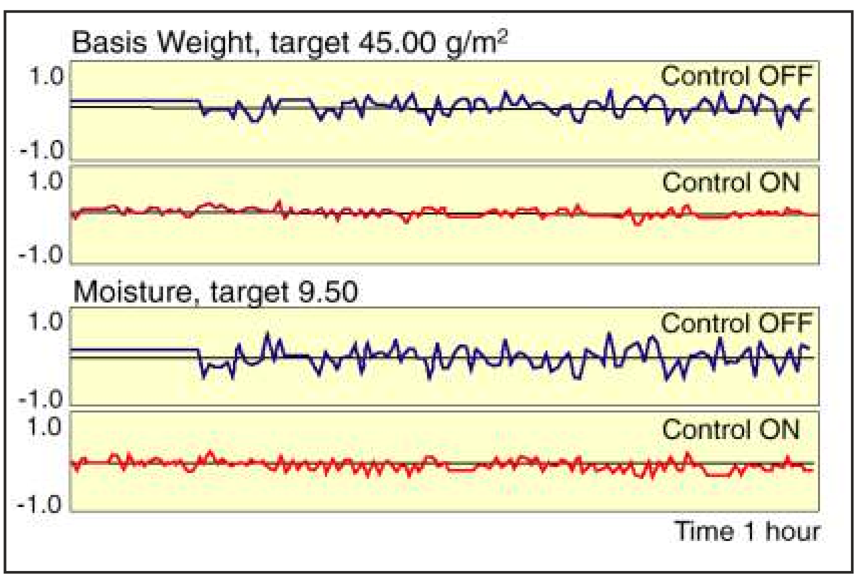

Figure 6. Basis weight and moisture with and without white water consistency control

More stable wet end means more stable dry end. Example of that can be seen in Figure 6. Basis weight and moisture are much more stable when retention control is on.

Control results have been studied in various paper machines by comparing the standard deviations of certain measurements for the same grade runs with and without automatic white water consistency control. The relative results of the comparison are shown in table 2. As the table shows, the control periods show great improvement in wet and dry end stability, which means better runnability and improved paper quality.

In Figure 7 is an example of improved runnability in a paper machine after the white water consistency control was put on. Before the average lost production time was 118 minutes a day and after the control was put on the lost time was decreased by 41 % to 66 minutes. The machine speed was also 1.7 % higher during control runs.

Charge Control

The purpose of charge management is, first and foremost, to maintain a stable charge in the short circulation and to keep it at the desired level. While the dissolved and colloidal material in stock affect strongly retention and thus retention control, the stability of charge is important for the performance of retention control. One key idea of measuring cationic demand is to find that average pulp charge, which is the most suitable for the used retention system may it be mosaic, bridging or microparticle mechanism.

Cationic demand can be measured from many places in the process, Figure 8. One of the most important places is the **short circulation**, as this measurement combines the effects the different pulp types, broke, water circulations, and the various process chemicals. It is very important to know the final charge level of the short circulation after all chemical additions, because it has a direct effect on the paper machine retention, runnability and finally to quality of the produced paper. It is important to keep wet end charge **level** at right level, while:

1. the level affects retention aid performance and retention control and therefore runnability and paper quality
2. wet end charge level correlates with center roll release angle <=> affects to runnability
3. if the wet end gets overcationized , the runnability and retention will be lost totally.

White water is good place to measure, because the material gone through the wire carries the information essential for flocculation. Every sudden bigger

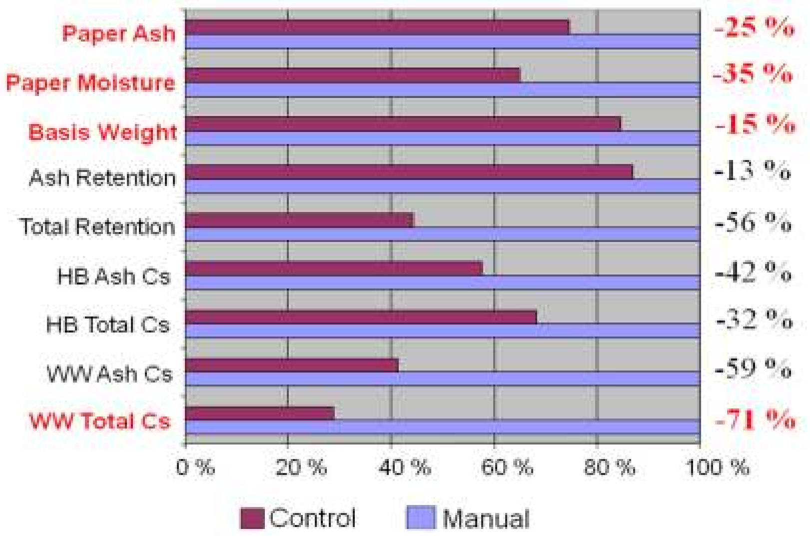

Table 2. Variability Reductions from Retention Control

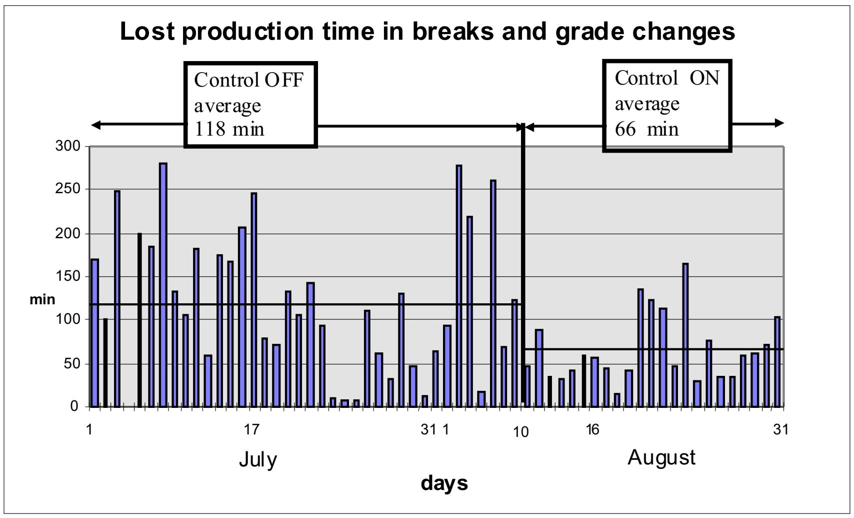

Figure 7. The reduction of lost production time after retention control

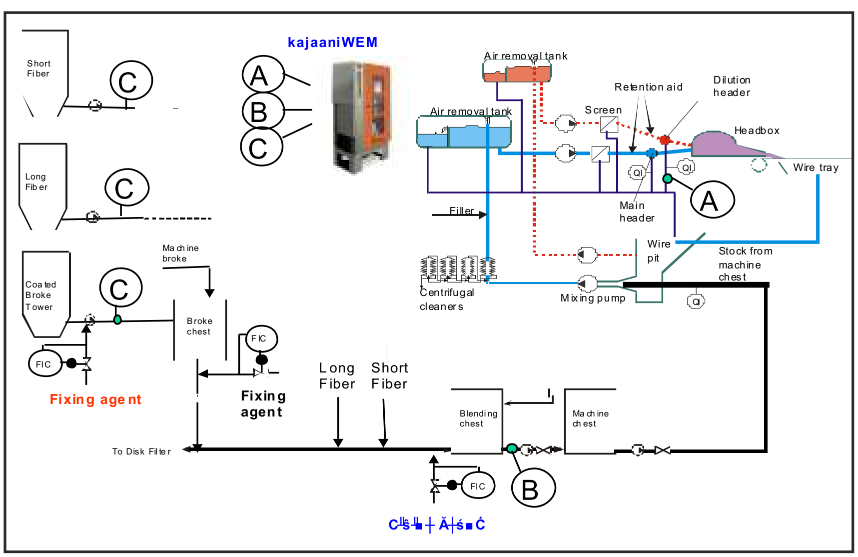

Figure 8. Right charge measurement points in process

change in white water charge will disturb also the HB consistency and drainage. For automatic control of white water cationic demand the fixing agent addition point can be in blend chest. In control solution the dosing of the fixative is based on charge measurement and thus constant level of charge can be maintained. Another obvious measurement point is the primary source for charge fluctuations on the paper machine, usually coated broke or groundwood line.

By measuring and controlling **only** thick stock charge (e.g. coated broke), there is a big risk that it is not enough to maintain stable charge later on in head box. This is easy to understand, when looking the process. The other stock lines and many charge effecting chemicals and fillers are added after thick stock addition but just before HB! For example controlling only the quality of coated broke is not enough because there is always also quantity changes, which will be seen as charge variations in mixed thick stock and wet end. Also the variation in coated broke line can be extremely large, e.g. from -500 μeq/l to -200 μeq/l in few minutes especially when level of the tower is low. Because the measurement cycle with on-line charge analysers is relatively long, it makes the task for the controller quite difficult.

By measuring the charge after blend chest we can combine all information of furnish components quality and quantity changes. White water measurement is still needed to ensure final proper level in short circulation (Fig 8).

Figure 9 shows an example of a control run during disturbances. The graph shows that the control is able to keep the charge very close to the setpoint even though changes occur in the coated broke flow. Usually the charge stays within ± 5 eq/l from the setpoint.

Automatic Charge Control based on the kajaaniWEM very effectively stabilizes charge and totally prevents charge reversal. Experience so far has shown that the control is robust against minor process changes, and does not require re-tuning. Moreover, it has many benefits for the process itself.

CONCLUSIONS

Total wet end chemistry control becomes more important every day. Paper quality and PM runnability must meet ever harder requirements.

This paper presents the idea of total wet end management. The aim of wet end management is to ensure stable total and ash consistencies and stable basic

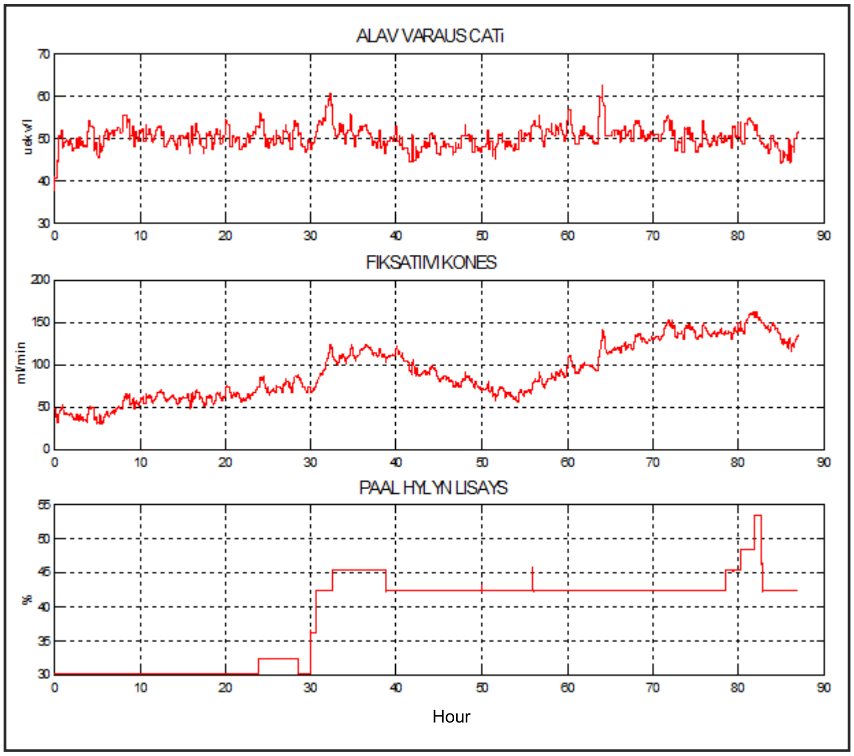

Figure 9.White water cationic demand on automatic control

chemistry in the paper machine short circulation. Stability is very important because it is directly connected to paper machine runnability and the quality of produced paper.

When constructing automatic controls, continuous real-time measurements are an absolute must. The measured information must be reliable and describe the dynamic state of the process. Moreover, frequent enough sampling is needed and the measurement instruments must have low fouling tendency, low maintenance need, and good resistance to high temperatures and moisture.

This paper describes a mill example of retention and cationic demand management. The main focus is on automatic retention and cationic demand control.

On-line retention control based on white water consistency measurement and control is effective way to stabilize the whole wet end. When amount of circulating material in the wet end is stabilized, the runnability of the machine and stable quality of paper is guaranteed. Automatic cationic demand control improves the performance of retention control. Thus paper machine runnability and paper quality is also further improved. Both of these automatic controls help also to optimize chemical usage in the wet end.

The crucial factor is to pinpoint the sources of charge disturbances and to build the control around them. Another important step is to choose the control chemical so that it is effective in every situation. It is worth remembering that the sources of disturbances and the means to control them are specific to each and every process, so that the background work must be done all-out in each case.