Rethinking Best Practices, Felt Cleaning and Conditioning

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ABSTRACT

Press felt contamination with materials such as calcium carbonate and organic deposits have been problematic for papermakers for years. Press felts without an effective cleaning program can suffer in performance from decreased water handling capability and shortened felt life. Chemical cleaning strategies have been used to deal with such deposits in the past. However, an often overlooked component to both establishing and optimizing a chemical cleaning program is understanding how contaminants are removed and measuring that removal. This paper explains how new testing and measurement methodologies can be used for determining contaminant removal in press filtrates at the weir during machine operation thus providing valuable data for establishing variables like proper chemistry, washing frequency, and duration. The end result will be press felt cleaning programs which are both high performance and cost effective.

INTRODUCTION

An effective chemical felt cleaning program is an important tool in optimizing press section operation. When developing these programs there are certain conditions that need to considered before implementation, once implemented, optimization steps should ensue for maximizing results.

In most cases, the first step in developing a felt cleaning program is determining the amount and type of contaminant present in the felt which can be done through a used felt analysis performed by a technical lab. A good lab report will identify both the type of deposition present, whether organic or inorganic, as well as the relative amounts of these contaminants present in the felt. If desired, the lab can perform a wash study which compares efficacy of several different chemistries to determine a good candidate for the cleaning program. A drawback to current lab technology is that lab wash studies are not able to mirror the exact conditions present in a press section while cleaning on the fly, i.e., mechanical action, chemical dwell times, rate of deposition, etc. Lab wash studies should be used as a starting point for chemistry selection while using actual machine monitoring for evaluating product performance.

Once a cleaning chemistry is identified, the next step is to determine the duration of the cleaning cycle and the applied chemical concentration. The current practice in determining wash duration is to choose a length generally between 10-60 minutes, usually based on prior experience with machines producing similar grades. Chemical concentrations are arrived at in a similar manner. In the case of most on-the-fly cleaning, an in-shower chemical concentration of 0.25%-2.5% is commonly applied depending on type of showering application. In many felt cleaning programs these initial parameters are applied and some degree of benefit is realized such as reduced uhle box vacuum, reduction in steam consumption, or felt life extension.

These wash parameters should be considered starting points only. What remains is the opportunity for optimization with the objective of providing a cost effective higher performance program. On-line and off-line weir effluent monitoring techniques provide a path to that optimization.

METHODOLOGY

Felt Cleaning Application Performance Monitoring

Press effluent process monitoring with on-line sensors combined with offline lab testing can provide valuable insight into the cleaning performance of chemical washing events. Measuring and comparing certain press effluent parameters before, during, and after cleaning events help generate program optimization strategies for chemistry type, application, duration, and concentration.

The utility of these methods is particularly good when used and interpreted together and also when compared against data obtained from the press section such as weir flows, uhle box vacuum, wet felt permeability, grade, furnish variations, and additives levels.

It is important to recognize each press section will respond differently to cleaning chemistries based on a number of variables including but not limited to grade, machine speed, felt water content, felt design, needle showering, and type of contaminant.

On-Line Weir Effluent Sensor Analysis

Conductivity may be used to measure the general concentration of dissolved ions in weir effluent. Hence, conductivity can determine the concentration of cleaning chemicals as well as the concentration of dissolved ionic contaminants that are released from the felt into the weir water. The background level of conductivity must also be considered when evaluating any changes in conductivity measurements. For example, during a felt cleaning event the simple addition of an alkaline cleaner will cause the conductivity in a weir-monitoring device to increase. The removal of some types of felt contaminants will cause conductivity to increase above and beyond that caused by the addition of felt cleaning chemistry. The change between baseline and total conductivity reflects the removal of ionic felt contaminants. Conductivity may thus be used to infer the removal of dissolvable soils.

Turbidity is another parameter which can be used as a monitoring tool. Felt cleaning programs not only solubilize some contaminants but also remove particulate contaminants. Particulate soils exist in felts and may not be easily removed through a solubilization process. Many felt cleaning programs nevertheless are able to remove these contaminants through mechanisms of dispersion and suspension. These dispersed contaminants will normally give an increase in weir turbidity. Thus, turbidity may be used as a tool to measure the relative removal of these particulate soils from a press felt. Again, the absolute turbidity value obtained during a felt cleaning event must be corrected for background levels to determine the true effectiveness of a specific cleaning event. One caveat for on-line turbidity monitoring is that cleaning events often create entrained air and foam in the weir effluent. The entrained air present can skew on-line measurement readings, therefore, on-line measurements should always be cross checked with lab turbidity once samples are allowed to rest and the entrained air is removed.

pH in many felt cleaning programs relates to the use of alkaline or acidic components to disperse or solubilize felt contaminants. Continuous measurement of pH may be used to determine the effect of these chemistries on the pH environment in a press felt. The length and time of these changes can thus be used to verify the effective concentration of cleaning chemistries in the press felt, lag times, and any latency of residual effects of the chemistries in the felt.

Uhle box vacuums when measured concurrently with other parameters may be used to infer the extent of soil removal from a felt. Assuming uhle box vacuum is not a controlled variable, measured vacuum is generally proportional to press felt density. Press felt density is related to a combination of dry mass, water mass and contaminant soil mass per unit area. Although felt density can change throughout a felt's operational life due to compaction & wear factors, it can be assumed that dry & water mass will be fairly constant in a short time period of just one hour. Any change in contaminant deposition mass (after versus before) the cleaning chemistry application, will result in a proportion change in uhle box vacuum. It has been observed that felt water permeability will also be increased, resulting in increased uhle box dewatering rate.

More specialized probes like ORP and dissolved oxygen can also be used to help measure the effect of specialized cleaning additives such as the effect of peroxide based chemistries on press felt soils removal.

Off-line Measurements

Another important tool for validating felt cleaning effectiveness is to employ off- line weir box sampling and testing. These methods can be used to measure how specific felt contaminants respond to varying concentrations, cleaning chemistries and time periods for specific cleaning events. By sampling at specific time intervals before during and after a cleaning event the amount and type of felt contaminant can be determined. A good example of this is to measure turbidity on samples off- line in a lab. These measurements can often shed additional information on real time weir probe measurements by removing the effects of entrained air.

Calcium testing Calcium is a significant contaminant found in many alkaline machine press felts which utilize calcium carbonate as a filler. Calcium carbonate contamination may be removed through the application of various cleaning chemistries. The effectiveness of these chemistries can be evaluated by taking samples of weir effluent and performing calcium titrations at regular intervals. Calcium exists as a contaminant in the press felt in both particulate form and in the form of a bound salt. Particulate calcium could originate from added GCC or PCC. Deposits may also form from calcium salts or carbonates which precipitate out in the wet end or in the felt. Calcium salts from deink furnish or from broke can also contribute to felt filling materials. In addition, calcium in the form of background total suspended solids must be considered. In order to properly measure the effects of a cleaning cycle therefore both dissolved and suspended calcium must be taken into account. This can be accomplished by filtering the weir effluent and measuring both unfiltered (total) and filtered calcium (dissolved). The net particulate calcium can be used to represent the amount of particulate soil removed from the felt.

RESULTS

The following data was collected from a multi-sensor probe installed in the uhle box weir of one press position on a North American fine paper machine. In this case the probe is programmed to record values at one minute intervals. It is important to install the probes in an area of the weir that sees good mixing to ensure consistent sample data.

Figure I below displays pH and conductivity data collected before during and after a single fifteen minute batch-on-the-fly (BOTF) washing event with an alkaline cleaner. You will notice there is an initial spike in pH which validates that cleaning chemistry has been effectively delivered to the press felt and consequently arrived in the weir. The pH remains high and consistent suggesting chemical flow rate is consistent. Conductivity spikes at the beginning of the wash demonstrating elevated levels of dissolved ionic material are above and beyond the baseline, it's important to note the change in conductivity above baseline conductivity which in this case is 2000 µs/cm. Conductivity tapers as the wash progresses indicating that the amount of soils readily available for dissolution is declining. Following the wash, conductivity returns to close to pre-wash levels.

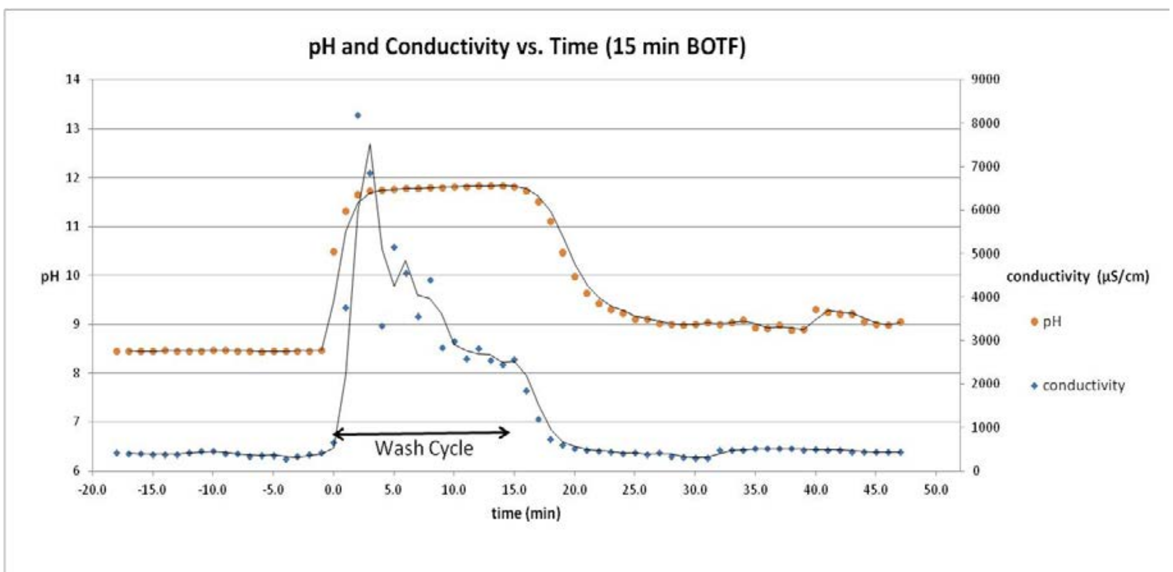

Figure I

Figure II below displays pH and turbidity as collected by the weir monitor once per minute along with a separate off-line lab turbidity measurement sampled every three minutes. The on-line turbidity does not follow the same trend as the off-line lab method, as mentioned earlier, there was a certain amount of foam and entrained air generated during this wash cycle. In this case, on-line turbidity needed to be verified against an off-line lab measurement. The off-line lab turbidity spikes at the six minute mark, takes a sharp drop at the 9 minute mark, and continues to decline as the wash progresses. Increased turbidity indicates the removal of dispersed but not dissolved contaminants. In this case, the bulk of the dispersed contaminant removal takes place in the first ten minutes of the wash cycle.

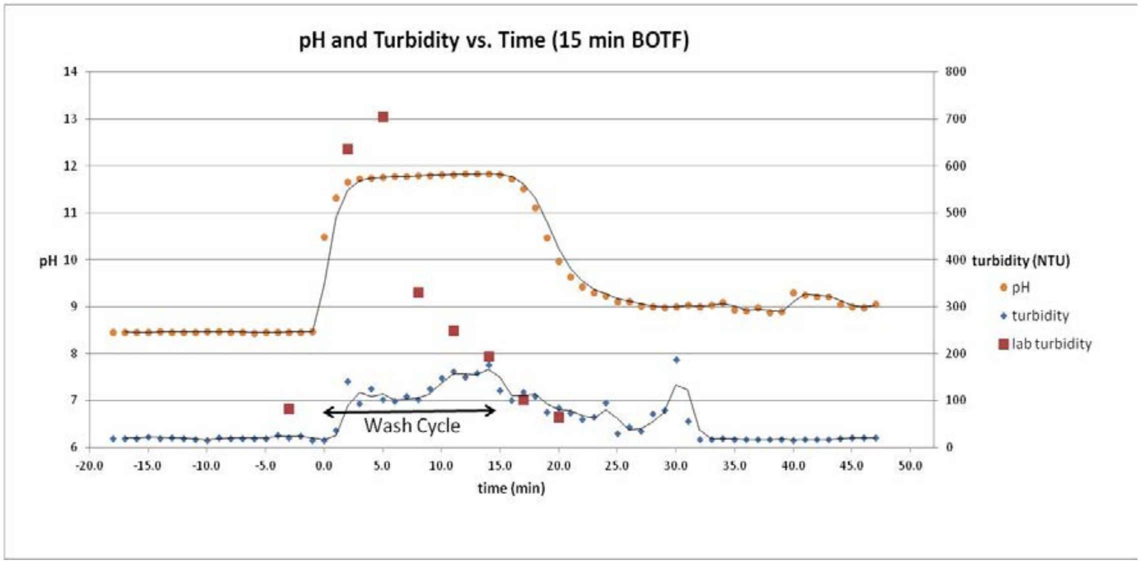

Figure II

Figure III shows the uhle box vacuum response to the wash. Uhle box vacuum was measured by vacuum transmitters. Notice there is an initial spike in uhle box vacuum, which is to be expected as additional liquid is being added to the felt with the fan shower application and can cause an increase in vacuum. Similarly, the use of an alkaline cleaner can produce some initial swelling of contaminants prior to removal. Fines and other contaminants swelling takes up void volume in the felt thus causing an increase in vacuum. Vacuum levels peak about three minutes into the wash and drops quite rapidly before leveling off after about 10 minutes.

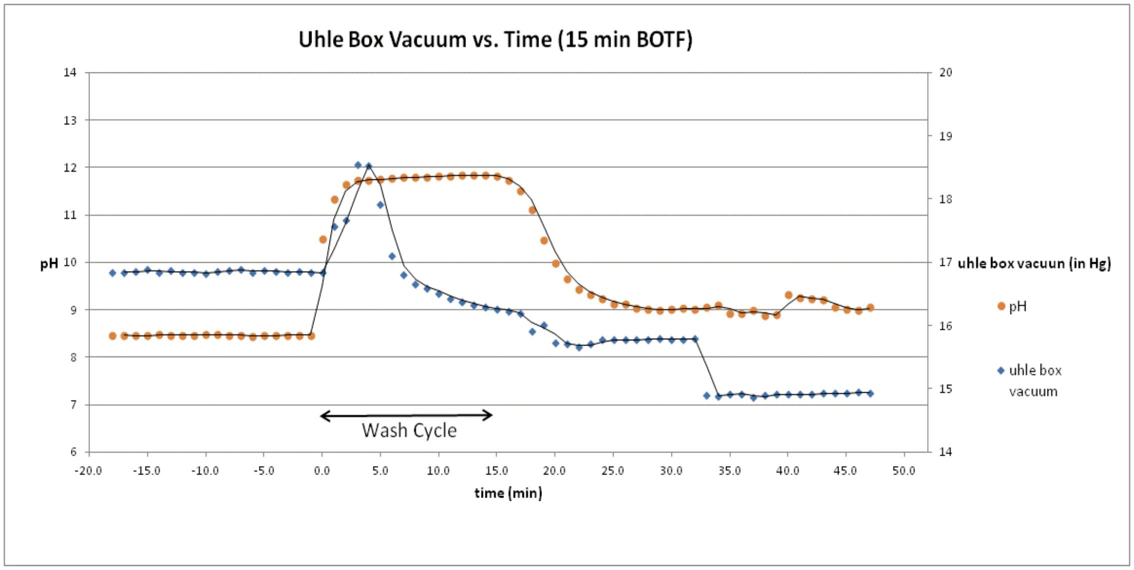

Figure III

Off -line measurements of samples collected before during and after a felt cleaning cycle can be also be used to identify the types and quantity of contaminant removed.

An example of calcium removal is shown in the next pair of graphs where off-line calcium testing was performed in both uhle box and nip weirs concurrently during a 15 minute alkaline washing cycle. Figure IV displays the cleaning effect where the amount of total calcium present in the weir increases during the course of the cleaning cycle. Additionally, even after the cleaning cycle had ended, calcium particulate material is still being removed from the press felt. Presumably this material has been dislodged from the felt matrix and continues to be removed through action of the high pressure needle showers and uhle box vacuum.

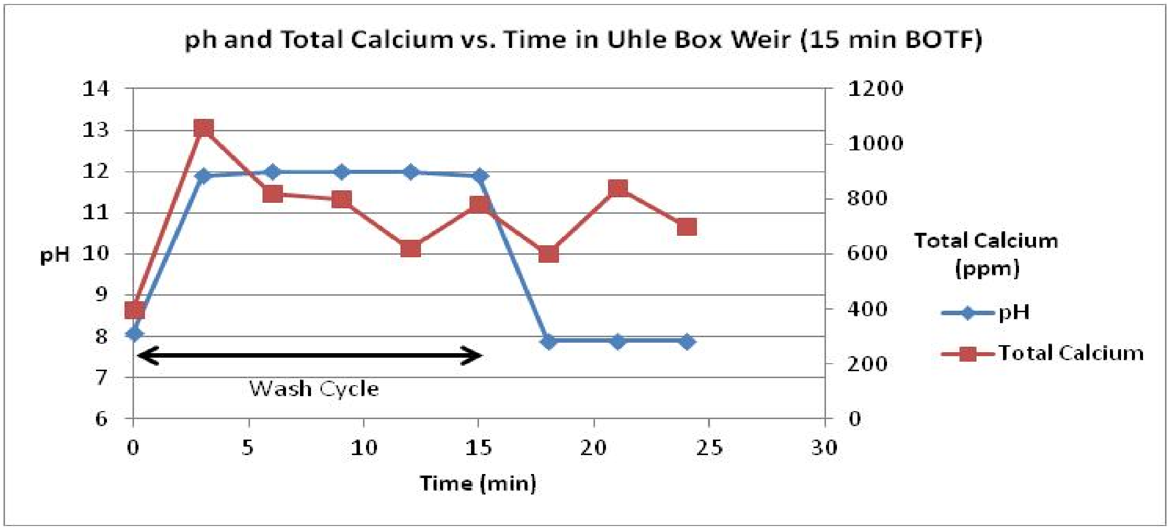

Figure IV

In Figure 5 total calcium levels are seen to rise especially during the course of the first half of the cleaning cycle. However, during the last half of the cycle the level of calcium removal decreased indicating that the total amount of this specific soil is removed early in the cleaning cycle at the nip.

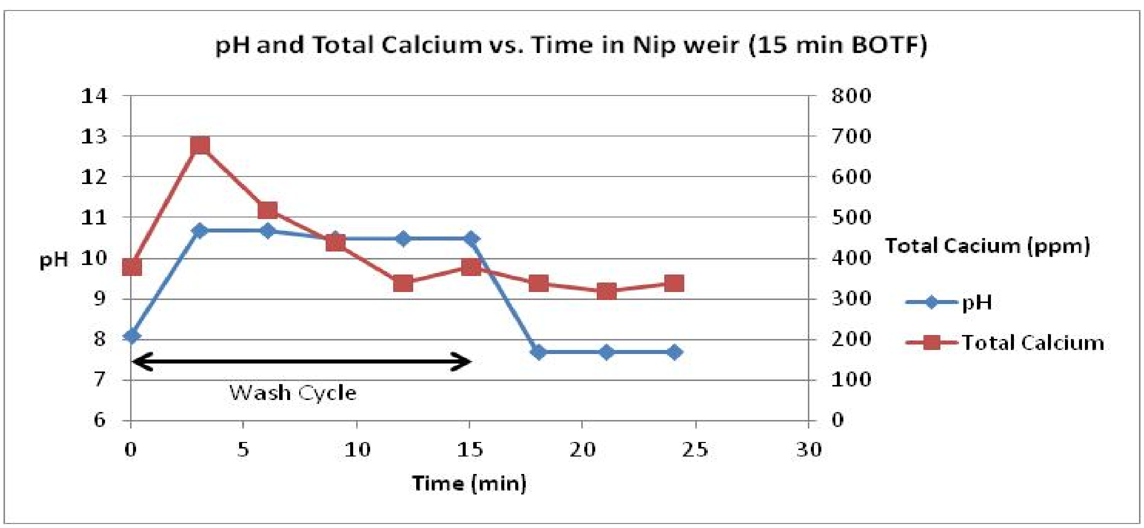

Figure V

Results Summary

The examination of both on- line and off -line data collected during wash cycles gives the papermaker an indication of the effectiveness of the program. For example, if parameters such as turbidity and conductivity stay high throughout the washing event without returning to prewash levels until after the wash is over, one can conclude that the cleaning event was incomplete and soils are still available for removal. Washing for a longer duration and/or using a higher concentration is the next logical step to ensuring maximum contaminant removal per cycle. On the other end hand, if conductivity and/or turbidity drop well before the wash cycle is ended, there may be room for optimization through reducing the time of the wash event or lowering the chemical concentration.

By evaluating washes using fixed chemical concentrations and washing durations it is also possible to determine the relative efficacies of different chemistries on soils removals. For example, a certain type of cleaner may yield better results in the form of total calcium removal or uhle box vacuum reduction than another cleaner at the same applied concentration and wash duration.

CONCLUSION

It is apparent that the monitoring and analysis of press section effluent parameters during chemical cleaning applications is a highly useful tool to assess and optimize chemical cleaning programs. It can be used to evaluate optimum concentrations, frequency and cycle length of felt cleaning programs.

It should be emphasized that this performance optimization methodology should work equally well on existing long-term felt cleaning programs as well as on the evaluation of new cleaning chemistries and application methods.

REFERENCES

Harold Laser, *Approaches to Optimizing Press Felt Cleaning,* PaperCon 2013