Novel Press Fabric Cleaning Method Increases Productivity in a Sustainable Manner

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ABSTRACT

A novel press fabric cleaning method has been shown to increase the productivity of a paper machine while at the same time reducing costs and the mill's environmental footprint. Most traditional forms of press fabric cleaning have some weaknesses. Continuous felt cleaning can use a relatively large amount of cleaning chemical in relation to the cleaning result. Downtime batch cleaning, while often effective reduces machine up-time. Batch on-the-run felt cleaning can impact press section stability as a result of pH swings and increased water loading during cleaning.

A new method of fabric cleaning was developed to avoid the limitations of such cleaning methods. This method has been shown to use less cleaning product than continuous felt cleaning, while providing more effective results. It also avoids substantial changes in pH and water loading during cleaning events, which increases the stability in the press section as compared to batch on-the-run felt cleaning.

The new method has been demonstrated to provide simultaneous financial and ecological benefits. Savings in water use, energy, and dryer section steam reduce operating cost while reducing the mill's environmental impact. This method has also been documented to boost production through increased machine speed, fewer breaks, and less downtime cleaning.

INTRODUCTION

A paper machine not using the most effective methods available to clean press fabric may be losing production while concurrently increasing operating cost. Effective fabric cleaning can increase paper machine profitability substantially, while simultaneously improving the mill's ecological footprint.

More stable operating conditions in the press section during cleaning can lead to fewer web breaks and increased uptime. Better web dewatering can lead to less steam usage in the dryer section, with the potential to increase machine speed. A program that is less reliant on down-time fabric cleaning can increase production uptime. Increased press fabric life can also increase uptime, reduce clothing cost, and reduce the number of used fabrics that ultimately go to landfill.

TRADITIONAL FABRIC CLEANING METHODS

Many of the traditional press fabric deposition control strategies have significant deficiencies.

One conventional method of fabric cleaning is to continuously apply a low concentration (usually 300-700 ppm) of cleaning chemistry to the fabric. This method of cleaning became popular 20-30 years ago as whitewater systems became more closed and machines converted from acid to alkaline papermaking. Continuous press fabric cleaning often uses an excess of cleaning chemistries in an inefficient manner. Acidic cleaning products while excellent at removing carbonate filler materials need to first neutralize the dissolved carbonates in the shower water. For this reason, many continuous programs fail on alkaline machines. If for example the white water has an M-alkalinity of 225 ppm and a total hardness of 225 ppm it will take 1,000 ppm as total acidity of product simply to neutralize this background alkalinity. The pH must then be brought down in order to solubilize the calcium carbonate in the felts. Calcium carbonate is 100 times more soluble at pH 5 than at pH 7. Various chelants and sequestrants also need to achieve a minimum concentration before they can attack the soils in a felt, otherwise they are absorbed by the background level of dissolved ions. Finally, many nonionic surfactants common in cleaning applications also have a minimum concentration needed to accomplish a desired cleaning result.

Downtime batch washing of press fabrics generally uses a significantly higher concentration of fabric cleaner. While often an effective means of remedial cleaning, this application method wastes precious manufacturing uptime.

A third method of fabric cleaning, commonly called “batch on-the-run” or “ batch on-the-fly”, applies cleaning chemistry via dedicated chemical fan or Uhle box lube showers. The higher shower product concentration may improve soils removal effectiveness versus continuous cleaning methods, but can negatively impact the press section water balance and press section stability during each cleaning cycle. It may also impose worker contact and exposure issues when attempting to work near the press section when press fabrics are being washed.

Continuous and batch on-the -fly intermittent cleaning commonly use dedicated chemical cleaning showers. These showers generate additional capital & maintenance costs, plus the added water and energy costs for their operation.

NEW METHOD OF PRESS FABRIC CLEANING

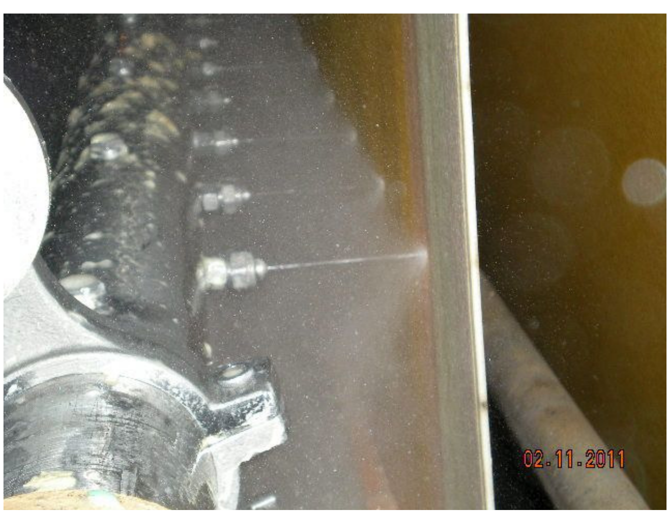
Given that each traditional method of fabric cleaning discussed has drawbacks, an experimental project was performed on a few paper machines, which led to the development of a new patented fabric cleaning method.

This new method provides a much more cost effective, safe, and sustainable solution for paper mills, without the problems associated with traditional application methods. This method uses frequent pulses of cleaning product which are applied only to small sections of the felt at one time. The cleaning product is applied using the high pressure needle showers already in continuous operation on most paper machine press sections. This eliminates the requirement for operation of dedicated press fabric cleaning fan showers, which will significantly reduce the water usage in the press section. In press sections with press speed matched shower oscillators, the pulsed cleaning event duration is selected based on the time requirements for needle jet point coverage of the entire fabric.

Using the H.P. needle showers also concentrates the applied cleaning chemistries in the finite area of the press fabric impacted by the needle jet at any given moment. Furthermore, the kinetic energy of the needle jet delivers the cleaning chemistry deeper into the press fabric top batt layer, where the majority of contaminant soils tend to accumulate. A cleaning synergy also results from combining the applied needle jet force with optimum spot cleaning chemistry concentrations.

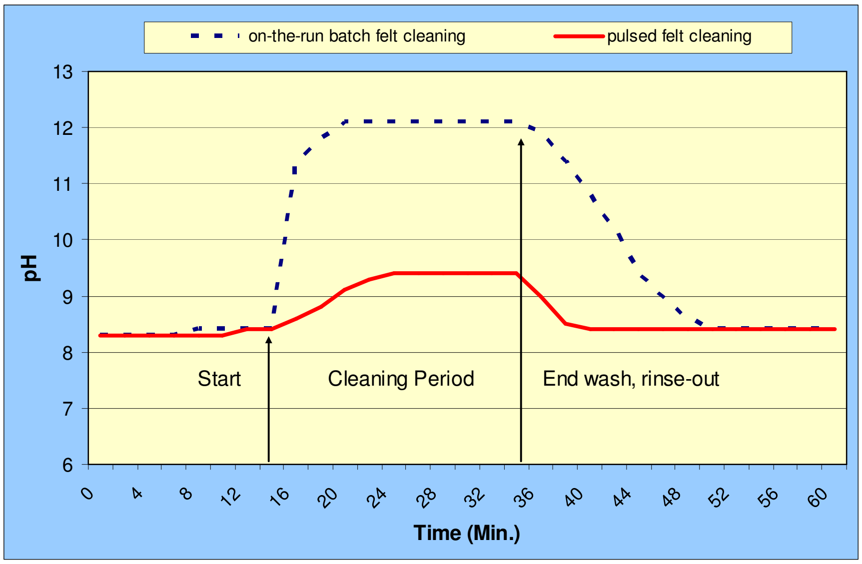
Compared to a method that applies the cleaning chemistries across the entire fabric width, the high pressure needle jets allows a more effective concentration to be achieved in the localized felt section being cleaned at a given moment. Figure (i) shows a typical high pressure needle shower on a press fabric.

Figure i. High pressure needle showers can effectively cleaning localized sections of the press fabric



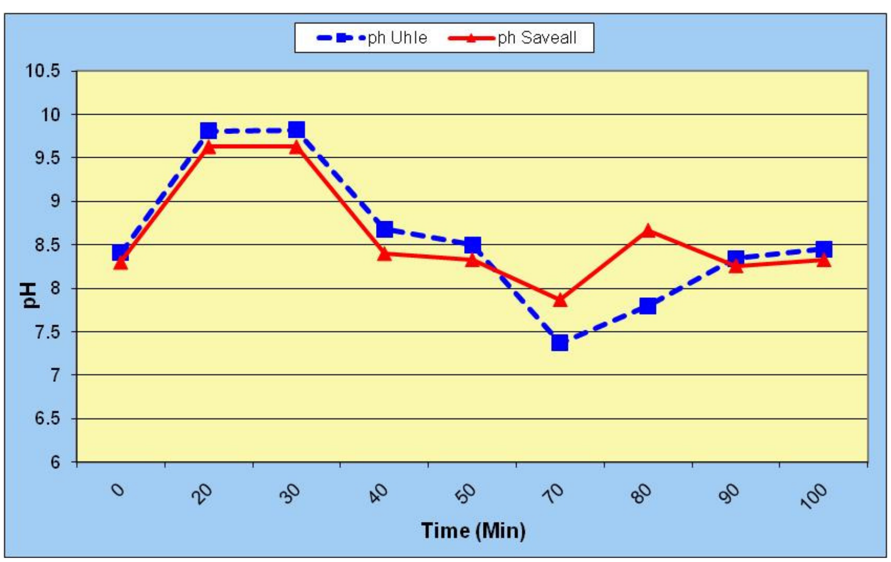
Press fabric shower water pH should be maintained near the same pH as the headbox to avoid additional deposits or chemical shock[1]. Conventional "batch on-the-run" cleaning often can substantially change the pH throughout the press section. Figure (ii) shows a comparison of the pH effect of an alkaline detergent washing of press fabrics utilizing the pulsed cleaning, versus typical conventional "on-the-run" fan shower washing. Both washes used the same alkaline fabric cleaner on a coated free-sheet machine. The impact on the pH of the press filtrate during the batch on-the-run wash is substantially greater than with the pulsed cleaning method. Large pH swings in the press section can inhibit water transport, lead to tackification of organic soils, increase press draws, and possible increases in sheet defects and sheet picking tendency[2].

Figure ii. Impact of Conventional On-the-run Batch Wash vs. Pulsed Fabric Cleaning Method



A second example demonstrates a typical pulse scenario where an alkaline detergent is immediately followed by an acidic cleaner on a coated free sheet machine. As Figure (iii) below shows, the pH does not deviate more than 1.5 points from the baseline. There is no large pH swing that can inhibit water transport and affect press stability.

Figure iii, pH effect of pulsed cleaning event at Uhle box and save-all, bottom fabric



Advanced PLC control of the cleaning chemical pulse events provides the capability to more closely match chemical cleaning intensity to needs. This program control flexibility allows for customized application times, variable concentration, and multiple chemistry applications. Additionally, the program can be optimized by fabric position to maximize the program ROI, by providing only the cleaning intensity needed on a given fabric position. The ability to apply varying ratios of solvent, acidic or alkaline cleaning chemistries can provide optimum broad spectrum contaminant control. The cleaning program for each fabric position can also evolve over time as mill process changes result in a changing nature and rate of fabric soiling.

PLC control also makes a less elaborate pumping system possible. A single pump can be directed to deliver cleaning chemistry to all fabric positions, while still tailoring concentration, duration, and frequency by individual fabric. This control flexibility allows for a chemical feed system that is less complex, less expensive, requires less maintenance, and has a smaller physical footprint.

CASE STUDIES

The pulsed method of fabric cleaning has resulted in simultaneous productivity gains, operating cost saving, and environmental benefits on many machines. In one example, a Midwestern U.S. paper machine producing specialty and printing and writing grades was experiencing poor press stability while using a traditional batch on-the-run fabric wash program. The production staff was interested in a fabric cleaning program that would improve fabric cleaning efficacy, improve press stability while cleaning, and provide for improved safety around the machine press section.

After conducting a press section survey, water balance studies, fabric analytics, and fabric permeability analyses a fabric cleaning and performance monitoring program was implemented using the pulsed cleaning method. The program employed alternating pulse cycles of an organic acid cleaner and an alkaline cleaner. PLC control allowed the frequency, duration, and chemical concentration to be tailored to each fabric position. The cleaning program was coupled with a press filtrate monitoring system that continually recorded press filtrate chemistry parameters and aided in optimizing the fabric cleaning program.

Because this method of fabric cleaning was applied through the high pressure needle showers, the showers used for the prior fabric cleaning method were no longer operated. Consequently, almost two million gallons per year of heated shower water were eliminated.

Sheet solids increased by an average of 1.3% across all grades. This corresponded to a savings of over six million pounds of steam use in the dryer section, which corresponded to an annual savings of $24,000.

Fabric life was increased by five days on average for each position, resulting in 2.7 fewer fabrics used per year and an estimated $80,000 annual cost savings.

Productivity gains were also achieved in addition to the environmental and cost savings. First, the concentration of chemical used during the cleaning cycles was 7-8 times lower than with the previous program, increasing the stability of the press section. The improved stability resulted in an overall 15% reduction in sheet breaks. Secondly, machine speed increased by an average of 0.4%. Finally, downtime batch fabric washes were reduced by 50%. The combined improvements yielded the ability to produce an additional 3,905 tons annually, with an estimated value of almost $345,000.

The overall economic impact of the new program yielded $459,683/year, which was achieved with no increased felt cleaning cost compared to the previously program. This corresponds to a net ROI of 222%,

Finally, the combination of lower concentrations of cleaning chemistry and the fact that only a small sections of the fabric are cleaned at any one moment improved worker safety during cleaning events.

Table (i) summarizes the program savings achieved by the program.

Table i, First Case Study Results Summary

Key Process Savings	Program Results	Value
Defect/Rejects Saving	12 tons/yr	$2,460
Production Savings from Reduced Breaks	864 min/yr	$79,950
Production Savings from Reduced Batch Washing	720 min/yr	$66,625
Production Savings from increased Speed	965 tons/yr	$197,896
Press Water Savings (Heated Water)	1,890,000 gal/yr	$8,503
Dryer Steam Savings	6,115,200 lbs/yr	$24,461
Increased Fabric Life Savings	2.7 felts/yr	$79,787
Total Returned Value		**$459,683**
Net Return on Investment (%)		**222%**

In a second application, a Midwestern U.S. paper machine producing coated free sheet grades, principally medium to heavy basis weights, was experiencing poor press fabric de-watering performance and severe fabric shedding. Consequently, the machine was required to operate slower on heavier grades. The legacy fabric cleaning program insufficiently removed internal fabric deposits, while fabric shedding was determined to be primarily due to damage from the halogens level in the shower water.

After reviewing the problem, a new fabric cleaning and performance monitoring program was implemented. The traditional batch on-the-run fabric cleaning program was replaced with the pulsed method of fabric cleaning using alternating cycles of acid and alkaline cleaning. In addition, an organic oxidant scavenger product was applied continuously to the shower water to protect the fabric from halogen damage.

The new program provided cost and environmental benefits. As in the first example, the dedicated fabric cleaning showers were eliminated. These showers had been relatively high flow and consequently 18 million gallons per year of heated shower water were removed from the press section. The improved fabric dewatering and reduced showering increased average sheet solids leaving the press section by 2.0% (from 42.3 to 44.3%). The increased sheet solids reduced dryer steam usage by an estimated 13.4 million lbs/yr, which was valued at $67,000.

Press fabric life increased by an average of 5 days, resulting in a cost savings of $66,000.

Production gains were also achieved. Average machine speed increased by 0.6%. Uptime increased due to fewer downtime batch fabric washes (60 minutes less per month) and a slight reduction in breaks (average 30 minutes/month). The overall increased production had a value of $219,000/yr.

The combined operational cost savings and production gains yielded a total financial benefit of $443,518, which equaled a 493% net ROI. The benefits were obtained at a cleaning program cost that was lower than the previous program. The gains demonstrated are summarized in Table (ii).

Table ii, Second Case Study Results Summary

Key Process Savings	Program Results	Value
Production Savings from Reduced Breaks	360 min/yr	$19,113
Production Savings from Reduced Batch Washing	720 min/yr	$38,225
Production Savings from increased Speed	931 tons/yr	$161,790
Press Water Savings (Heated Water)	18,144,000 gal/yr	$90,702
Dryer Steam Savings	13,440,000 lbs/yr	$67,200
Increased Fabric Life Savings	2.7 Felts/yr	$66,489
Total Returned Value		**$443,518**
Net Return on Investment (%)		**493%**

The pulsed method of fabric cleaning has also been utilized on machines producing printing and writing, linerboard, tissue, and specialty grades.

CONCLUSIONS

Effective felt cleaning increases the competitiveness of a paper machine while providing ecological benefits. Every machine should quantify the results of its chemical felt cleaning program and maximum the return on that investment. The cleaning method and the program monitoring protocol are critical to gaining the most advantage for press section operation. The new pulsed method of cleaning has been demonstrated to provide a greater total return than historical felt cleaning methods on machines across North America.

ACKNOWLEDGEMENT

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