Sustainable Cleaning & Deposit

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Abstract

Sustainable cleaning products and practices can lead to better profitability for a paper machine. Eco-efficient methods of cleaning in paper mills can improve runnabilty, reduce downtime, and save water and energy, which can contribute to profitability at the same time as sustainability.

One example of eco-efficient cleaning is newer boilout products that can be used to reduce downtime, water, and energy use. The pH neutralization of high alkalinity boilout solutions can often be eliminated. In some cases, a boilout can be completed as a "zero discharge" process.

Newer methods of cleaning paper machine fabrics can also provide more sustainable solution for paper mills. New application strategies can provide substantial profitability gains by reducing dryer section steam consumption, minimizing press shower water use, and minimizing the need for downtime press fabric cleaning. Practices like continuous cleaning of press felts can in many cases be eliminated by using application methods that utilize less cleaning chemical. Press section stability during cleaning can also be improved in many cases.

Additionally, a paper mill's choice of cleaning product is another area where direct cost savings and sustainability can simultaneously be achieved. A traditional approach to the purchase of cleaning products is sometimes focused on price per gallon as the method of comparing cost. However, highly concentrated cleaning products and product intermediates can be shipped to a mill site and then be used efficiently with properly designed dispensing systems. Such products can provide significant direct cost savings to the mill as well as reducing the environment impact of shipping and packaging. Ultimately, use-cost via the application methods often have the greatest impact upon sustainable cleaning programs, not the unit cost for the chemical.

This paper will provide examples of the savings that can be associated within each of these areas of cleaning solutions.

Introduction

While sustainability has no one official meaning, a commonly used definition is "the ability of an ecosystem to maintain ecological processes, functions, biodiversity and productivity into the future". While this definition covers the global enviromental goals, it is is hard to think about in terms of profitable day to day operation of a paper machine. The term eco-efficiency was defined by the World Business Council for Sustainable Development (WBCSD) in its 1992 publication "Changing Course" as a management philosophy which encourages business to search for environmental improvements that yield parallel economic benefits. It focuses on business opportunities and allows companies to become more environmentally responsible and more profitable .

Ultimately this concept of creating more with less results in increased productivity from resources and ultimately a competitve advantage. While the term may be relatively new, the concept is not. In 1926, Henry Ford wrote "You must get the most out of the power, the materials, and the time". His lean and clean policies saved his company money by recycling and reusing materials, reducing the use of natural resources, minimizing packaging, and setting new standards in human labor with his timesaving assembly line . The paper industry has a long history in which numerous examples of eco-efficiency could be sited. One of the biggest examples would be the kraft mill, which is essentially a cyclical process which recycles pulping chemicals and is a renewable source accounting for 41% of the overall paper industry energy use .

Eco-efficient methods of cleaning in paper mills can use this concept of doing more with less. Cleaning technologies that improve runnabilty, reduce downtime, and save water and energy will contribute to profitability at the same time as sustainability.

Increasing pressure on water and recycled fiber supply will provide greater challenges for eco-efficient cleaning. It has been reported that 46 states expect some water shortages by 2013 . The paper industry has had a long term focus on reduced water usage, and will likely be tasked with further reducing use. Increased water system closure, achieved through recycling of treated water, will lead to higher levels of dissolved organic and inorganic substances in the whitewater, which is likely to result in both operational and product quality problems. Potential problems which may result include: buildup of fines, pitch, and dissolved solids, system temperature increase, increased potential for scaling and corrosion, deterioration of product quality, reduced production efficiency .

While the economic downturn of the second half of 2008 resulted in a short-term drop in the demand for recovered fiber, long-term global demand has increased dramatically. North American recovery rates continue to increase, but cannot keep up with demand. The expansion of the Chinese paper industry and its reliance on foreign sources of recovered fiber has strained supply. As a result, lower quality sources of recovered fiber which were not normally collected are now being utilized. These sources can be higher in plastics and other contaminants.

Three areas of paper machine cleaning will be discussed as examples of where eco-efficient products and application methods can yield solutions with both economic and environmental benefits.

Boilout Strategies

A paper machine wet-end boilout is one example where new chemistries can be used to improve eco-efficiency. A conventional caustic thin stock boilout procedure sometimes includes dumping the stock prior to charging the system with the boilout solution. The boilout is often completed at very high pH (over 12.0). In most cases the boilout concludes with the discharge of the spent boilout solution to the mill wastewater treatment facility. In many cases, neutralization of the boilout solution is required.

The typical boilout process has several opportunities for better profitability and sustainability. Every dump and refill of the system looses the energy used to heat the thin stock loop, increases mill effluent and water use, and extends down-time. The time during the boilout process can be unproductive time for maintenance and machine clothing changes since the harsh chemistries used prevent working in area of the wet-end. Furthermore, the cost of commodity sodium and potassium hydroxide, which are used for manufacturing alkaline boilout products, has increased approximately 40% and 90% respectively during 2008 . Some mills are also required to chemically neutralize the pH of spent boilout chemical, which increases chemical use and extends the downtime. If the neutralization is performed while the boilout solution is still in the machine system (which is often the case), then soil precipitates can reform and redeposit. This procedure can undermine the intended cleaning program, not only wasting effort and costs, but may also lead to sheet dirt or defects upon startup.

Products are available for boilouts that can eliminate some of the system dumping steps, eliminate the need for neutralization, and in some cases even be done without discharging the spent boilout solution. One such product class is built around a stabilized hydrogen peroxide backbone. The peroxide, along with detergent and co-solvent, provided the ideal combination to breakdown the soils encountered without presenting cleaner residues with a high pH. An advantage of hydrogen peroxide is that it breaks down organic soils, and is converted into oxygen and water during the chemical reaction. The chemistry is also effective in removing the products of bio-fouling without the use of harsh chemistries. After reaction with organic soils in the system, the spent boilout solution will be near neutral pH. In addition, the safety profile of some newer boilout products can allow mill personnel to work closer to the wet-end and complete maintenance work and press felt changes.

A comparison of the cost of using a stabilized peroxide cleaner versus an alkaline boilout was completed for a specific coated freesheet machine. In this example, the traditional boilout practice was to use a specialty alkaline boilout product along with commodity sodium hydroxide. The mill's procedure was to initially dump and refill the system, requiring one hour. Secondly, a one-hour boilout was completed. Afterward, the pH was then neutralized with phosphoric acid, requiring 30-minutes. The boilout then concluded with a final system dump and refill, which required one additional hour. A cost comparison was made using the stabilized peroxide boilout strategy. In this scenario, the initial dump and refill would be eliminated along with the neutralization step. The annual cost savings are shown in Table 1.

Table 1. Boilout Savings using a Stabilized Peroxide Product vs. Alkaline Boilout with pH Neutralization

	Total Savings
Downtime*	$210,000
Chemical Cost	$2,622
Total	**$212,622**

*Based on seven boilouts per year and downtime costs of $20,000/Hr

A stabilized peroxide cleaner has been used to perform a boilout with no discharge. The Greif Corp. mill in Massillon OH manufactures 140,000 tons annually of 100% recycled 21#, 23#, 26#, and 33# medium. In the spring of 2005, the mill's two machines had to shut down every couple of days to wash up due to slime breaks. Biocide use was increased, but it still had minimal effectiveness. The mill had no wastewater discharge beyond atmospheric evaporation. DuBois Chemicals worked with Grief to develop a plan for a zero-discharge boilout of the entire production system from the pulper through the wet-end of both machines using a product containing a stabilized hydrogen peroxide .

Upon start-up after the boilout, no production problems were reported. System pH was normal, and there was no excessive foaming on the machines. Aerobic bacteria counts 24-hours after startup were 95.7% lower than the level prior to the boilout. In the three months before the boilout, the mill averaged 1-2 sheet splices per day as a result of slime holes. In the months after the boilout, there were no reported slime holes and no resulting splices, which improved product quality. The number of wash-ups dropped from one every 3.1 days to one every 5.3 days. The length of wash-up was also reported to have decreased . Grief has continued to refine the procedure and continues to boilout 2-3 times annually.

The same class of stabilized peroxide cleaner has been successfully used in coater system cleaning as a cost-effective and sustainable solution. Caustic boilouts can be relatively ineffective because they have little reactivity with the coating formulation (i.e. calcium carbonate, bentonite clay, TiO_2 as a brightening agent). A stabilized peroxide cleaner has been shown to penetrate into fissures and cracks in the deposited coating while also attacking the coating binders. Oxygen bubbles generated inside the deposited coating causes pressure and breaks apart the coating. External coater system cleaning can also be completed effectively and more safely with this chemistry. The following example depicts the superior results of using this cleaning technology on a paper machine coater head. In addition to effectively cleaning the internal coating system via a boilout, it is equally important to clean the coater-head area to avoid sheet defects due to coating deposit slough-offs and contamination. Likewise, coating deposits can harbor microbiological organisms that can cause odor and sheet contamination, while producing an environment for under-deposit corrosion of metals such as stainless steel. Over twenty coater systems in North America and a few in Asia have used this chemistry for both boilout and external coater cleaning.

Figure 1. Before (left) and After (right) Photos of Coater Head when cleaned with Stabilized Peroxide Cleaner Product

Press Felt Cleaning Strategies

Newer methods of cleaning paper machine fabrics can also provide more sustainable solutions for paper mills. Traditional continuous felt conditioning can be replaced in most situations by newer cleaning strategies which are more cost effective. Continuous felt cleaning often uses an excess of cleaning product in an ineffective manner. On-the-run batch washing may be more effective at soils removal versus continuous cleaning, but can negatively impact the press stability during each cleaning cycle. Downtime batch felt washing is an effective means of remedial cleaning, but wastes precious manufacturing time.

A new method of felt cleaning can utilize cleaning product to provide more effective results while minimizing impact to press section stability or downtime dedicated to felt washing. This method uses frequent pulses of low concentration cleaning product applied to localized sections of the press fabric. This method can also allow for the elimination of dedicated felt cleaning showers, which reduce water usage in the press section. Furthermore, it also eliminates possible press section runnability issues versus traditional on-the-run batch cleaning. Figure 2 shows a comparison of the pH effect of an alkaline detergent washing of press fabrics utilizing the pulsed cleaning, versus conventional on-the-run batch washing. The study was completed on a coated freesheet machine and used the same alkaline felt wash product. The impact on the pH of the press filtrate during on-the-run batch wash is substantially greater than with the pulsed cleaning method. Large pH swings in the press section can lead to tackification of organic soils, increased press draws, possible increases in sheet picking tendency, and possible sheet defects. It can also impose worker safety issues when attempting to work near the press section when felts are being washed.

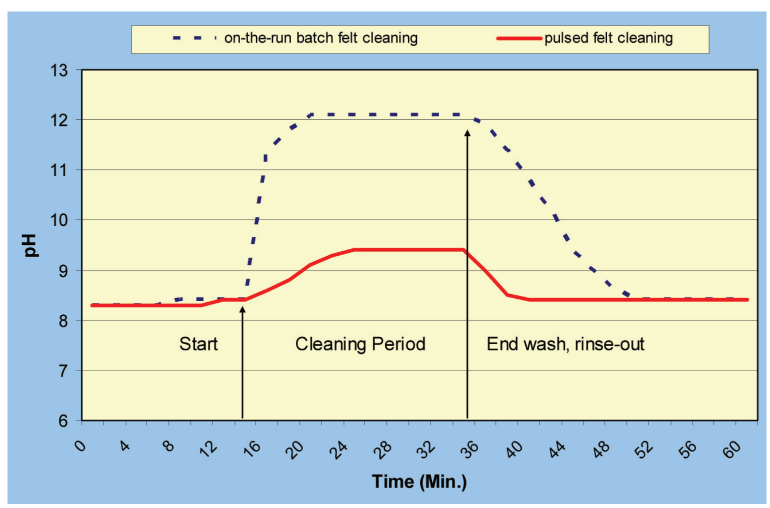

Figure 2. Impact of Conventional On-the-run Batch Wash vs. Pulsed Felt Cleaning Method

In another case study, a coated freesheet machine converted from using on-the-run and downtime batch washing to a pulsed cleaning. The press felt cleaning efficacy was greatly improved, producing an average of a 2.1% increase in sheet solids entering the drying section, which has a substantial impact on steam usage in the dryer section. A higher solids sheet entering the dryers will also typically be stronger and allow for the draw going into the dryer to be reduced, which can reduce sheet breaks. Dedicated press felt cleaning showers were eliminated, resulting in a savings of 20 million gallons of warm shower water annually, along with the energy used to heat that water. As shown in Table 3, the value of such a change in cleaning strategy can be over $500,000 annually.

Table 3. Savings at a Coated Freesheet Mill After Converting to a Pulsed Press Felt Cleaning Strategy

Average change in solids leaving the press section	2.1%
Heated water use reduction (gallons)	20 Million

Savings from dryer steam reduction	$394,474
Saving associated with water reduction	$30,000
Saving from energy to heat shower water	$59,327
Felt cleaning chemical savings	$16,940
Total savings	**$500,741**

Savings based on estimated steam cost of $8/1000 lb, total water costs of $1.50/1,000 gallons, and shower water heated by 57°F using natural gas at $8/MM Btu

Since every machine differs in its operating characteristics, a press felt cleaning survey should be performed to ensure the most effective cleaning strategy, and the return on investment should be verified with analytical tools.

Concentrated Cleaners

In addition to the many new cleaning strategies available to mills, various cleaning products can also be formulated in concentrated forms that have cost and sustainability benefits. A traditional approach to the purchase of cleaning chemistries sometimes focused on price per gallon of product as the method of comparing cost. This purchasing behavior promoted formulation of products to lower concentrations in order to suggest a lower application cost. A more sustainable solution is to establish a cleaning program that minimizes the total amount of products that must be brought to a mill site and ensure it is used efficiently. Many costs associated with freight, packaging, receiving, inventory and handling can be minimized. Secondarily, this approach lowers the mill's overall carbon footprint.

In the simplest form, highly concentrated cleaners are available that can be diluted accurately at a mill site to the end-use concentration. More specialized products can also be brought into a mill site as components or intermediates used to build the products to satisfy the mill's cleaning needs. Accurate and consistent blending is important to success. Automated blending systems are available to formulate the materials with accuracy. Automated systems are also available to dilute product to end-use concentration and eliminate the risk of overusing the concentrated product.

Profitability	Cost of producing and shipping 1 tote bin of Product A	Cost of producing and shipping 3 tote bins of Product A	Cost of 1 tote bin of triple strength Product A concentrate
Raw materials	0.48	1.44	1.44
Labor	0.27	0.81	0.27
Packaging	0.11	0.33	0.11
Transportation	0.14	0.42	0.14
Total Relative Cost	**1**	**3**	**1.96**
Savings, resulting in lower product cost			**35%**

Sustainability
Fewer totes of product to transport, saving fuel and reducing carbon footprint 66%
Less petroleum-based material, energy, and other resources used to manufacture tote bins
Fewer empty totes to be shipped for return
Fewer totes to be storred and transported around mill site
Less water and energy used to clean and recycle totes
Fewer totes to be landfilled at end of useful life

Table 4. Example of eco-efficiency associated with using concentrated chemical cleaner products

Table 4 illustrates the potential savings from such a program. The costs associated with providing three IBC/tote bins of a specific papermill press felt cleaner are compared to one tote of a triple strength concentrate (values shown are relative costs of each component, not specific monetary values). The overall cost of the triple strength concentrate in this example is 35% lower than three totes of the alternative, and result in a lower cost to the paper mill.

Conclusions

Eco-efficient strategies can be incorporated in paper mill cleaning products and application methods to meet the needs of today's paper industry. Savings in downtime, energy, water and chemical cost can be achieved using such principles. By adopting such strategies, profitability and sustainability can be simultaneously enhanced.

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