# Approaches to Optimizing Press Felt Cleaning

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## Abstract

Cleaning, conditioning and the prevention of soils accumulation in press felts is a vital aspect of press section operation. Higher speed machines, including modern tissue machines, present limits on the types and amounts of chemicals needed to properly clean press fabrics. As machines close up their water loops and the levels of additives increases, maintaining press felt performance has become more challenging. This has necessitated looking at the mechanism of how felt cleaners operate at a more fundamental level. The effects of cleaning chemicals in felts is modeled and simulated to determine the most effective application methodologies for specific machine conditions. A variety of factors such as machine speed, press felt moisture, type and levels of background contaminants in the press felt and process water can have significant impacts on the cleaning effectiveness of a felt conditioning program. Threshold cleaning is the concept of finding and attaining the minimum amount of cleaning chemistry needed to achieve a cleaning effect in a press felts. This is done by measuring and calculating the background levels of soils in press felts and then applying the appropriate amount of functional cleaner to remove the soils present in the felt. Various cleaning strategies are evaluated using this type of modeling and their effectiveness is compared.

## Introduction

Proper sheet dewatering is important for the development of sheet properties, water removal, and press section runnability. Maintaining felt cleanliness by the removal of accumulated contaminants is a key method needed to accomplish this objective. This can be accomplished by a variety of means; including proper showering, optimizing Uhle box operation and the suitable application of cleaning chemicals. This paper will focus on the proper application of cleaning chemicals.

The soils in press fabrics typically accumulate over the life of the felt and are often complex mixtures of various contaminants. These contaminants consist of a variety of materials embedded in the felt matrix. Once particulate material enters the press felt, it may become attached to other soils in the fabric through chemical or physical adsorption. Mechanical cleaning may be able to remove the soil at this point. Once established in the press felt batt, the carbonate deposits may then grow in size to the point where only chemical cleaning may be able to remove it. Understanding the nature of these soils is paramount to being able to remove them in order to apply the proper cleaning chemistries and concentrations. Typically, inorganic soils require an acid or chelant to remove them. Organic soils often require a source of alkali combined with builders, solvents, surfactants and possibly oxidizers. Before a proper cleaning chemistry is selected, a proper understanding of the factors that influence the effective concentration is needed to achieve the desired cleaning effect. This latter step is often overlooked in felt cleaning applications. Many machine conditions cause changes in the activity of these components and/or alter the active form that these cleaning agents take when applied. A model is proposed to help evaluate these changing conditions and take into account their effect on felt cleaning. When chemical conditions in a press felt are modeled there is often found a threshold level below which felt cleaning agents do not work or work very poorly. Varying machine conditions can have a dramatic effect on these threshold levels.

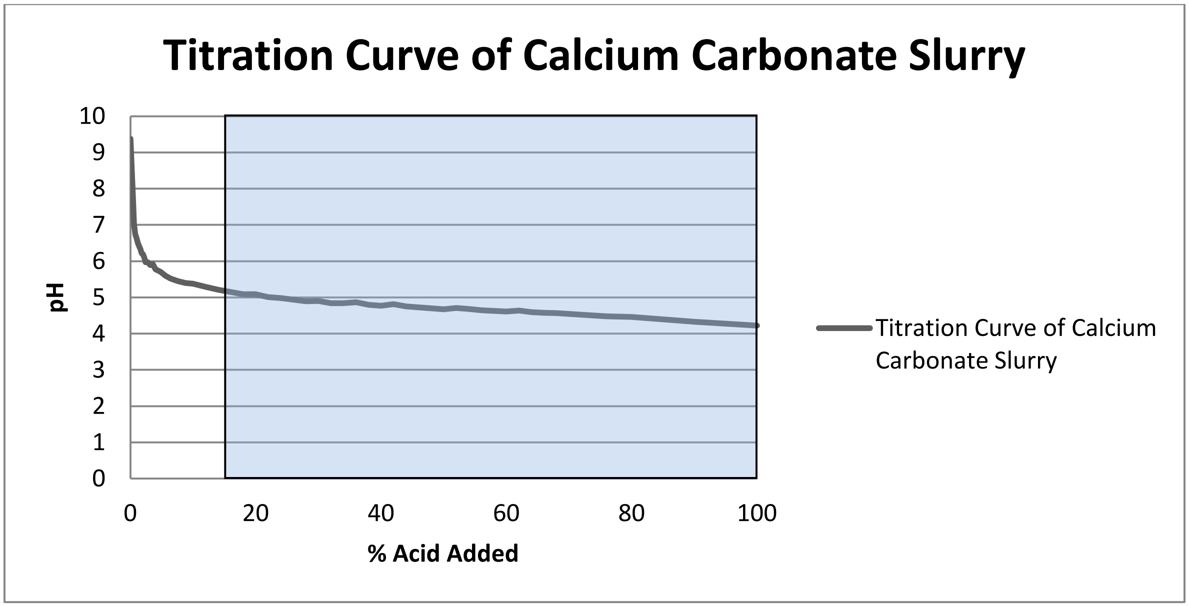
## Discussion

As a basic example, a common contaminant is calcium carbonate, which is often complexed with organic materials. Although chemically it is simple to remove calcium carbonate filling using batch washing, it is considerably more difficult to do so when the machine is running. Calcium carbonate may form in press felts in a few ways. The most common is through filtration of unbound calcium carbonate from the sheet and process water. As it passes through the felt, calcium carbonate particles become trapped in the felt batt. The majority of this material can be removed if it done fairly quickly through the application of high-pressure needle showers and Uhle box vacuum. However, with successive nip cycles the calcium carbonate will become more deeply embedded in the felt fiber matrix, as well as become fixed with organic contaminants, which act as physical and chemical binders. At this point, the preferred method to remove this material will be predominantly chemical based using materials such as acids and chelants. Batch cleaning is an option since it is easy to achieve the required chemical concentrations through the application of high strength cleaning agents. This requires taking downtime and is often not economically desirable. Therefore, continuous or batch-on-the-run cleaning is often considered to be a viable alternative. However, wet end machine conditions and press operations will now have a dramatic influence on the effectiveness of these two approaches.

As an example, neutral and alkaline machines, which have high total and dissolved solids will often have background buffering which neutralizes cleaning chemicals applied. This is a factor often overlooked when these products are applied onto a machine, resulting in ineffective felt cleaning, excessive use costs, and excessive chemical consumption. This level of background contamination is one source for establishing the threshold level needed to attain adequate felt cleaning. Actual felt cleaning will not take place below this level since all the active ingredients in a felt conditioner will be consumed at these levels found in press and shower water. When using a batch-on-the-run or continuous cleaning program the effect of this contamination becomes substantially more dominant compared to downtime batch cleaning. This is because generally a large volume of press water is exposed to the cleaning chemical before it ever contacts the contaminants in the press felt.

The threshold levels are directly proportional to the volume of water processed by the press felt and hence are dependent upon factors such as wet end chemistry, machine speed, press felt design, total shower flow volumes and locations. Wet end chemistry is a major factor. For example, in order to clean calcium carbonate by using an acid, certain pH levels are required. The neutralization curve for calcium carbonate filler is shown in Figure 1.

**FIGURE 1**



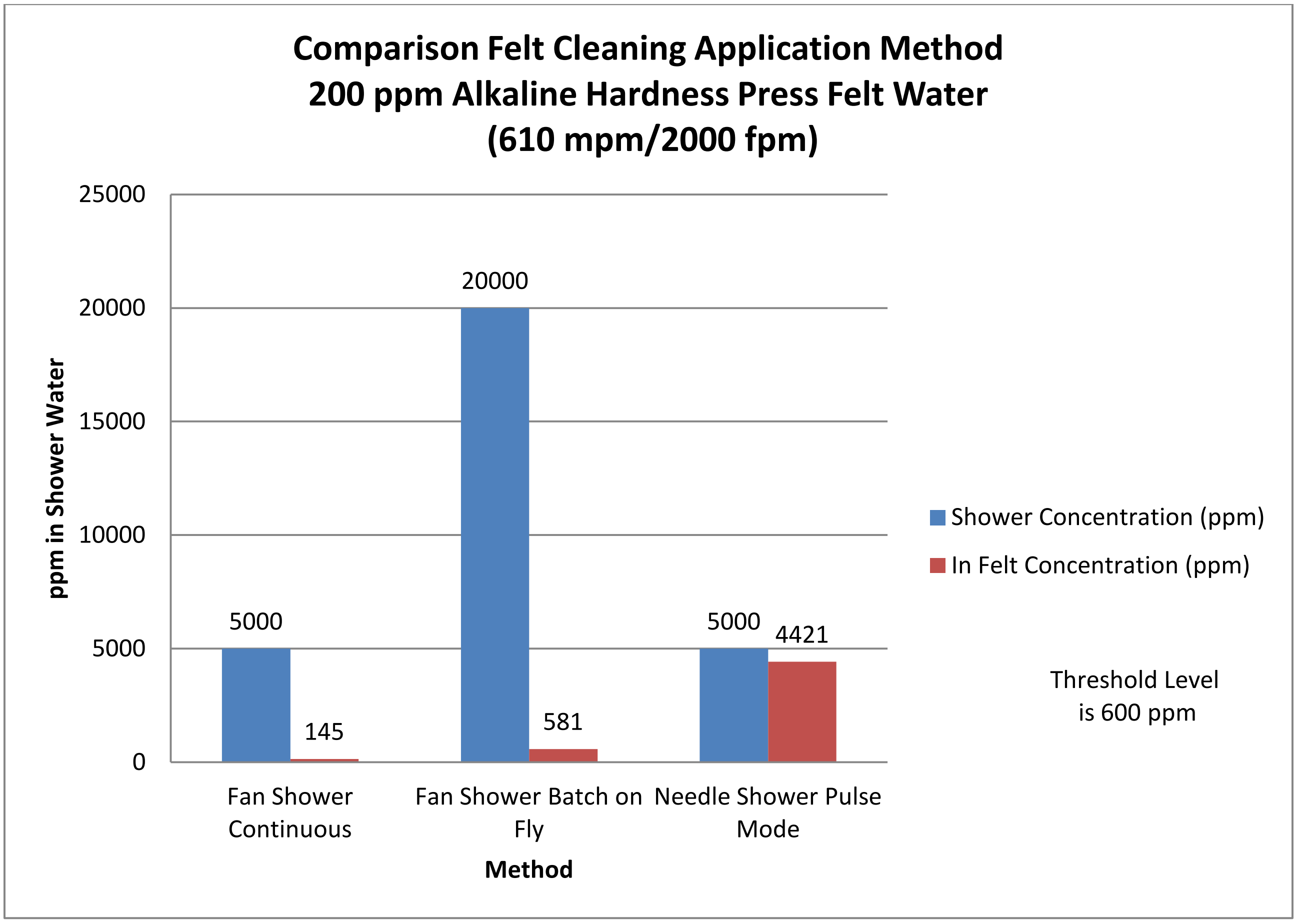

This curve reveals that the cleaning agent needs to achieve a pH below 5.5 in the body of the felt. Some alkaline machines have wet end chemistry that has a high buffer capacity. This buffered water in the felt will absorb any acid applied before it has a chance to react with the accumulated carbonate soils in the press felt. The concentration of acid felt cleaner needed to overcome this buffering effect would be one example of the threshold that must be achieved before providing any cleaning to the press felt. It is sometimes extraordinarily difficult to overcome this threshold effect to provide felt cleaning while the press section is operating due to the speed and dilution effects inherent in the press felt itself.

As an example, consider the following scenario:

- Fan shower with nozzles of 0.5 GPM (1.89 lpm), 55 degree angle, distance 8 inches from the fabric, 10.2” coverage per nozzle
- High pressure needle showers 0.04” (1 mm), 0.5 GPM (1.89 lpm)
- 2000 ft/min (610 m/min) machine speed
- 400 g/m2 average felt moisture
- Press filtrate water alkaline hardness of 200 ppm
- Acid used is organic, press felt safe at a rate of 6% of 20% active for fan nozzles and 4000 ppm for needle jet application.
- The threshold value is calculated by taking a neutralization rate of 50% of alkaline hardness by organic acid

- In this example, the acid needed was 150 mg/liter of press filtrate, which translates into 600 ppm of actual cleaning product.

**FIGURE 2**

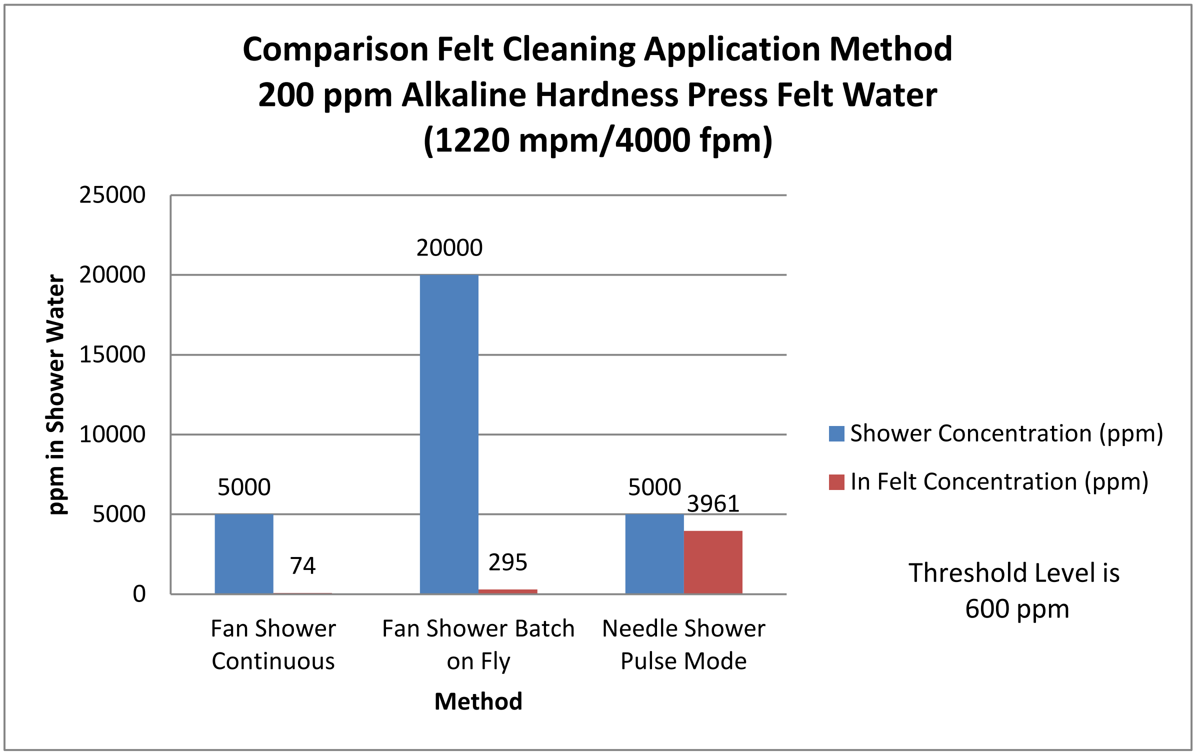



With a threshold value of 600 ppm needed to effect cleaning, it can be seen in Figure 2 that a continuous felt cleaning program that achieved 5000 ppm in the shower would only result in 145 ppm in the press felt under this scenario. Therefore, a continuous program would be completely ineffective. A batch-on-the-run program, which applied a 2% cleaning solution (20,000 ppm), would only neutralize the background alkaline calcium in the water and have little acidity remaining to target the soils in the felt.

Using needle showers allows the application of sufficiently high levels of cleaning chemicals, which provide high “in-felt” concentrations while at the same time leaving the majority of the felt unaffected by excessive chemical use.

In the above example, the speed of the machine was set at a conservative 2000 fpm. However, when machine speed increases the model will predict that the “in-felt” cleaning concentration will decrease. In fact, using similar parameters to that shown above, it can be shown that the significance of the threshold level needed to effect cleaning increases, such that, unless special consideration is given to the “in-felt” concentration, all cleaning agents will be below the threshold value.  Using this model and increasing the speed to 4000 fpm (1220 meters/min), it can be demonstrated that the actual concentration in the felt of the cleaning decreases below the threshold in the batch-on-the-run scenario but not in the pulse method using the needle showers in Figure 3.

**FIGURE 3**




The effect of variations in machine speed can similarly be modeled with the same acid and carbonate cleaning system. Using the example of fan showers in Figure 4 and using 250 ppm of alkaline calcium carbonate, an acid cleaner can provide cleaning only up to 1500 fpm. As the speed increases the threshold level increases such that above 500 m/min (1600 fpm), all the cleaning agents are neutralized and cleaning effectiveness is significantly diminished.

When the same cleaning program is applied using needle showers, speed will also have an effect, however it will be to a much lesser degree and the useful range for cleaning is extended to significantly higher machine speeds as seen in Figure 5. In this example, using the same parameters as in Figure 4, the in-felt concentration remains well above the threshold level.

Figure 4

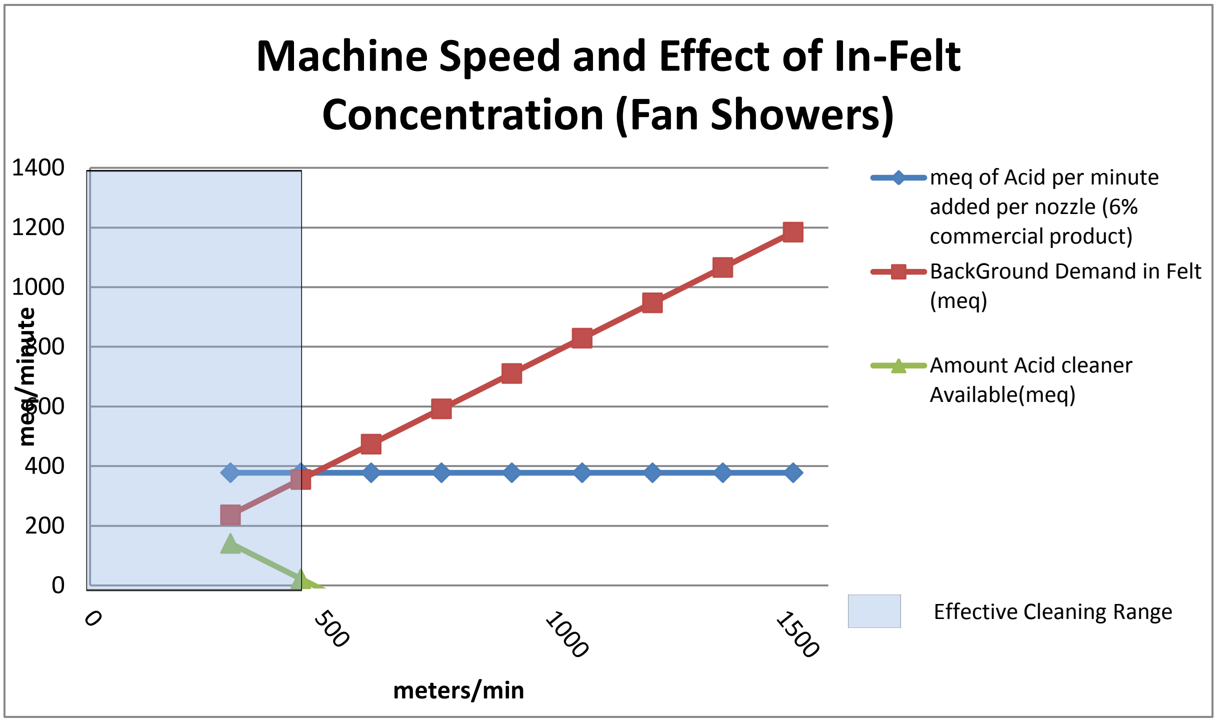
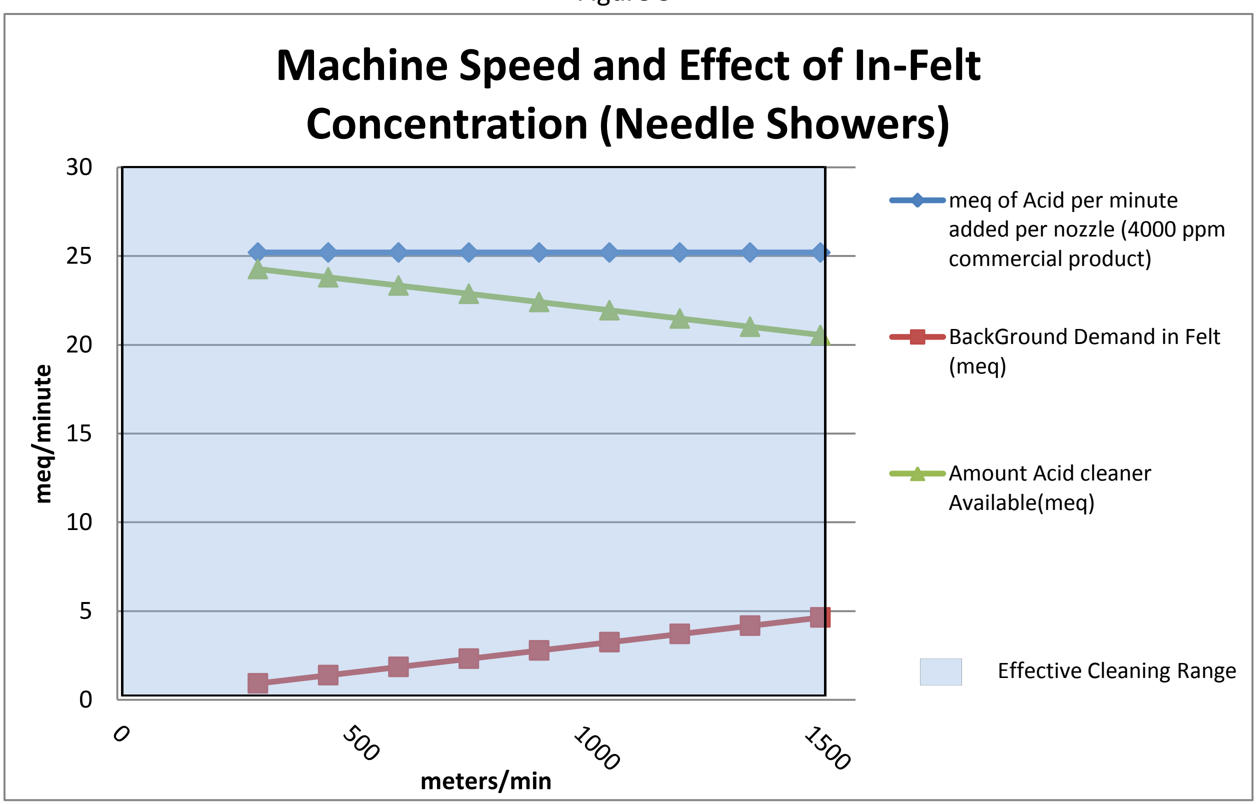


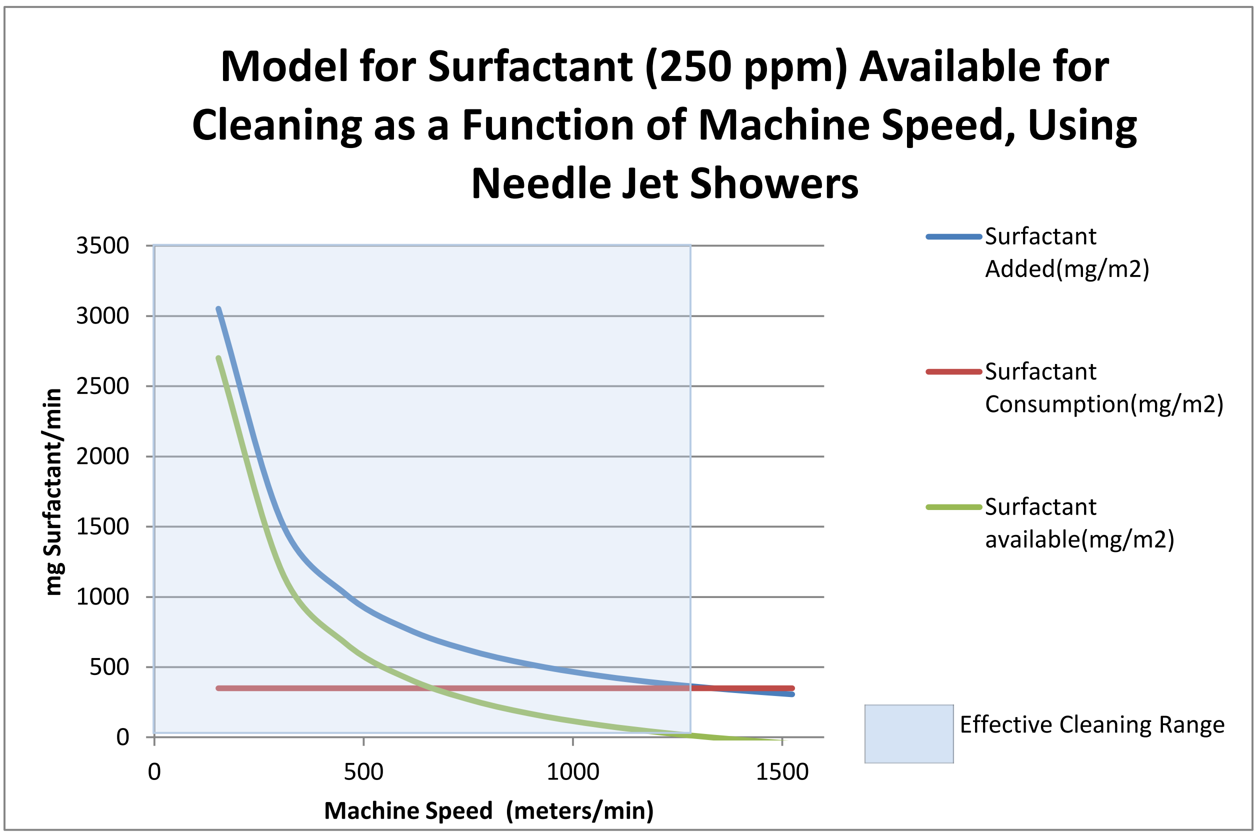

Figure 5



Threshold levels will vary depending on the type of cleaning agents used. Surfactants, for example, are an important component for conditioning and cleaning press felts. They typically adsorb onto hydrophobic organic surfaces. As such, they adsorb onto resins and fatty acids and help to disperse and emulsify them. However, they will also adsorb onto nylon surfaces found in press felts. This should be taken into account when determining optimum levels of surfactants. In another experiment, the threshold value of a particular surfactant was determined by measuring surfactant uptake of a press felt. Normally an excess of nonionic surfactant is needed to effect adequate removal of organic soils from synthetic fibers in a press felt. Using surface tension measurements it was shown that a 1210 GSM press felt consumed 350 mg/sq meter of the surfactant. This means that this threshold value must be satisfied before cleaning can be achieved. For example, in a scenario where 250 ppm of surfactant in the cleaning shower is used to clean a press felt the area treated must be kept to a minimum to avoid excessive adsorption of the surfactant by the fabric.

The impact of adding 250 ppm concentration of surfactant through a needle shower of 0.5 gpm (1.89 lpm) flow was modeled. The results are shown in Figure 6 and show that there is surfactant remaining available for cleaning up to a machine speed of 1200 m/min.

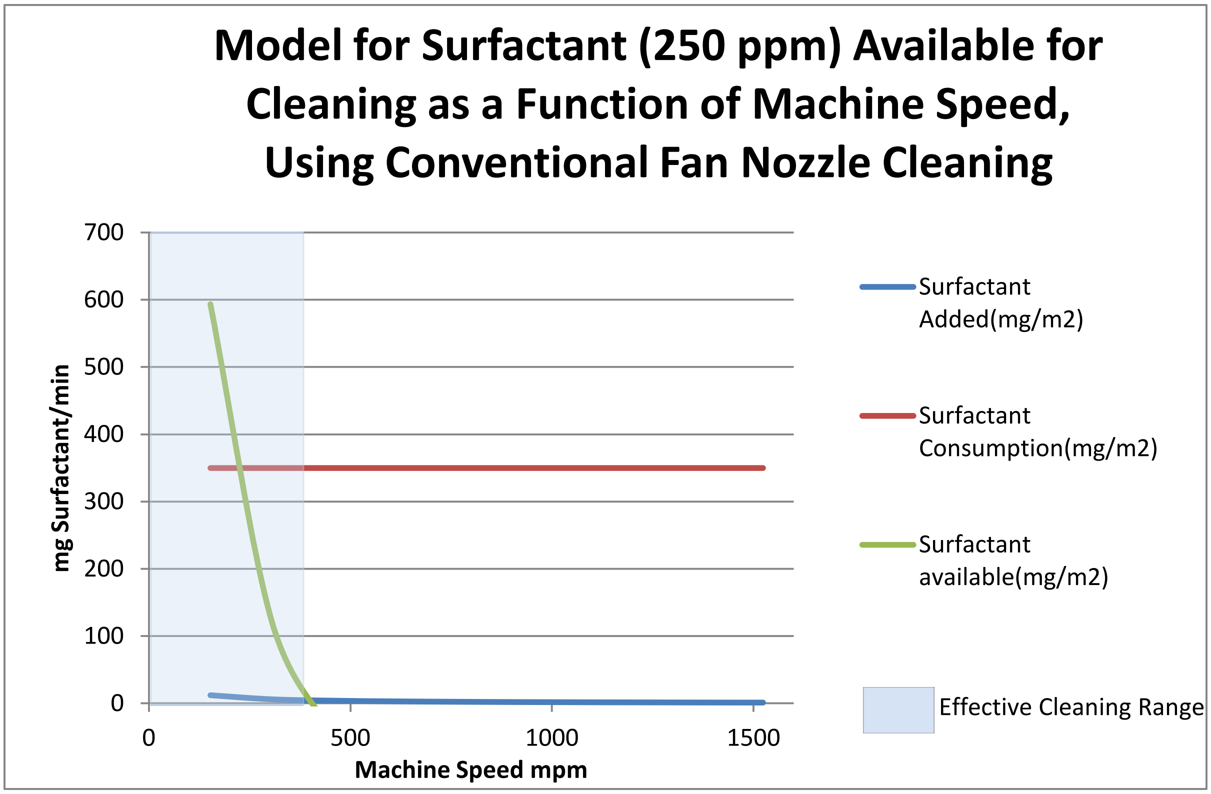
**FIGURE 6**




As machine speed increases, more and more of the area of the felt is exposed to the felt conditioner and the effective remaining agent available for cleaning is decreased to the point that at 1300 m/min the surfactant is largely adsorbed onto the press felt and not available for soil emulsification and dispersion. This model will vary by other factors, which include temperature, ionic strength of the water in the fabric, as well as the organic contaminants in the press felt, which all play a role in the surfactant uptake of the press felt.

Figure 7 shows the same conditions, but using fan nozzles of 0.5 gpm (1.89 lpm) flow. This model predicts that much less cleaning of existing soils will take place.

**FIGURE 7**




## Mill Monitoring

The principles of threshold cleaning have been employed in numerous felt cleaning applications. In one example, a twin-press alkaline machine was monitored for pH and threshold levels to determine the effective amount of cleaning agents present in the felt during alkaline and acid cleaning cycles. The two press felts on this machine experienced routine felt filling with calcium carbonate filler. In order to remove this material, downtime batch washing was used routinely. Instead, it was decided to try an application of cleaning chemicals through the high-pressure needle showers during production. By looking at the Uhle box weir water, shower water, and threshold levels for cleaning, an optimum cleaning agent concentration could be calculated.

Figure 8 summarizes the acid and threshold levels needed to achieve cleaning (negative numbers denote free acid):

**FIGURE 8**

| | pH | Threshold Level (meq acid/liter) |
|---|---|---|
| First Press Uhle Box | 8.03 | 5.99 |
| Second Press Uhle Box | 8.07 | 7.79 |
| Acid Event UB1 | 7.72 | 8.22 |
| Acid Event UB2 | 7.51 | 3.58 |
| Shower Water | 7.45 | 2.39 |
| Total Acid Added (Meq/min) in Shower | 4.54 | -10.46 |

It can be deduced that a level of at least 5.99 and 7.79 meq/liter of acid needed to be applied in order to achieve a threshold cleaning level for calcium carbonate removal in the first and second felts, respectively. The acid in the shower water can accomplish this since it is at a level of 10.46 meq/liter, and hence it can remove the threshold level of carbonate as well as have excess acid left over to clean the felt. Other cleaning methodologies make achieving threshold levels much more difficult due to the dilution effect of water in a moving felt and the background levels of carbonate and soils present in press felt water. The comparison of fan shower and needle shower cleaning methods is shown in Figure 9.

**FIGURE 9**

| | | UB1 | UB2 |
|---|---|---|---|
| Needle Shower | Total Liters/min Press Felt Exposed to Shower UB1/nozzle | 0.18 | 0.08 |
| | Total Meq/min Carbonate Threshold | 1.08 | 0.62 |
| | Total Acid Added (meq/min) | 19.77 | 19.77 |
| | Residual Acid Available for Cleaning (meq/liter) | 18.69 | 19.15 |
| Fan Shower | Total liters/min press felt exposed to shower (10”coverage) UB1/nozzle | 45.10 | 20.00 |
| | Total Meq/min Carbonate Threshold | 270.15 | 155.80 |
| | Total Acid Added (meq/min) | 19.77 | 19.77 |
| | Residual Acid Available for Cleaning (meq/liter) | -250.38 | -136.03 |

An acidic fan shower application will reduce the pH in the press felt. However, due to the high buffer capacity of the water in the press section (i.e. the threshold amount) there will be no cleaning of the press felt since these methods will experience a dilution of only 1-5% of the original applied concentration. This means that in order to clean this felt, very large quantities of acid must be used, which can typically only be achieved in downtime cleaning. The only real, viable alternative for cleaning during machine operation would be to use a pulse method through needle showers, which will have a dilution achieving 70-80% of the applied concentration and so will overcome the threshold levels in the felt.

## Conclusion

Effective felt cleaning is highly dependent on machine factors, which influence the threshold level of application cleaning chemistries needed to maintain felt porosity.

Higher levels of all of the following will typically increase the threshold levels for effective cleaning:

- Higher machine speed
- Increase shower flow volumes (pressure and orifice size)
- Press felt moisture content between the nip and the Uhle box
- Dissolved and suspended solids
- Flooded nip showers
- Heavier felts or felts with finer denier

These factors need to be considered when implementing a felt cleaning program. The proper monitoring of shower bar concentration of active cleaning materials using parameters such as pH, free and combined alkalinity, surface tension, calcium and other inorganic material, as well as matching these to weir box analyses means the effective concentration of the cleaning agents can be calculated in the felt. This information can be used to determine the optimum concentration of product in the press felt. Using this approach, a lot of guesswork can be eliminated and the relative effectiveness of press felt conditioning can be anticipated.


## Acknowledgements

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## References


John Schwamberger David Kelso, *Novel Press Fabric Cleaning Method Increases Productivity in a Sustainable Manner*, 2011 PaperCon Conference Proceedings (May 2012)