Select the Right Brown Stock Defoamer for your Washing Operations

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ABSTRACT:

Brown Stock Washing is a critical step for optimizing production as well as controlling production costs. There are many different washing systems in use with a variety of configurations and characteristics influenced by fiber morphology, liquor parameters, etc., all with their own advantages and limitations. A common thread amongst all of the variations is that to operate beyond a very rudimentary level, they all use defoamer chemistry to function efficiently. With each process being unique in terms of configuration, equipment technology, capacity, process constraints, and control strategy, etc., how do you select the right defoamer for your washing operations? This paper reviews the selection criteria and methodology for determining the right product for any BSW system. The implications of product chemistry and characteristics are covered as well as the process characteristics and impacts of control strategies. By broadening the view beyond lab screening or what is being used at another location, selecting the optimal defoamer for a washer system is a comprehensive approach that rewards the operation with the best cost performance.

INTRODUCTION:

Pulp washing is crucial to the economics of chemical pulp manufacturing. The washing process separates fibers from the chemicals and dissolved wood components generated during the cooking process. Washed pulp quality is always weighed against production rate, bleaching costs, evaporator loading and make-up chemical costs. Clean fibers are essential for optimization of bleaching and papermaking chemistries as well as minimization of make-up chemical costs in the liquor cycle. Those benefits are balanced against the water and energy costs associated with washing and evaporation, as well as the efficiency degradation experienced as production exceeds design capacity of the processing equipment.

The generic goals of washing are: use the minimum amount of shower water; recover the maximum amount of liquor solids; and, produce the cleanest pulp possible. Every mill is unique when considering the aggregate variables of wood species, process configuration, equipment design, cooking parameters, control strategies, and quality targets. Therefore, the minimum amount of water, maximum solids and cleanest pulp possible are specific to an operation and not universal values. The washing process serves two internal customers with expectations that at
times can be in conflict. The Recovery operations usually desire the highest black liquor solids possible while the Paper or Bleaching operations want the least amount of carryover or residual chemicals remaining with the fibers, at the desired production rate. In this scenario, production rate is often the overruling factor and no one gets everything they want.

Fortunately there is a solution to many of these trade-off challenges - defoamer. Defoamer, wash aid, drainage aid, and antifoam all refer to products developed as foam control chemistries and washing enhancers (collectively referred to as “defoamers”). The purpose of these products is to regain, or even exceed, efficiencies lost due to foam and/or entrained air in the washing process, as well as efficiency deterioration associated with increased throughput. The right chemistry in conjunction with the right application strategy can generate dramatic improvements in a challenged washing operation.

Selecting the right defoamer for a given process can bring the following benefits:

- Improved entrained air and foam control
- Increased washing efficiency
- Reduced soda loss, pitch deposition and extractives content
- Enhanced drainage and increased pulp production
- Reduced bleach chemical demand
- Higher black liquor solids to Evaps
- Lower operational cost

There are numerous chemistries and raw materials (1, 2) that can be combined to create unique defoamers with very specific characteristics and price points. Regulatory compliance will also limit certain chemistries depending on the application or end use of the pulp. The result is a plethora of defoamer products available that may, or may not, provide the optimal washing performance in any given system. So, how do you select the right defoamer for a specific washing system?

A common approach has always been “What product is being used at mill X?”’, “What is being used by someone that makes the same grade?”, or “What product is being used in this wood basket?” The limitations with this approach are that a product being used somewhere else doesn’t establish that it is the right product for that location, nor does it verify that the needs and demands of one location are identical to the other.

Another approach has been, “This product was developed for xx liquor (or yy pulp or zz washers.) You have xx liquor, so this is the best product for your operation.” There are generally some key
characteristics related to a product that will make it a decent choice for other mills that have that same criteria, but that doesn’t ensure that it is the right product.

The most utilized selection approach has been to use some version of the recirculating foam cell to compare products. This has been an invaluable tool for product development and an aid to product selection for many, many years. The limitation is that it does not mimic any washing process or equipment and cannot be used to select products based solely on the comparative data generated (3). Picking a defoamer based only on what product generates the most impressive Knockdown or Persistency graph is hit or miss in real world success rate.

These devices are great for establishing relative performance characteristics for different products, but do not reliably identify the right product for a given application. A skilled foam cell operator can discern subtle characteristics relating to bubble size, stability and drainage implications that are not obvious to an inexperienced operator or casual observer. It is very effective in establishing how much of that characteristic is present in one product relative to another. But, the foam cell does not establish how much of a performance characteristic is required for a given system. And it does not provide any direct feedback on the liquor – fiber interactions.

The pulp and paper industry is always under pressure to maintain cost competitiveness. The washing process has significant implications on the economics of the operation both upstream, in chemical recovery, and downstream, in subsequent fiber processing and quality. Selecting the right defoamer for a system plays a key role in not just the applied cost of the defoamer but the overall operating costs of the mill. With carryover of hydrophobic defoamer components a potential downstream cost, the best performing or lowest cost defoamer on the washers is not always the right product for a mill. Some equipment, processes and control strategies are more susceptible to hydrophobe carryover than others. Defoamer formulations will exhibit different dispersibility characteristics depending on the formulation specifics as well as the process liquor qualities. Selecting the best defoamer for an operation is more complex than most realize.

A holistic approach is necessary to define performance criteria, process limitations and unique demands in order to select the right defoamer. Wood species, black liquor chemistry, process configuration, equipment design and capacity, control strategies, application considerations, chemistry restrictions, upstream and downstream sensitivities, and operator influence all have a role in defoamer selection. Only by taking into account all of the demands and limitations of a specific location and the unique and subtle characteristics of available defoamer formulations can the product that provides the greatest benefit be selected.
Impact of Black Liquor

Foam issues in Kraft pulping are almost exclusively relegated to systems containing black liquor. Air can be physically trapped in fiber streams but is not stable foam without stabilizing agents, which are abundant in the black liquor created from the cooking process. Black liquor is the most complex liquor in the pulp mill and consists of a wide range of organic and inorganic components (4). The composition of black liquor varies from mill to mill and is influenced greatly by the wood species and cooking conditions. Black liquor foaming characteristics are impacted primarily by the organic portion of the liquor. While there are multiple organic chemistries transferred into the liquor during the cooking process, the most important in terms of foam stabilization are fatty and resin acids (5). The quantity of carboxylic acids in the liquor and their specific structures are mainly regulated by wood species, chip source and storage conditions, and pulping conditions. To stabilize foam, a surface active agent is necessary to lower the surface tension. In Kraft pulping, the materials released from wood provide enough surfactancy to reduce surface tension (6) and stabilize enormous quantities of air in black liquor systems.

The surfactants present in the black liquor also help to emulsify and disperse contaminants which enable them to be washed from the pulp easier. Generally softwood black liquors have greater surfactancy than hardwood black liquors which accounts for higher foaming and lower pitch deposition tendencies. In Scandinavian mills, it is common to add tall oil recovered from softwood operations into the digester to improve deresination of hardwood pulps (7).

During the washing process, the foaming nature of the liquor is very important but the interaction between the liquor and the fibers plays a crucial role in washing efficiency. Fiber morphology helps to establish the pore structure and permeability of a pulp mat as liquor is drained or displaced. Larger, bulkier fibers naturally have higher permeability than smaller, more compressible fibers. Drainage and displacement rates can be a limitation for any pulp washing operation but are typically more pronounced when dealing with shorter or low coarseness fibers. With or without foam present, drainage rates for an equivalent mat mass are slower for low coarseness pulps. This impact is exacerbated by significant levels of entrained air and foam in the liquor passing through the mat. The volume flux requirement is greater in direct proportion to the volume of air in the liquor and additionally, depending on the size and stability of the air, the overall mat permeability can be decreased due to pore blockage by bubbles (8, 9).

The solids level and the viscosity of the black liquor play a role in the drainage characteristics on a given washer as well. At higher solids levels the relative concentration of all of the liquor components increases. When systems are pushed to provide higher solids to the evaporators, there is a trade-off between wash water and the degree of washing possible. Heavier black liquor in the
first stage filtrate means higher solids in the pulp and dilution streams entering the washers. Assuming the washing efficiency remains the same, the amount of liquor solids and soda loss exiting the washers rises. Increasing liquor solids requires that washing efficiency is also improved or washed pulp quality suffers. A defoamer program that is quite capable at one liquor solids level may be insufficient when operating at higher solids due to changes in liquor characteristics and demands of the process.

Additional challenges arise in swing mills as soapier SW black liquor must drain through the less permeable HW mat during transitions. The low coarseness HW fibers generate more resistance to the flow of the soapy liquor than the higher coarseness SW fibers, resulting in washing and production limitations until the SW liquor is purged from the process. Swing lines can be extra challenging for defoamer selection because instead of a single fiber/liquor combination to deal with, there are 4 blends that are transitioned through routinely. Those include SW fiber/SW liquor, HW fiber/SW liquor, HW fiber/HW liquor, SW fiber/HW liquor, and the less defined variations in between. An effective defoamer in these systems is a compromise of cost and performance over the range of varying demands.

Defoamers are designed to interact in specific manners with black liquor to provide foam control and drainage enhancement. Different black liquor properties can change the dispersibility, spreading characteristics, foam control performance and deposition potential of a given product. Normally a product has a range of liquor properties in which it performs reliably but once that range is exceeded, costs will outweigh benefits. It is important to understand the role that black liquor plays in washing performance as well as how it interacts with defoamer formulations.

**Process Limitations and Requirements**

While black liquor characteristics play an important role in the potential for foam generation, the process configuration and characteristics will determine how much of the liquor foaming potential is actually realized. A relatively low foaming liquor in a process with lots of agitation and air introduction will require a more robust defoamer program than a high foaming liquor in a well-designed process with few shear points and minimal air introduction. The types of equipment as well as the piping configurations, vessel capacities, line velocities, and control strategies influence the defoaming demands and must be considered in defoamer selection.

Many types of washers have been used in the Kraft pulping process including Diffusers (atmospheric and pressurized), Displacement Drum Washer (DD), Drum Washer (Vacuum and Pressure, as well as Compact Baffle), Chemiwasher and Wash Press. Even though all washers are designed around similar pulp washing theories, each style emphasizes a different
combination of wash strategies over others. As a result, there are differing requirements for
defoamer properties and performance based on the type of washer utilized.

**Pressure and Atmospheric Diffusers**

Diffuser, classified as pressurized or atmospheric, is most often associated with a continuous
digester but can function in other configurations. Because it is a closed system, defoamer demand
is typically low but the filtrate tanks can require treatment. If the wash filtrate contains significant
entrained air or foam, it can impact the washing efficiency and channeling characteristics in the
diffuser. Unlike most other washing equipment, diffusers provide time for intra-fiber diffusion of
liquor and contaminants. As production rate increases, the screen stroke increases and outlet pulp
consistency can decrease. In order to recover outlet pulp consistency, high draining defoamers are
more effective than high knockdown products to improve the washed pulp quality.

**Drum Washers**

Drum washers include vacuum washers that operate with a lower than atmospheric internal
pressure, and pressure washers that drive drainage through application of pressure greater than
atmospheric outside the drum. The *Vacuum Drum Washer* is the most common washer in the
industry. Simple operation and flexibility over broad operating conditions make this type of washer
very popular. Even though this washing system is open, control of foam in the feed stock or first
vat is very important. The majority of defoamer applied to vacuum drum washers is typically
required in the earliest stages of the wash line. Depending on the pulp qualities and the washer
specifics, both surface foam and drainage can be required from a defoamer. The demands will
range from high surface foam demand and minimal drainage enhancement to the other extreme of
minimal surface foam control and high drainage augmentation. Shower velocity is also a crucial
variable in defoamer demand on vacuum drum washers. Excessive velocity and/or improper angle
of contact can disrupt the mat and generate excessive foam, inhibiting washing. *Pressure Washers*
tend to be more sensitive to operating conditions and changes in pulp drainage characteristics.
Capacity and washing efficiency are greatly impacted by entrained air level, vat consistency,
shower flow and temperature, vacuum, wood species, cooking conditions and the pulp grade or
kappa number. Systems that rely on air pressure as the driving force for displacement are
susceptible to excessive foam generation when air break through the mat is not controlled. Low
production rates can compromise washing efficiency due to channeling and air breakthrough. Both
surface foam and drainage characteristics are important in defoamers used on these types of
washers.

**Chemiwasher (Table washer)**

*Chemiwasher* is also called a table washer. It consists of four to six stages of washing and one or
two formation zones. Feed consistency is a critical parameter of operation. It not only impacts pulp
production rate, but also affects basis weight and how much liquor can be drained from the
formation zone. Feed consistency governs production rate and the structure of the mat. Since there
is no repulper between each stage, fiber orientation, mat porosity and drainage character are established during formation and remain relatively fixed through the entire washing sequence. Initial drainage on the wire is critical to the performance of the washer. Excessive drainage early can create a compact, low permeability mat that reduces displacement efficiency in subsequent stages. Insufficient drainage reduces washing in the initial stages causing carryover and hydraulic overload in successive stages. Air blowers provide a slight positive pressure above the mat and a slight vacuum below the wire. If not controlled, excessive air can be transferred through the mat, generating foam that can be pulled into the blowers. Protecting the blowers from foam is a primary demand for defoamer on these systems and requires a quick acting, high knockdown product. As drainage from stage to stage can somewhat be customized through vacuum adjustment, high draining defoamers are rarely required. In fact, too much drainage is more often a problem during mat formation than not enough drainage. Experienced operators will often look at the color of the stock exiting the headbox. If it becomes too dark they will decrease defoamer, as having some entrained air in the mat during formation prevents excessive drainage and sustains mat permeability down the washer.

**Drum Displacer (DD) Washer**

Displacement drum (DD) washer usually contains 2 washing zones though up to 4 stages can be designed into a single washer. The DD washer is pressurized and each washing zone is segregated and operated in a counter current washing fashion. Stock feeds into pockets to form a mat of a defined thickness. Showers are applied on surface of mat to displace liquor through the mat and a perforated plate in the base of each pocket. Feed pressure and shower pressures are critical operational variables and are indicative of the drainage rate of the pulp. Maintaining high drainage rates through the pockets is key to operation of these washers. Removal of air from the feed stock prior to entering the washer is beneficial since any entrained air passing into the filtrates is not able to be released until the filtrate completely exits the washer. The final dewatering stage utilizes vacuum and a small liquid separator that can easily be overcome with foam. An effective defoamer for the DD Washer must possess high drainage characteristics with enough foam control to enable the liquid separator to function efficiently.

**Wash Press**

Wash presses remove liquor from pulp through a mechanical thickening process. The nip pressure of counter-rotating rolls forces filtrate out of, and away from, the fibers resulting in a very high consistency pulp. The pulp is thickened as it approaches the nip and excessive foam or entrained air in the entering slurry can impede the thickening phase prior to the nip resulting in high internal pressure and lower than desired consistency entering the nip. A wash press does not typically demand a lot of defoamer. If the stock does not drain well or contains excessive entrained air, it will build pressure, increase press rotational speed and reduce washing efficiency. Generally, wash presses have low demand for surface foam control, except in the filtrate tanks, and limited need for drainage enhancement but either can be required depending on the operational specifics.
**Other Equipment**

Often the ancillary equipment and neighboring unit operations create the air issues that have to be dealt with on the washers. It is important to understand locations of air integration into the pulp and filtrate streams as well as locations providing time and surface area for the release of air. Defoamer demand can be influenced by the operation of, or variation in, screens, tanks, refiners, agitators, and any equipment that can introduce air and/or impart energy to disperse and stabilize the air. Every process will be unique in the flows, velocities, retention times and overall impacts of the equipment surrounding the washers. This is a major reason why a product that works well in one system may fare poorly in a seemingly similar mill. The washers may be almost identical design but the configuration, limitations and supporting equipment rarely match.

Pump capacities, tank sizes, consistency controls, and washer control strategies can all have significant influence on defoamer selection. The specific loading of the equipment, source and quality of shower water and the demands of the upstream and downstream customers will all have an impact on selecting the right defoamer. Recovery or evaporator limitations may box in the washing operation on one end while pulp quality, soda loss or bleach plant demands may pressure the washing operation from the opposite side. Defoamer demands will vary with the system limitations and selecting the right defoamer requires an understanding of the overall goals and limitations of the mill.

Process configuration can be a significant influence on the defoamer characteristics required for a particular mill. The need, or the ability to release air prior to high shear locations must be considered. Air releases from the filtrate by coalescing to larger and larger bubbles until the buoyancy is great enough to drive the bubble to the surface. A primary mechanism for defoaming activity is to promote and accelerate bubble coalescence. If air is not effectively released from the stock or filtrate prior to encountering high shear, the energy imparted will act on the existing air bubbles to reduce the average bubble size. This pushes them further away from the critical buoyancy required to escape from the system. It can also generate bubbles in a size range that are more prone to impede drainage and reduce efficiency in downstream unit operations. Knotters, Screens, agitators and other equipment have the ability to reduce bubble size in an existing flow. More aggressive defoaming characteristics may be required in operations that have limited opportunity to purge existing air prior to high shear locations.

Defoamer control strategy also play a role in defoamer selection. The right defoamer is not always the best performing product in a process. In instances where control of the defoamer is not aligned directly to washing performance, over usage is common. In cases of either manual control of feed pumps or alignment to parameters not directly associated with quality or washing efficiency, the highest performing products are not necessarily the right choice. Cost of use and deposition potential can outweigh performance in situations with high potential for over usage. Control strategies based on process variables aligned to performance and quality of the washing operation allow for higher performing and/or more expensive, products to be used safely and cost efficiently.
Defoamer Characteristics

There are multiple characteristics that dictate how a product interacts and performs in a process. Spreading rate, dispersibility, agglomeration potential, degree of hydrophobicity, longevity, foam destruction capability, foam prevention capability, etc. can be controlled or formulated into a product. Defoamer performance is influenced by numerous variables that are manipulated by skilled formulators to provide the desired performance over a defined range of conditions and filtrate properties. The primary function of defoamers is to de-stabilize air-filtrate interfaces and promote the release of air from the process streams. Additional functionality such as drainage enhancement can be designed into the products as well.

Generically, defoamers consist of a carrier fluid, active defoaming components, performance enhancers (spreading agents, drainage aids, etc.), and stabilizing agents (thickeners, emulsifiers, preservatives, etc.). The potential combinations and permutations are seemingly endless though the modes of action are the same. Defoaming mechanisms and modes of action are well documented and researched (10, 11) so will not be covered in this discussion other than a quick visual review of the concepts in figure 1.

Figure 1. Illustration of the defoaming mechanism of silica/oil droplets in aqueous foam. (12)

1.) Draining foam, 2.) Entry the defoamer droplet into the foam interface and spreading, 3.) Bridging between adjacent foam films, 4.) Dewetting, 5.) Rupture of the foam film

A wide variety of chemistries have been utilized for controlling foam in the Pulp & Paper industry. For a host of reasons including cost, environmental stewardship, process compatibility and deposition potential, the favored chemistries change over time. Currently, silicone based products dominate in the demanding process conditions found in chemical pulping operations. Regardless
of the active components in a product, to function efficiently as a defoamer, there must be a degree of incompatibility between the defoaming agents and the foaming medium. A product that is too incompatible with the filtrate will generally look very good in a foam cell evaluation but will lead to deposition issues under mill conditions. A product that is not incompatible enough will lack the driving force to reach the air-filtrate interface of the foam and performance suffers.

Compatibility between a defoamer and a filtrate changes with the liquor characteristics and process conditions. As temperature and the concentration of natural surfactants drop during countercurrent washing operations, the degree of incompatibility between a product and the filtrate will change. A product that functions well at 190°F and high alkalinity may become deposit prone at 140°F and reduced alkalinity. Experienced defoamer formulators are able to develop products that provide specific characteristics over a range of conditions but they all have limitations. Understanding the conditions at each potential application point as well as the characteristics of a particular product over that same range is important in selecting the right defoamer for a system.

Specific drainage enhancing chemistries are not subject to the same compatibility guidelines as defoaming chemistries as they do not necessarily function at the interface between air and filtrate (13). Mechanisms related to the interaction between filtrate and fibers are expected to be accountable for the performance of the most effective drainage enhancers. This is supported by improvements in drainage without corresponding reduction in air content or foam, as well as improvements in systems absent of measurable air.

**Defoamer Evaluation**

Ideally, defoamer screening methods would mimic the equipment and conditions for each application as closely as possible. Unfortunately this is not easily accomplished due to the range of equipment, configurations, fiber properties and liquor characteristics encountered. There are several evaluation methods developed for defoamer screening (1) such as the Bartsch method, automated shake tests, Ross-Milles method, tumbling cylinders, gas bubbling, direct air injection, and measurement of bubble distribution. The recirculating foam cell is the most popular defoamer screening method used in the Pulp and Paper industry. Several different methods are utilized for defoamer development work in research laboratories but the recirculating foam cell is commonly the sole screening method for mill site work.

The advantage of this method is that samples can be evaluated relatively quickly using filtrate directly from the process. Shear rates can be manipulated to vary the intensity of the test and defoaming, as well as antifoaming, characteristics can be evaluated. With modification to the standard design, density of the filtrate during the testing can be monitored as well. This method has proven invaluable for many years as an aid to selecting products for a given process.

There are also several limitations to the foam cell that need to be kept in mind. As a comparative tool, it generates relative data. Data generated in one location is not directly comparable to data
generated in a different location or under different conditions. Interactions between the filtrate, fibers and air are excluded. The method does not simulate any given system or washer, so the data developed does not independently establish the best product to be used in an application.

It does provide a relative comparison of particular characteristics that can be used to influence proper product selection. For example, the foam cell can establish which product provides the greatest knockdown rate in a filtrate but it does not establish how much knockdown is necessary. For that reason, it is important to gauge the desired characteristic against the degree of that characteristic present in the incumbent product. Providing additional knockdown power in a system that requires minimal knockdown most often only increases the cost but not the performance of a program. Similarly, providing additional persistence, drainage or other characteristics beyond what is needed, or can be taken advantage of, does not improve washing performance.

Figure 3. Traditional recirculation foam cell testing: (a) Knockdown (KD) and Persistence (P) (14)
## Industry Examples of Benefits from Defoamer Selection Process

### Right Defoamer Case 1

<table>
<thead>
<tr>
<th>Furnish</th>
<th>Southern SW, High Kappa Kraft Mill</th>
</tr>
</thead>
<tbody>
<tr>
<td>Washing Equipment</td>
<td>Vacuum drum BSW</td>
</tr>
<tr>
<td>Program Limitation</td>
<td>Struggling with soda loss and maintaining adequate BL solids to evaps</td>
</tr>
<tr>
<td>Baseline Defoamer</td>
<td>Same product in use at other High Kappa SW mills in the region</td>
</tr>
<tr>
<td></td>
<td>Exceptional performance in foam cell</td>
</tr>
<tr>
<td>Insights</td>
<td>High soap content in liquor resulted in a high foaming potential</td>
</tr>
<tr>
<td></td>
<td>Equipment configuration provided very few foam generating locations</td>
</tr>
<tr>
<td>Right Defoamer</td>
<td>Defoamer with reduced foam knockdown (poor foam cell results) but high drainage characteristic</td>
</tr>
<tr>
<td>Results</td>
<td>Improved washing, Soda loss target achieved with 0.6% increase in BL solids</td>
</tr>
<tr>
<td></td>
<td>No surface foam issues</td>
</tr>
<tr>
<td></td>
<td>Reduced Defoamer cost 12%</td>
</tr>
</tbody>
</table>

### Right Defoamer Case 2

<table>
<thead>
<tr>
<th>Furnish</th>
<th>HW/SW, Integrated Bleached Kraft Mill</th>
</tr>
</thead>
<tbody>
<tr>
<td>Washing Equipment</td>
<td>Vacuum drum BSW</td>
</tr>
<tr>
<td>Program Limitation</td>
<td>High defoamer usage on SW runs. Difficult SW to HW transitions. Silicone spots on Paper.</td>
</tr>
<tr>
<td>Baseline Defoamer</td>
<td>Highly concentrated defoamer with very effective foam cell performance in SW liquor.</td>
</tr>
<tr>
<td></td>
<td>Defoamer feed fully controlled by operators.</td>
</tr>
<tr>
<td>Insights</td>
<td>Concentrate not dispersible enough for chosen application points.</td>
</tr>
<tr>
<td></td>
<td>Operators overfeed in preparation for transition issues.</td>
</tr>
<tr>
<td></td>
<td>Insufficient tank volume for adequate deaeration at current production rates.</td>
</tr>
<tr>
<td>Right Defoamer</td>
<td>Dispersible defoamer with balanced knockdown and drainage characteristics</td>
</tr>
<tr>
<td></td>
<td>Application point changes to address problem areas without carryover risk</td>
</tr>
<tr>
<td>Results</td>
<td>All washing targets achieved and silicone spots eliminated</td>
</tr>
<tr>
<td></td>
<td>Transition issues minimized resulting in reduced preparatory overfeed.</td>
</tr>
<tr>
<td></td>
<td>Reduced Defoamer cost 19%</td>
</tr>
</tbody>
</table>
Selecting the Right Defoamer

Determining the right product for a system is a multi-step endeavor that requires detailed knowledge of the mill specific conditions, requirements, and goals. A generic example of the required steps follows:

- Define chemical restrictions and regulatory requirements
- Determine process constraints and goals
- Identify specific equipment/process challenges and opportunities
- Understand defoamer control and operating strategies
- Define limitations or shortcomings of current program
- Identify current and potential application points
- Select products meeting performance characteristics, composition and regulatory guidelines, price range, and any specified local criteria
- Screen acceptable candidates in appropriate process liquor(s)
- Select product that meets all critical criteria and is best fit for closing the desired performance gap
- Validate selection in process trial
- Re-define and re-evaluate as necessary

Selecting the right defoamer for a process requires an understanding of the system, operational goals and limitations, and the defoamer characteristics required to perform within those constraints. Cost is always a consideration but the advantage of putting the right defoamer in use will provide the maximum value for a given application. Under certain circumstances the lowest-priced product is the right defoamer. Occasionally, the best choice is the highest priced product. The right product is not the one that generates the best foam cell graphs or is being used in another mill. The right defoamer provides the optimal mix of cost and performance characteristics required for the unique conditions and limitations of a given system. Identifying the optimal defoamer for a process is a comprehensive effort that is aligned to the unique demands of an operation to provide the maximum overall value.

Literature Cited


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Michael Wang, Ph. D. Senior Application Manager, Solenis LLC
Selecting the Right Defoamer

• Defoamer Chemistry Vs Defoamer Formulation
• Liquor Properties
• Process Demands and Limitations
• Equipment and Process Configuration Aspects
• Regulatory and Commercial Considerations
• Defoamer Screening
• Benefits of Comprehensive Selection Process
Defoamer Chemistry

Ingredients
Common Ingredients

Variety of Products
Defoamer Formulations
Unique and Differentiated
So Many Options
How to Choose?

- Similar Process
- Same Wood Basket
- Same Grades
- Same Washer Design
- Foam Cell Data
- Supplier History
- Price
- ??
Black Liquor Chemistry

- Chip Supply
- Species
- Cooking Conditions
- Solids
- Temperature
- Season
Influence of Liquor on Defoamer Performance
More than Liquor Characteristics

- Foam stabilizers
- Energy Source
- Gas Source

- Air Introduction
- Air Release
  - Locations
  - Consistency
  - Time
Washer Design Considerations

- Atmospheric Diffuser
- Pressure Diffuser
- Vacuum Drum Washer
- Chemiwasher
- Pressure Washers
  - Compaction Baffle
  - Drum Displacer
- Presses
Process and Equipment Capabilities

- Equipment Design/Condition
- Process Configuration
- Production Capacity
- Retention Time
- Application Points
Control Strategies

**Process**

- **Operations Targets**
  - BL Solids
  - Soda Loss
  - TPD

- **Process Levers**
  - Shower flow
  - Rate
  - By-pass

- **Operation Variability**
  - Shift-to-shift
  - Seasonal
  - Pulp
Control Strategies

**Defoamer**

- **Level of Automation**
  - Manual - remote
  - Manual - local
  - Single variable
  - Multi-variable

- **Ancillary Feed**
  - Buckets
  - Hoses
  - Add-on pump
  - Booster pump
Regulatory and Composition Restrictions

- Grade
- Customer
- Corporate
- Local

KNOW THE RULES!
Product Screening

- Appropriate Methods
- Cost Based Dosing
- Relative Comparison
- Characteristics

If there is a wrong way to do something, then someone will do it.

Edward A. Murphy (Murphy's Law)
How to Choose?
Put the Pieces Together

Constraints

Targets

Controls

Screening

Equipment

Regulations

Goals

Price/Cost

Limitations
# Mill Results

| **Background** | Southern SW, High Kappa Kraft Mill  
|               | Vacuum drum BSW  
|               | Struggling with soda loss and maintaining adequate BL solids to evaps |
| **Baseline Defoamer** | Same product in use at other High Kappa SW mills in the region  
|               | Exceptional performance in foam cell |
| **Insights** | High soap content in liquor resulted in a high foaming potential  
|               | Equipment configuration provided very few foam generating locations |
| **Right Defoamer** | Product with reduced foam knockdown (poor foam cell results) but high drainage characteristic |
| **Results** | Improved washing, Soda loss target achieved with 0.6% increase in BL solids  
|               | No surface foam issues  
|               | Reduced Defoamer cost 12% |
### Mill Results

| **Background** | HW/SW, Integrated Bleached Kraft Mill  
Vacuum drum BSW  
High defoamer usage on SW runs. Difficult SW to HW transitions. Silicone spots on Paper. |
|----------------|--------------------------------------------------------------------------------------------------|
| **Baseline Defoamer** | Highly concentrated defoamer with very effective foam cell performance in SW liquor.  
Defoamer feed fully controlled by operators. |
| **Insights** | Concentrate not dispersible enough for chosen application points.  
Operators overfeed in preparation for transition issues.  
Insufficient tank volume for adequate deaeration at current production rates. |
| **Right Defoamer** | Dispersible formulation with balanced knockdown and drainage characteristics  
Application point changes to address problem areas without carryover risk |
| **Results** | All washing targets achieved and silicone spots eliminated  
Transition issues minimized resulting in reduced preparatory overfeed.  
Reduced Defoamer cost 19% |
Selecting the Right Defoamer

- Goals
- Constraints
- Limitations
- Controls
- Commercial
- Performance Gap
- Appropriate Screening
- Best Fit
Thank You for Your Attention

Questions?