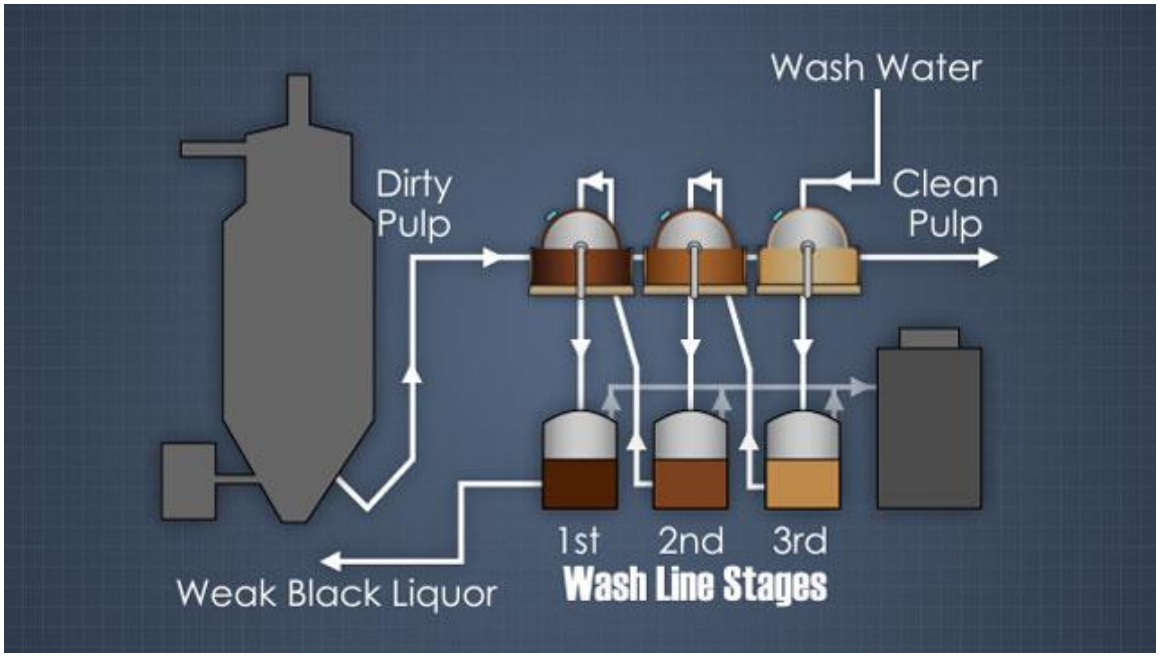
Defoamer Application Training – Pulp Washing

Overview: The purpose of pulp washers is to clean the cellulose which has been extracted from wood chips and prepare the fibers for use in a paper machine. Pulp washing, also called brown stock washing, most often uses a series of rotary drum washers that take a mixture of lignin, cellulose, chemicals, and surfactants, and cleans the cellulose by rinsing it with water which runs countercurrent to the pulp. Each washer, known as a 'stage', gets the pulp cleaner and cleaner until it is qualified for use. Defoaming agents in brown stock washing should help to remove residual liquor from pulp via deaeration, reduce downstream costs related to chemical recycle and energy consumption, and rinse out with the undesirable black liquor.

Process Example:



"Brownstock Washing Back Cover." *Vector Solutions*, 2021, www.convergencetraining.com/Images/Courses/brownstockwashing_backcover03.jpg.

The above diagram shows a general 3 stage rotary drum pulp washing process. Wood chips are added to a digester (far left) and heated to high temperatures with caustic or acid in order to dissolve the lignin from the wood chip and free the cellulose. At the bottom of the digester, the pulp slurry exits into the blow tank where the dirty pulp is pumped to the first stage washer. Dirty pulp is fixed to the surface of the washer via suction to create a mat, and water is showered over the pulp mat as it rotates over the washer. The water shower flows through the pulp mat, taking with it undesirable chemicals, lignin, dissolved solids, and anionic trash. The source of clean water is at the

third stage washer, which flows through the pulp mat on the third stage washer first, is collected in the tank below the washer (known as the 3rd stage filtrate), then pumped up to wash the 2nd stage pulp mat, etc. A counter current flow ensures that the pulp mat is cleaner than the wash water at each stage, and the washing efficiency is optimized. The dirtiest liquor in the first stage filtrate is pumped as 'weak black liquor' (15-18% solids) to a boiler where the water is boiled off and the black liquor concentrates into 'strong black liquor' (65-80% solids). The strong black liquor can be burned for energy and the chemicals contained in the strong black liquor can be recycled and reused in the digester.

The defoamer, which should function as a deaerator and antifoam, has a bigger job than just controlling foam generation. A good defoamer product will increase the washing efficiency of the brown stock washing process. The savings to a mill if they can increase their total dissolved solids due to improved washing efficiency will far outweigh any material cost associated with the defoamer. Some ways that a defoamer can help improve washing efficiency is: reduce the amount of shower water needed to equal removal of solids, increased chemical recovery, reduced energy needed to boil the weak black liquor, cleaner pulp, and increased production.

So how does the defoamer product lead to improving washing efficiency? By increasing the rate of bubble coalescence in the pulp mat, preventing the formation of new bubbles, and removing adsorbed bubbles on the fiber surface, the path length of the wash water through the mat is decreased and the contact area of the wash water to the pulp fibers is increased. This increased contact and reduced path length increases the amount of solids washed out and decreases the amount of time it takes to rinse.

Key Areas of Foam:

a. First stage washer/filtrate
b. Second stage washer/filtrate
c. Base of the digester

Typical Process Conditions:

Temperature (°C)	Target Washing Efficiency (Rotary Drum)	Key Surfactants	Factors that Affect Foaming Potential
~85°C	Single Stage: >98.5% Overall: >99.5%	Lignin derivatives, Anionic Surfactants	Temperature, pH, Total Dissolved Solids, Wood Species, Washer Type

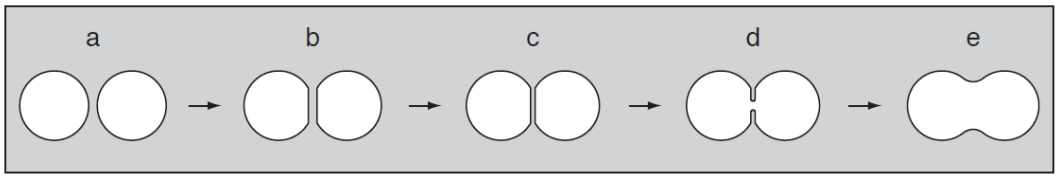
Primary Causes of Foam: High concentrations of anionic surfactants which are created during the chemical reaction between the alkali washing chemicals and wood chips during cooking easily trap air to create foams during the high shear washing process. Surfactant rich liquor is transported through pipes at high speed and are aerated through the pulp mat.

Common Antifoam Technologies:

Silicone Emulsions: Silicone emulsions, or organosilicone emulsions, are the most common type of product used in brown stock washing because of their low surface tension, resistance to degradation at high temperature and high pH, and modification potential. Emulsions are normally sold to mills between 20-40% active solids.

Polymeric Concentrates: In some specialty papers, residual silicone must be kept to 0ppm, or undetectable. Even the best silicone products will yield some residual carryover into the pulp mat. Special acrylate ester polymeric antifoam is used in cases where silicone deposition is of a primary concern. Polymeric antifoam is a specialty and often sold in concentrated form.

Mechanism of Action: In the pulp process, the primary mechanism of action of a 'defoamer' product is through deaeration. The goals of the product are to enhance drainage through the washers and increase chemical recovery.



Deaeration improves drainage because the path length of the liquid from the mat to the filtrate tank. In a slurry saturated with bubbles, the liquid which drains from the fibers is required to travel in a crooked line downward, around all the bubbles in its way. By combining the bubbles into flocs or unstable large bubbles, the cumulative pathway from the mat to the filtrate tank is shortened and drainage rate increases.

Lab Screening Tests:

Ross-Miles Foam Cell

Industrial Process Measurement Tools:

Primary evaluation of performance is conducted by an engineer trained in calculating washer efficiencies.