Tannery Brine Concentration

Background

To preserve the quality and beauty of leather, animal skins and hides are chemically treated in a process known as tanning. The majority of leather made today is produced from tanned cattle and sheep hides. A piece of hide which has been tanned produces strong flexible leather which is able to resist decay and spoilage.

The first step of the process takes place at the slaughterhouse to prevent decay and bacterial growth. Once the animal is stripped of the hide, it is cured; a process that consists of drying/salting of the hide. Hides can be cured either by wet-salting or brine-curing. Brine-curing is known to be more efficient and is more common in industry. After the hides have cured in the brine, the slaughterhouse ships them to the tannery.

Figure 1- Dry/Wet Process Drum

Before the hides are ready for the tanning process, they go through a series of preparation steps known as the "beamhouse operation." First, the hides are soaked in cold water to remove the salt from the brine cure. Alternatively, if the hides have been cured in dry salt, it rehydrates them. Additionally, while the hide is soaking, the moisture in the hide is restored and any unwanted wastes such as dirt or manure are cleaned off. The next step of the process is known as liming or unhairing. After the hair has been cleaned from the skin, hides are delimed followed by bating and pickling. Bating involves the adding of enzymes to help improve the softness and flexibility of the leather. Pickling increases the acidity of the hide to enabling chromium tannins to enter. Before tanning actually begins, the hides are washed until all hair, fat and chemicals have been removed.

Figure 2- Drying and Coloring Equipment

Hides can undergo go two different types of tanning procedures known as vegetable tanning and chrome tanning. The initial steps of the process, curing, liming/ dehairing, deliming, bating and pickling are essentially the same in vegetable tanning and chrome tanning. Chrome tanned leather tends to be softer and more flexible. Chrome tanning also includes retanning, dying and fatliquoring whereas vegetable tanning does not. After fatliquoring, the hide is wrung out, dried and finished. Depending on the tannery, leather may be finished in a variety of ways. The tanning procedure selected depends largely on the hide and the end product.

Figure 3- Traditional Tanning and Dying

Treatment Challenge

Known for its unpleasant smells, tanning also produces large quantities of wastewater from every step of the process. It is possible for a plant to recycle its waste for minimal environmental impact and perhaps even to create a product for resale or reuse. In particular, curing hides and skins requires large amounts of salt which results in a brine waste water stream which is typically hauled away. The recovery and reuse of the salt and water is a solution to this growing problem.

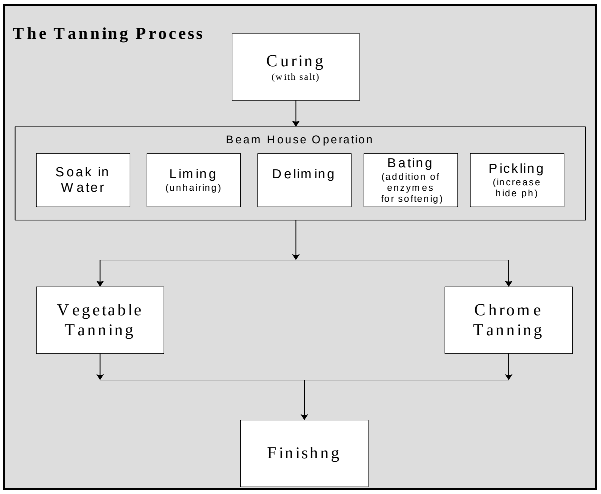

Figure 4- Tanning Process

Treatment of this wastewater is difficult due to the high concentrations of salt, organics, and suspended solids. Due to these difficulties a multiple step process is typically required including: screening, filtration, and evaporation. All of these required process equipment steps have fouling problems due to the high salt concentrations and consequently have low recoveries of reusable products. This leads to additional capital, operation, and disposal costs.

V✧SEP Technology

When comparing all the possible treatment methods, V✧SEP stands out with its simplicity, reliability, and economical benefits. Conventional membranes are limited in their abilities: particles can become lodged in the membrane pores causing fouling, which causes reduced flow and permeate recovery with more frequent cleanings. A boundary layer will form at the surface of the membrane resulting in a formation of a barrier that restricts flow. By applying a shear force to the surface of the membrane to disrupt the boundary, these problems can be decreased or even eliminated.

V✧SEP is a vibrating membrane system able to produce economical flow rates reliably with the fouling resistance of mechanical shear. The membrane oscillates at ¾" displacement at ~55Hz. The vibration generates shear waves at the surface of the membrane, thus decoupling the cross-flow velocity requirement from the need to keep the membrane clean. The resulting performance translates into a greatly reduced footprint and significant performance increases when compared to conventional technology.

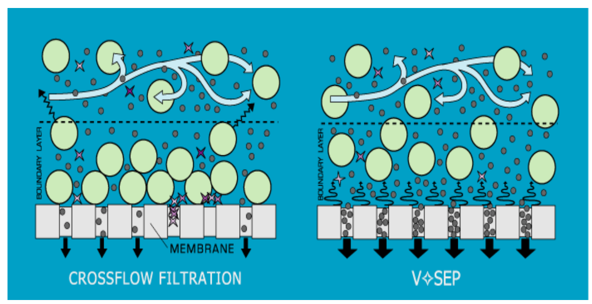

Figure 5- Differences in Technology

V✧SEP systems are compact and modular and as such can accommodate any flow rate in a small footprint. Modularity also affords invaluable operational flexibility as flows increase or decrease.

This unique system has many advantages over conventional membrane systems and other competing technologies. One reason is that V✧SEP can process much higher concentrations of contaminants in the feed solution. In many cases, the feed can come from a variety of sources and can vary in composition. The V✧SEP is designed to handle variation in feed characteristics without sacrificing product quality.

Case Study

A tannery in Australia has a desire to recover the salt from their Brine Effluent liquor (from their salting of hides operation) then further concentrate it up for recycling and return it to the operations. The brine effluent contains fats, suspended solids, protein, blood, pesticides, and other BOD/COD components. Due to the variety of contaminants, a multiple step process will be required, pre-treating effluent prior to VSEP to remove fine hairs, and large suspended particles.

The process goal includes: removing 99% of the suspended solids, reducing organics from 0.5 down to <0.1 %weight/volume, and make a 10-15% salt water solution. The filtered brine is sent to "polyhouses" where evaporation of water takes place and salt is recovered and reused in the process.

Using VSEP to remove organics and solids provides several key advantages over other technologies. The use of full digestion followed by evaporation ponds was considered as an alternative to VSEP, but quickly proved to be less efficient. Digestion would require large tanks leading to an enormous footprint compared to VSEP. It is also unknown how well bacteria can survive in a highly concentrated salt environment.

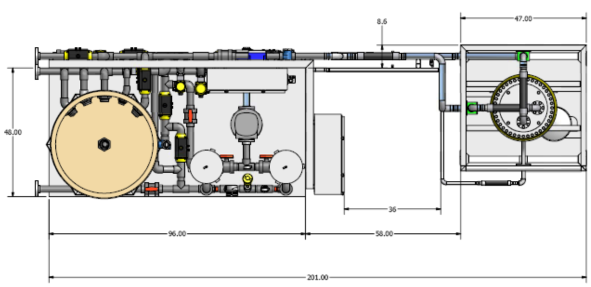

Figure 6- VSEP Footprint

Pilot Testing

Prior to full-scale design, lab testing was performed in Australia on prescreened effluent samples. According to similar applications already in operation, it was concluded that a Teflon membrane was the most suitable membrane due to its chemical resistance and compatibility, high flux rates and tough concentration requirements. During lab testing, after an initial 25% decline the membrane flux stabilized over a 6 hour period.Analytical results of the lab testing confirmed that a Teflon Micro Filtration (MF) filter pack was capable of meeting the

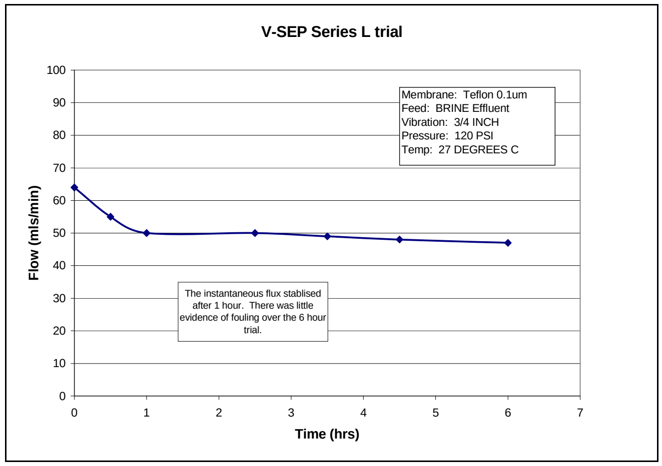

Figure 7- Filtration Flux Results

concentration requirements.

	Brine Effluent	VSEP Permeate
TDS (mg/L)	282,000	274,000
Organic Carbon (%w/v)	0.5	<0.1
Na (mg/L)	109,000	108,000
Cl (mg/L)	179,000	166,000
Suspended Solids (mg/L)	7270	66
Conductivity (mg/L)	487	478
pH	7.84	7.80

Table 1- Analytical Results

From this data it was estimated that 1300 ft^2 of membrane should process approximately 30 gallons per minute of brine effluent giving an average flux of 33 gallons per square foot per day. However, depending on the process temperatures and requirements for BOD/COD/TDS removal (percent rejection) for effluent streams, the permeate flux rate in the VSEP can vary anywhere from 20 – 70 gallons per square foot per day.

Good chemical cleaning is an essential requirement in order to recover the membrane flux. The Teflon membrane will handle extreme chemical cleaning conditions (pH 1-14) and is also chlorine tolerant (in case of biological growth in the membrane stack). Piloting showed the necessity for standard cleaning frequency of once every two days (acid +alkaline clean) with a chlorine clean to address any biological growth required once a week. The cleaning cycle takes around 140 minutes and is fully automated on the Series I unit.

Process Description

Pilot testing confirmed a single 84" MF filtration VSEP module is required to accomplish the goal of processing about ~44,000 US gallons per day (7000 LPH). The VSEP machine is used in series with other equipment and will process the feed slurry to produce approximately 80% recovery of filtrate. VSEP is expected to produce a concentrate and permeate flow rate of 0.75 GPM (1.3 m^3/hr) and 34 GPM (~7.7 m^3/hr) respectively.

It is recommended that the processing be undertaken in batch mode. This will require two Feed Tanks (of around 2 - 4 hours capacity) in which the Feed will be progressively concentrated up to around 80% recovery. The final concentrate in the Feed Tank will then be pumped away and the second Feed Tank filled with fresh Brine Effluent will start. The filtration sequence is then repeated. This mode of operation has worked without any problems during piloting at the tannery.

The VSEP system is fitted with a local controller that can communicate with the main plant logic system if needed. The VSEP system includes automated integral Clean in Place (CIP) functions.

Micro Filtration	
Composition	Teflon
Nominal Pore Size	0.1um
Operating Pressure	120psi
Continuous pH range	1-14
Max Flat Sheet Temperature	110^{o}C

Table 2- Process Conditions

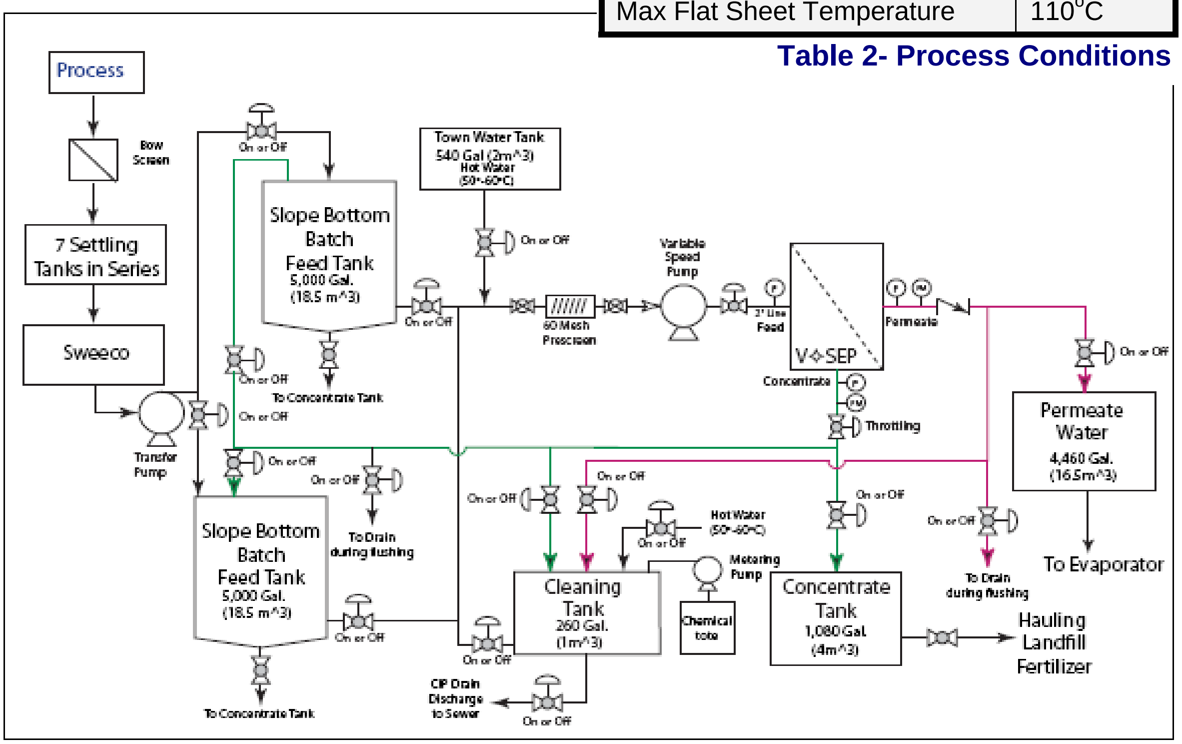

Figure 8- Process Flow Diagram

Series i Installation

A highly attractive benefit to using VSEP is its energy efficiency in this low pressure MF application. The full scale system only requires a 20HP drive motor and a 10HP pump motor, both running 65% load. Operators and maintenance interaction is limited to starting and stopping the unit after sensor alarms or for periodic scheduled repairs. The system performs automated Clean-In-Place cleanings on the membrane based on time setpoints.

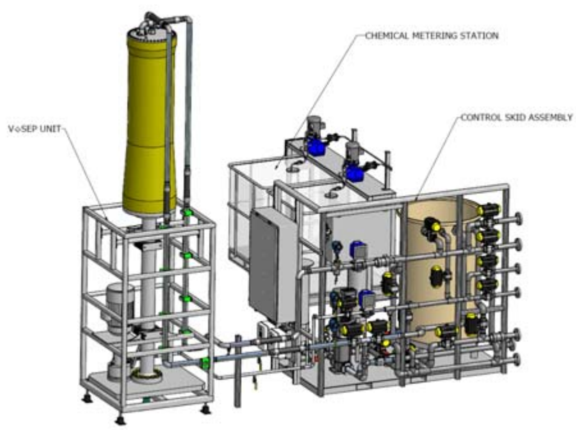

Figure 9- Series i System

New Logic Research has successfully used VSEP separation technology to concentrate the brine effluent. The tannery industry's effort to recycle waste water is made possible through membrane filtration techniques combined with Vibratory Shear Enhanced Processing. The efficiency and minimal operating cost of VSEP makes it an ideal solution for tannery wastewater applications.

New Logic Research Information

Each application that comes to New Logic goes through rigorous tests and each system is customized. The process is also custom-designed based on the data gathered during piloting. The initial test is conducted on a small feed sample using lab scale VSEP systems. An important characteristic of VSEP is that it can be fitted with a wide variety of membranes from microfiltration to reverse osmosis to meet a customer's separation needs. A variety of membranes are tested based on the application and the best membrane is investigated further to test different process variables including pressure, temperature, pH, % recovery, and others. Further testing is completed onsite with pilot scale VSEP systems. New Logic works with a wide range of applications from food products, pulp and paper, all types of wastewater to even hog manure and works to meet each individual application's objectives.

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