Application of VSEP at a Major Inorganic Pigment Manufacturing Facility

Overview

New Logic International installed its Vibratory Shear Enhanced Processing (VSEP) system in October, 1997 at Dominion Colour, a major international inorganic pigment manufacturing facility in Canada. VSEP is used for treatment of a chromate batch solution at this facility. The VSEP system uses an ultrafiltration membrane module to treat pressate from the filter press operation in order to recover pigments and also generate a permeate stream that meets the required discharge limits. The estimated construction, operation, and maintenance costs for this system are presented. The application of VSEP membrane technology to inorganic pigment manufacturing facilities is found to be an attractive economic alternative to conventional wastewater treatment technology.

Background

Pigments are generally incorporated into paints to affect properties associated with appearance such as color, opacity, gloss, metallic look, and depth. One of the most important properties of pigments is the ability to cover or hide the surface being painted. This property is commonly referred to as "hiding power" or opacity. There is an optimum particle size range of 0.2 to 0.4 μm which affords maximum light scattering and hiding. Pigments are classified into two main categories: organic and inorganic pigments. This project summary discusses the application of VSEP to an inorganic pigment manufacturing process.

In the paint and coatings industry, membranes are being used in latex polymer recovery as well as treatment and recycling of pigments from paint shop waste and electrocoating process waste. Traditional cross-flow membrane technologies face substantial membrane fouling and the use of VSEP thus becomes attractive for these processes due to its fouling-resistant design.

For the treatment of pressate at this inorganic pigment manufacturing facility, the client considered two treatment schemes:

- Using an additional filter press followed by a cross flow membrane filtration system.
- Using a VSEP one-step treatment system.

Traditional technologies were evaluated to be much more expensive than the VSEP system for treatment of filter press pressate. The use of the VSEP system results in substantial savings primarily due to reduced membrane fouling and recovery of the pigment product. Wet ground pigment is easily concentrated to high solids in a VSEP using a 0.1 to 0.45 micron polycarbonate or Teflon membrane. Upon installation of VSEP, the concentrated pigment stream was recycled to the process. Clean water permeate generated from the VSEP is recycled to the grinding circuit/process or can be dicharged to the plant holding ponds and then to the sewer. This inorganic pigment manufacturing facility has installed the VSEP system to allow the treatment of waste water pressate more efficiently and to allow the recycle of the concentrated pigment stream to the process.

The inorganic pigment manufacturing facility where the VSEP system is installed operates 24 hours a day, 350 days per year. The maximum pressate flow rate to be treated in the process is approximately 62 gallons per minute (gpm).

Using an ultrafiltration module in the VSEP system has been shown to be a commercially-viable option for treatment of pressate from the filter press. Nearly 95 to 98% of the feed pressate is recovered as clean water that is suitable for discharge or reuse, while less than 2 to 5% is recycled as the concentrated stream. The permeate concentration of total suspended solids are reduced to well below the discharge requirements. This project summary report describes this application for the VSEP process, discusses the expected process performance, and presents its economic advantages.

System Description

A process schematic for this application of VSEP is presented in

Figure 1
Treatment of Inorganic Pigments/Chromate Solution Using VSEP

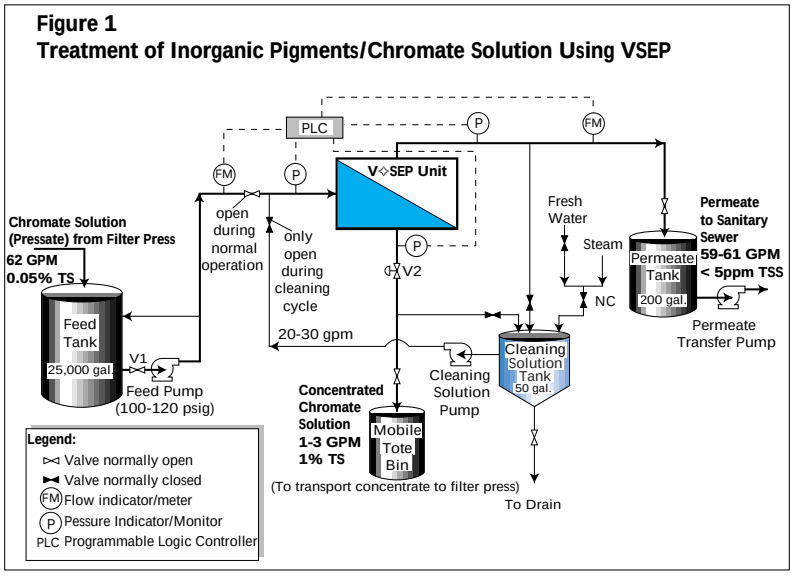

Figure 1. This diagram includes the overall material balance for the chromate solution treatment system and illustrates the performance of the VSEP unit. Pressate from the filter press is fed to the pressate storage tank and to the VSEP unit at an average rate of 62 gpm. In the actual operation, there are two different streams. The VSEP system processes 28,000 gallons in a 7.5 hour shift (62 gpm). About 23,000 gallons of this is from the filter press, the rest is rinse water. The other pigment is introduced in the same quantity for the same amount of time after a thirty minute cleaning. There are three shifts per day, seven days a week. One industrial-scale VSEP unit using an ultrafiltration membrane module processes the feed pressate/rinse water. The concentrated stream contains approximately 1% suspended pigment solids.

The VSEP produces a concentrated pigment stream at a flow rate of 1 to 3 gpm which is recycled to the filter press. VSEP also generates a permeate stream of about 59 to 61 gpm which is routed to the holding ponds and to the sewer. Concentration of the feed to the VSEP unit is about 0.05% total solids (TS, ~500 mg/L). The permeate concentration of pigments is reduced to less than 5 mg/L of TSS, well below the required discharge limits.

Project Economics

The VSEP field tests for treatment of filter press pressate were successfully conducted in April of 1997. At temperatures ranging from 21°C to 34 °C, permeate flux ranged from 100 to over 200 gallons per square foot per day (GFD) at a feed total solids (TS) concentration of about 0.05% by weight. A permeate recovery of over 98% was achieved. The effluent total suspended solids (TSS) levels were about 1 mg/L. These test results are based on data from the VSEP pilot unit at a feed pressure of 150 psig.

The concentrate level out of the VSEP unit is controlled by an automatic, timed control valve. This valve is set such that the concentration of the pigment fraction from the VSEP is held at the desired level. A multi-stage feed pump supplies the pressate to the VSEP unit at a flow rate of approximately 62 gpm at a pressure of about 150 psig. A variable frequency electronic drive is used to set feed pressure through a P.I.D. (Proportional-Integral-Derivative) control loop. This kind of drive acts to control the rotational speed of the pump, thus controlling the flow rate.

Table 1
Estimated Construction, Operation, and Maintenance Costs

Item	Costs	Unit Costs
Equipment/ Installation Cost		
VSEP System, freight, filter cleaning system, feed pump, holding tanks, piping and control (a)		
Operation and Maintenance Cost (b)		
Power Cost		
13 KW@ $.04/KWh		
System Maintenance and Cleaning		
Total O&M Costs		

(a) The VSEP system is able to process 62 gpm of pressate and to produce treated water suitable for discharge. The plant operates 24 hours per day, 350 days per year and thus processes 31.2 million gallons of pressate per year.
(b) Operation and maintenance costs are based on a Northwestern U.S. setting. Costs for power and shipping need to be adjusted for other locations.

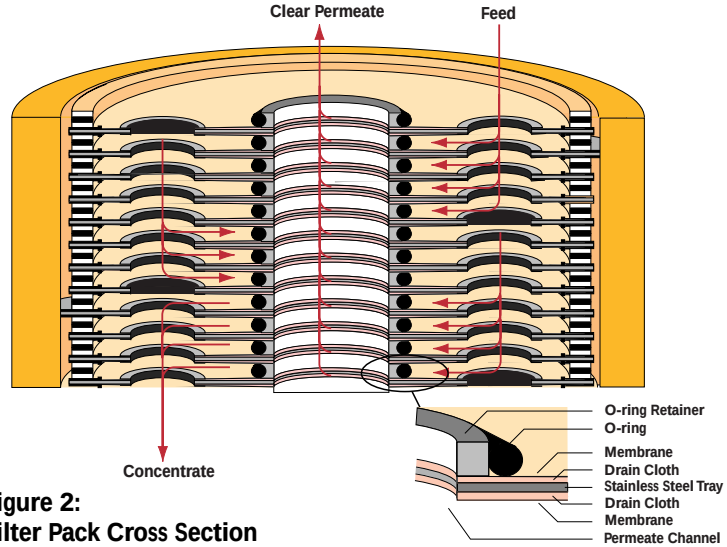

Figure 2:
Filter Pack Cross Section

VSEP Technology and Its Applications

The cost of installing and operating he VSEP system when compared with the alternative conventional treatment technology has been calculated.

For the VSEP treatment system, the operating costs are calculated based on the power costs to operate the filter unit (10 HP), filter feed pump (8 HP), filter cleaning cost, and membrane replacement. The operation and maintenance (O&M) costs are also presented in Table 1.

VSEP (Vibratory Shear Enhanced Processing) technology is being incorporated into the treatment schemes for product concentration/dewatering, recycled effluent and/or water/wastewater treatment in various process industries. Developed by New Logic International, Inc. of Emeryville, California, a VSEP system can filter streams containing a variety of materials or contaminants without the fouling problems exhibited by conventional membrane systems. The process not only filters suspended solids, but it also reduces or eliminates BOD, COD and color bodies in one step without pretreatment. The result is a crystal- clear, reusable water stream and a concentrated product stream or sludge. Rather than simply preventing fouling with high-velocity feed, VSEP reduces fouling by adding shear to the membrane surface through vibration. This vibration produces shear waves that propagate sinusoidally from the membrane's surface. As a result, the stagnant boundary layer is eliminated thus increasing the filtration rates.

As shown in Figure 2, the industrial VSEP machines contain many sheets of membrane which are arrayed as parallel disks separated by gaskets. The disk stack is contained within a Fiberglass Reinforced Plastic (FRP) cylinder. This entire assembly is vibrated in torsional oscillation similar to the agitation of a washing machine. The resulting shear is 150,000 inverse seconds which is ten times greater than the shear in crossflow systems. High shear has been shown to significantly reduce the fouling of many materials. The resistance to fouling can be enhanced with membrane selection. Virtually any commercially-available membrane material such as polypropylene, polysulphones or Teflon can be used.

Figure 3 presents a photograph of an industrial-scale Series i system.

Fig. 3 An Industrial-Scale Series i System

Each Series i system contains up to 1600 square feet of membrane filtration area. A single VSEP unit is capable of processing from 5 to 100 U.S. gallons per minute while producing crystal clear filtrate and a concentrated sludge in a single pass. This large throughput capability can be accomplished with a system that occupies only 20 square feet of floor space and consumes between 5 and 20 hp.

The VSEP system offers traditional membrane separation capabilities coupled with its own unique characteristics making it possible to successfully concentrate product streams and also to handle a variety of contaminants at high flux rates.

Operational savings generally occur in the following areas:

- reduction or elimination of chemical treatment
- retention of BTU value
- reduction of fresh water usage and effluent flows
- improvement in filtrate quality
- reduction of pumping energy
- improvements in reject concentration
- elimination of fouling of cooling towers, heat exchangers & evaporators
- reduction of BOD, COD, TSS, TDS and color
- lowering of labor and maintenance costs due to one step process

The major applications of New Logic's filtration technology include:

- Paints and Pigments (e.g. paint and pigment concentration and washing)
- Inks and Dyes (e.g. flexographic inks and starch concentration)
- Pulp and Paper (e.g. thermomechanical pulping effluent from medium density fiber board manufacture, whitewater, bleach plant effluent, box plant effluent)
- PVC latex/ Chemical Manufacturing (e.g. product concentration, raw water treatment)
- Industrial and Institutional Laundries (e.g. wastewater treatment and water recycling)
- Electronics Manufacturing (e.g. heavy metals recovery, raw water treatment)
- Chemicals Manufacturing (e.g. calcium carbonate washing and concentration)
- Oil production and petroleum processing (e.g. produced water filtration)

Reference

Culkin, B. (1990). "Vibratory Shear Enhanced Processing: A New Separation Technology for the Paint and Coating Industry," *Paint and Coating Industry*, pp. 220-221.

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