CIP ChemXtend™
Humbolt Case Study

PROJECT BACKGROUND

A creamery plant (the Plant) has been facing the challenge of increasing total dissolved solids (TDS) in ground water which is caused by the effluent from the Plant. This Plant uses CIP products that have been identified as a significant source of TDS in the waste water plant effluent. The Plant has been ordered to take measures to reduce the TDS discharge from the plant within 3 years to mitigate the increasing TDS concentration in the ground water. The Plant has been in the process of evaluating technologies for treatment to reduce TDS and total suspended solids (TSS) present in the effluent discharged from the plant.

CIP cleaning is done daily in this Plant to sanitize piping and process equipment. The Plant uses caustic cleaning product potassium hydroxide (KOH) and nitric acid (HNO3) for CIP cleaning, and currently reuses these CIP solutions for three to four days before CIP solutions are neutralized and discharged via the wastewater treatment system. To meet the TDS reduction goal, the Plant is evaluating CIP solution recovery, recycle, and reuse to extend cycles to ten days thereby receiving reduced CIP solution discharge frequency and total TDS (mass).

PROJECT GOALS AND OBJECTIVES

Layne proposed our membrane filtration system to recover and recycle CIP solutions. Layne supplied a membrane pilot and conducted a study at the Plant. There were two goals for this study; The first was to study the feasibility of recovering CIP solutions and produce good quality CIP solutions for reuse without quickly fouling the membrane. The second was to collect information for the design of a production system.

INTRODUCTION TO LAYNE MEMBRANE PILOT

Layne's membrane filtration pilot uses PTFE membrane for solid liquid separation. The pilot was skid mounted with membrane, equipment, instruments and control panel are integrated on the skid. Due to the nature of quality of the CIP solutions, a pretreatment 5 micron bag filter was added for this application to remove heavy solids that collected in the CIP solutions to prevent rapid membrane fouling. During normal operation, the membrane system cycles between filtration and the backwash cycles. The sequencing of the system was programmed and controlled by a PLC.

Chemical Enhanced Backwash (CEB) is required when the membrane exceeds a present trans-membrane pressure (TMP) or fouled. For the pilot, a CEB procedure is conducted manually by the operator. Blended solutions of potassium hydroxide and sodium hypochlorite were used for the CEB operation during this study. The pilot was operated in the batch operation mode due to the way the CIP operation was conducted in the Plant.

After CIP process, the contaminated CIP solution was stored in a day tank, the CIP solution is pumped to Layne membrane pilot for treatment. The recovered CIP solution was stored in product tank to be used for the next CIP operation. The pilot was run for ten consecutive days to validate the system performance and ensure this pilot would meet the Plant requirements.

CIP ChemXtend™
Humbolt Case Study

PILOT STUDY RESULTS

Over the trial period, the permeate flow was maintained between 0.5 to 0.7 gallons per minute (GPM). When the permeate flow dropped or increased, a control valve was adjusted to maintain this target flow. The trans-membrane pressure (TMP) was monitored through the pilot period. During initial stage of the pilot, gradual TMP increase was noticed, which was within the normal TMP range. After the initial 3 days operation, a chemical enhanced backwash (CEB) cleaning was performed to prevent deterioration of the membrane permeability. The blended solution of potassium hydroxide and sodium hypochlorite was used and the concentration of the two chemicals was 3% and 0.3%, respectively. The CEB was effective to recover the membrane and to keep the membrane TMP in the low range. The majority of the time the membrane TMP was below 3.0 psi and a CEB was performed every three days.

Throughout the trial, solution samples were collected and tested for the concentration of caustic in the solutions using the titration method. Samples were grabbed from feed solution, permeate solution and solution in the storage tank to monitor potential chemical loss in the treatment process. The concentration of the caustic in solutions are listed in Table 1 below, and no caustic solution loss was noticed as indicated by the test results.

Solution ID	Feed Solution	Permeate	Solution in Totes
Concentration	4.9%	4.7%	4.9%

Table 1. Caustic concentration in the feed and recovered CIP solution, tested by ChemCo.

Based on the volume of the caustic solution recovered each day, the recovery rate ranged between 70% and 85%.

PILOT TRIAL SUMMARY

Recovery of the CIP solution is a challenging application. The pilot study demonstrated that the membrane filtration system proposed by Layne could successfully recover the contaminated CIP solution and extend the CIP solution usage from 4 days to 10 days. Solution sample test showed that the chemical strength in the solution did not change after CIP solution treatment, and the recovered solutions meet the CIP operation requirements. The CIP solution recovery rate can be optimized in the production unit design to minimize CIP solution loss and to maximize the CIP solution recovery.

Layne membrane filtration system has demonstrated to be a viable solution for the CIP solution recovery and recycling, which will help the customer to reduce the discharge of TDS to the environment and to get the TDS concentration in the ground water under control. This is also a financially sound solution with the ROI period of 18 to 36 months by reducing chemical consumption for the CIP operation.