

Reprinted from December 2001

Food Processing

Potential savings through ceramic membrane caustic reclaim

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The recovery and reuse of common cleaning solutions such as caustic and acid can be very cost-effective, while improving environmental compliance. Some of the nation's leading food and beverage processors have embraced the idea of recovering spent caustic solutions for reuse. These caustic solutions primarily consist of sodium hydroxide or potassium hydroxide or a mixture of both.

Crossflow filtration with ceramic membranes

Crossflow filtration is a continuous process in which the feed stream flows parallel (tangential) to the membrane filtration surface and generates two outgoing streams. A small fraction of feed, called permeate or filtrate, separates out as purified liquid passing through the membrane. The remaining fraction of feed, called retentate or concentrate, contains particles rejected by the membrane. The separation is driven by the pres-



Figure 1

sure difference across the membrane, referred to as transmembrane pressure.

The parallel flow of the feed stream, combined with the boundary layer turbulence created by the crossflow velocity, continually sweeps away particles and other material that would otherwise build up on the membrane surface. As a result, crossflow membrane filters maintain high permeate rates, compared with those typically seen with conventional direct-flow filters, where the feed flow is perpendicular to the filter surface.

EXEKIA manufactures a complete line of the most widely used ceramic. Many ceramic crossflow membranes can withstand repeated chemical and/or thermal sanitizing cycles, as well as pH (0 to 14) extremes. This chemical compatibility enables the filtration of strong acid and/or base solutions.

Ceramic membrane filters are also uniquely suited to withstand high-pressure backpulse, an effective technique to further improve membrane performance.

Ceramic membranes are able to concentrate solids, recover valuable products and increase yields, making them a cost-effective alternative to traditional methods of filtration. The remarkable physical and chemical stability of some membranes allows reproducible performance over long lifetimes, a key feature in cost/benefit analyses, well-proven in numerous industrial installations.

Caustic reclaim systems processing parameters

Sanitary conditions are absolutely necessary to produce microbiologically safe and long-lasting products. Clean-in-Place (CIP), which requires caustic and acid cleaning solutions, is widely used in the food and beverage industry to maintain sanitary standards. Conventional CIP alternatives include floatation devices, decanters, centrifugal separators and media filters.

Increasingly, crossflow membrane filtration systems are being used for spent caustic recovery, offering several compelling advantages over conventional alternatives. The pH of a typical caustic solution ranges from 12 to 13.5. Caustic cleaners are often circulated at elevated temperatures in the range of 50 C to 80 C (120 to 176 F). The spent caustic contains both dissolved (e.g. sugars, polysaccharides, salts) and suspended matter (e.g. pulp, fats, proteins, soil). When high (>80 percent) recoveries are desired, the spent CIP solution becomes heavily concentrated with suspended solids.

Ceramic membranes easily meet pH, temperature and solids loading requirements compared with polymeric membrane filters. Some membranes do not retain

the chemical additives in the caustic solution, thus permitting almost 100 percent recovery of the additives in the regenerated CIP solution. At the same time, these membranes reject more than 99 percent of the colloidal and suspended solids.

Case in point: Beverage processing

Sunkist Growers is a world leader in the citrus industry, processing more than 20 million gallons of juice each year at its Tipton, Calif., processing plant. Sunkist is enjoying substantial cost savings since purchasing in 1994 a spent caustic recovery system from GEA Filtration (formerly NIRO Inc.) that utilizes Membralox® ceramic membranes.

"The use of reclaimed caustic has reduced the daily caustic usage by more than 40 percent and essentially eliminated spent caustic as a waste disposal issue," says Mike Grigus, a sales engineer with GEA Filtration, a manufacturer of membrane systems.

Grigus, who was closely involved in the pilot trials and scale-up/design leading to the sale of the GEA Filtration spent caustic filtration system, adds: "The annual savings for Sunkist were estimated at \$135,000 per year with a payback of two years. The system has been operating reliably for seven years on the original set of membranes."

Dairy processing

Microfiltration systems using Membralox® ceramic membranes are commonly used throughout the dairy industry to clarify and recover CIP solutions, primarily caustic, from a number of sources within a plant, such as cheese whey processing. For example, dilute caustic solutions are commonly used to clean evaporators. The traditional way to deal with the high volume of caustic used to clean an evaporator is to simply decant it from large tanks, allowing the heavy solids to settle to the bottom and then removing the supernatant from the top for reuse.

"The problem with this approach is that the reused caustic is not very clean, and the amount of sludge (settled solids) in the tank bottoms can be large," says Bob Keefe, sales manager for GEA Filtration. "Ceramic membranes can be used to process the spent caustic to reduce the sludge and increase the caustic recovery. The recovered caustic is cleaner and can be readily reused after adjusting the strength as needed. The end result is significant cost savings due to the reduced purchase of fresh caustic as well as reduction in the waste disposal costs," adds Keefe.



More citrus savings

Southern Gardens Citrus is a leading processor of bulk not-from-concentrate orange juice, frozen concentrated orange juice, and peel/juice byproducts. Approximately 800,000 tons of fruit (19 million boxes, each weighing 90 pounds) are processed each year at the SGC plant, located in Clewiston, Fla.

SGC uses caustic solution (1.8 to 2.0 percent by weight) to clean a variety of process equipment including tanks, extractors, centrifuges and finishers. The caustic solution also contains a small amount of additives, primarily wetting agents and surfactants. After cleaning, the spent caustic strength is typically 0.8 to 1.0 percent by weight and is contaminated with citrus peel, pulp and other suspended matter.

SGC formerly relied on centrifugal separators to separate solids from the spent caustic solutions. However, this proved to be very energy intensive and resulted in poor recovery of caustic solution.

"Until 1999, we were recycling spent caustic by centrifugation. The loss of caustic and the high energy consumption prompted us to look for alternatives," says Bill Adams, a process leader at SGC. "As a citrus processor in Florida we are limited by water use, water discharge, pH and COD requirements," adds Adams, pointing to some of the environmental and water conservation issues.

In May 1999, SGC installed a GEA Filtration caustic recovery system (see Figure 2). The filtration system

Figure 2

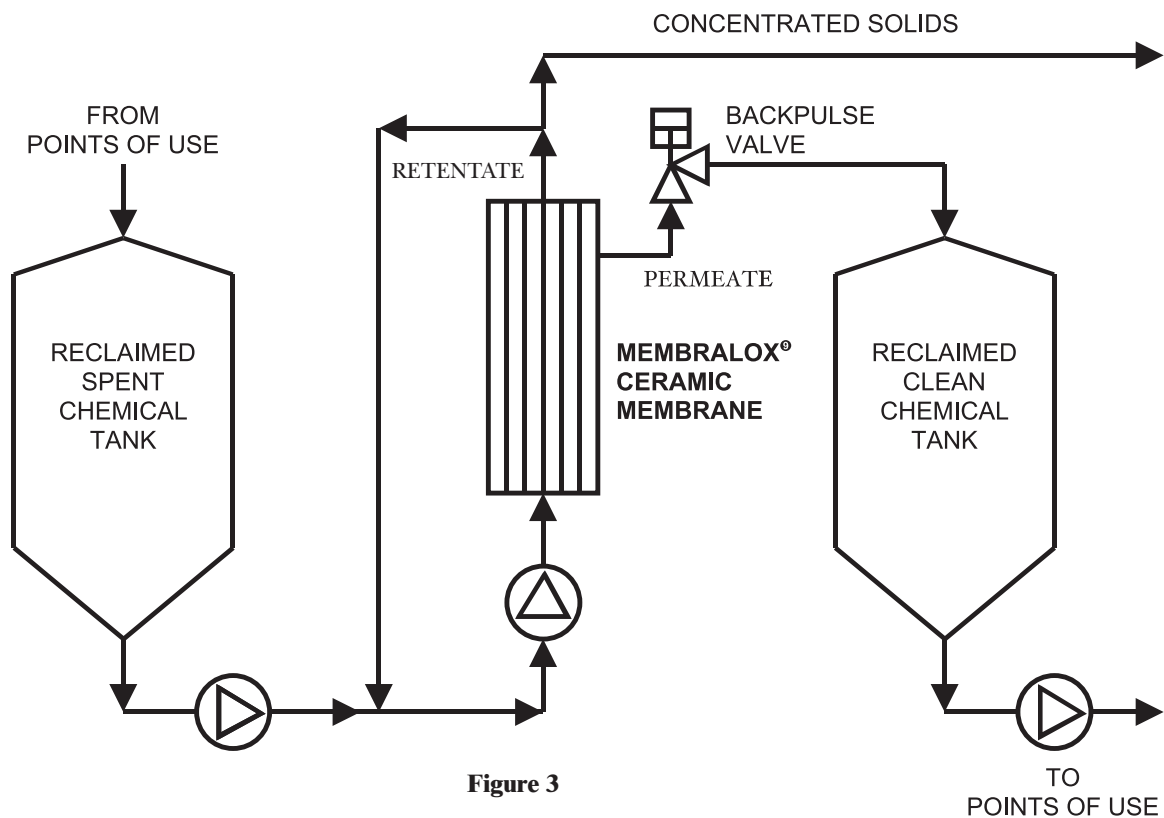


Figure 3

has two 37P19-40 GL Membralox® modules with 50 nm pore size ceramic membranes (total membrane area, 17.8 m²). The spent caustic solution is fed to the recovery system from a spent caustic tank (see Figure 3). The membranes filter the spent caustic to produce a clean caustic stream. This clean caustic is suitable for reuse after adjusting the strength of its primary constituents. The retentate is added back to the spent caustic tank, and the solids are decanted from the bottom of the tank.

The caustic recovery system has a production capacity of 6 to 8 gpm of clean caustic. On average, the filtration system operates 15 to 16 hours a day. The plant operating season starts around early November and ends in approximately the middle of July.

The filtered caustic from the ceramic membrane filtration system is much cleaner than that produced with the centrifugal separators. The new caustic recovery system also helps reduce the effluent treatment costs.

"The capital investment for ceramic membrane filtration was less than half the cost of a new centrifuge. With the installation of the caustic recovery system, our costs have been reduced by 25 percent, and the esti-

mated payback for the system is less than 1.5 years," says SGC's Bill Adams, highlighting the economic benefits of SGC's new system.

The yearly caustic consumption at SGC is about 200,000 gallons of 40 percent to 50 percent by weight solution. "We have reduced our annual caustic consumption by 30 percent after installation of the caustic recovery system," explains Adams. "Ceramic membrane filtration has reduced our total annual operating costs by about \$80,000 that excludes approximately \$10,000 per year savings in energy consumption and waste disposal," adds Adams

Grigus, who helped design the spent caustic recovery system for SGC, adds, "The system is providing the environmental and economic benefits desired by SGC, which will likely lead to its expansion when plant operations warrant it."

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