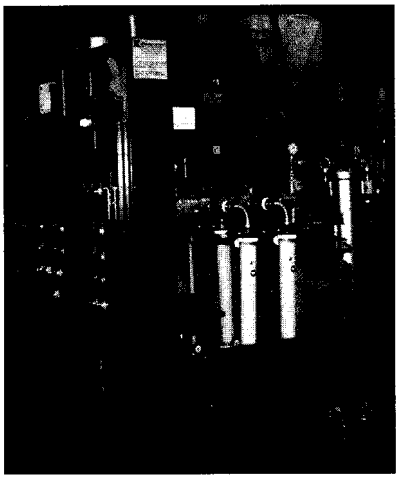
IMPROVED

MANAGEMENT

of Aqueous Cleaning Solutions

An ultrafiltration system with proper pretreatment and automation can reduce chemical costs, minimize environmental impingement, and improve production quality.

Cleaning parts through aqueous means has been in practice for many years in the metalworking and steel rolling industries. Companies that are considering switching or have recently switched from solvent-based to water-based parts cleaning can learn valuable lessons from the positive experience of others.



Parts manufacturing companies of all sizes are reducing the number of employees within their engineering and maintenance divisions. These companies are thus forced to rely more heavily on consultants and equipment suppliers to assist them in designing and choosing appropriate treatment processes and technology. Choosing the most effective technology for an application will not only guarantee high-quality cleaning, but it will also keep costs to a minimum and ensure the fastest possible return on the investment. The importance of complete, turn-key system design has never been more important.

Clean Solutions Are More Profitable

Instituting an aqueous cleaner management program has helped many companies improve process control and reduce operating costs. An efficient fluid clarification system is one designed to maintain soil loading in the cleaner at or below acceptable levels. When the wash solution is consistently clean, not only is the cleaning efficiency improved, but the process chemistry, temperature, and duration can be "tuned" for optimum performance.

It is often possible to wash parts with lower concentrations of cleaner, at lower temperatures, and for shorter periods of

time when the process is under control. Maintaining low levels of contamination in the washing stage will also help reduce soil carryover into rinsewater and later stages of the process, further improving quality and reducing waste.

The most obvious benefits of a cleaner recycling program are cost savings due to reductions in chemical usage, paperwork and manifesting, and frequency of dumping the fluid as waste. The possibility of environmental problems, resulting in fines and lawsuits, is reduced accordingly. In many cases, a nearly "closed-loop system" can be achieved, where the amount of cleaner used can be cut by more than 50 percent and waste hauling expenses can be reduced to nearly zero. This target level of performance and savings requires careful selection of cleaning chemicals and recycling equipment.

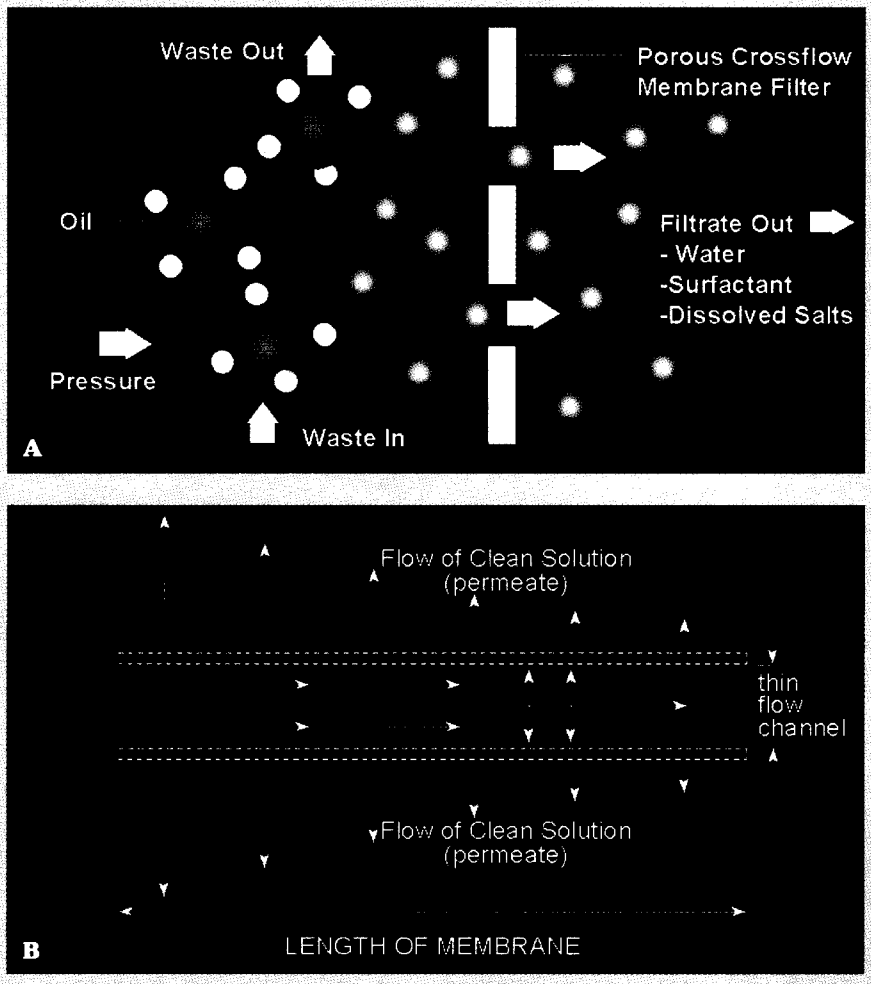


Figure 1: (A) Separation by size. (B) Basic concepts of ultrafiltration.

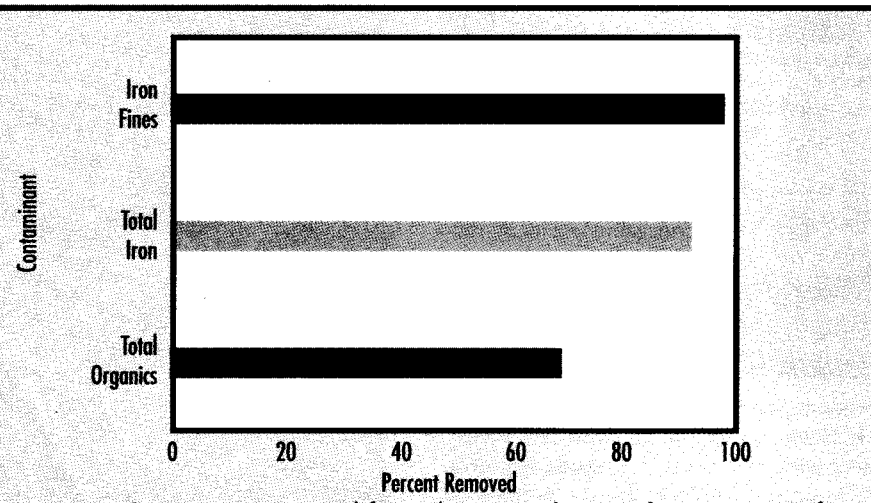


Figure 2: Contaminant removal from cleaning solutions after processing for 30 hours through ultrafiltration unit.

Ultrafiltration Proven Effective

Technology aimed at eradicating oily wastewater problems has been in use for nearly 20 years in the metalworking and metal finishing industries. A range of filtration, coalescing, and membrane technology has been applied with varying degrees of success. The most effective systems have incorporated technology that has been deemed appropriate for the process fluid and the contamination to he removed.

Ultrafiltration membrane technology has proven to be highly effective in removing dirt and oil contamination from aqueous wash solutions. Membranes have been developed that clean the liquid without removing the critical cleaning components of the wash solution (see Figure 1). The recycling system operates on a continuous side-stream basis, with the cleaner being returned directly to the wash process. Consistently low levels of contamination are maintained in the process for higher cleaning efficiency and better process control. In addition, a range of membranes are available to process the fluid at close to the normal cleaning temperatures, reducing the energy required to reheat the fluid prior to reuse.

A key factor in the success of ultrafiltration in industrial fluid processes is the selection of pretreatment components and the overall design of the package. Effective pretreatment removes free-floating oils, greases, and solids, which can reduce effectiveness and service-life of the membranes.

Pretreatment normally consists of staged filtration to remove solid contaminants and coalescing to remove free oils. Another important option for manufacturers is automation of the system, which reduces operator interaction and keeps the system running with high throughput.

Case 1: Taming the "Yellow Grease Washer"

A major automotive power-train components manufacturing plant in Michigan had a problem with its gear-and-pinion

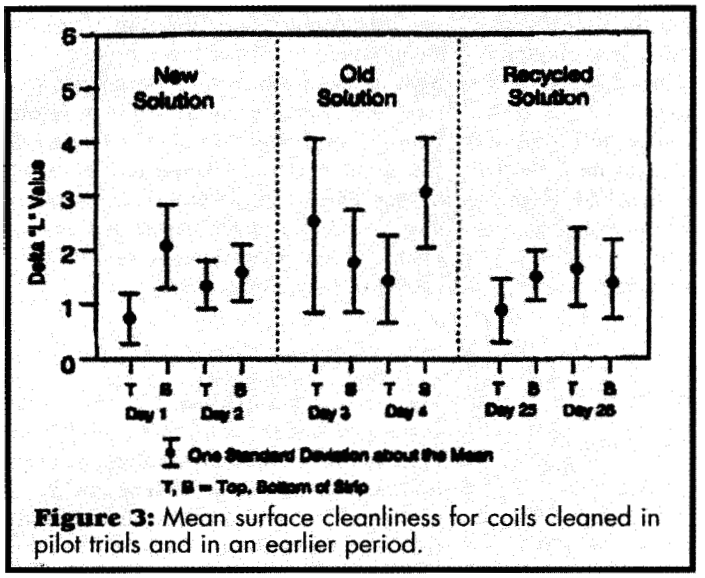


Figure 3: Mean surface cleanliness for coils cleaned in pilot trials and in an earlier period.

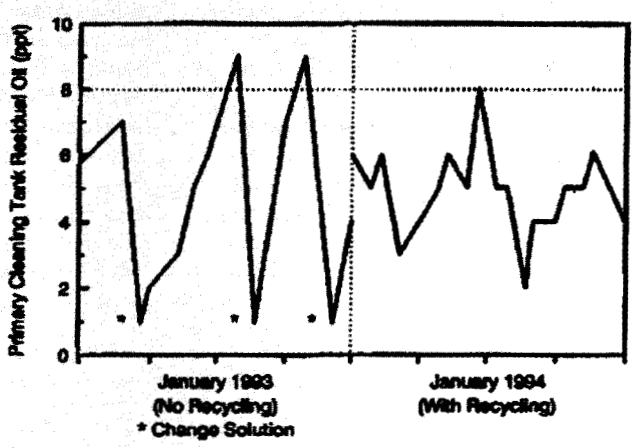


Figure 4: Residual oil level in alkali cleaning solution, with and without recycling.

washer, which was referred to as the "yellow grease washer." This overhead conveyor spray, two-stage washer cleaned off yellow grease that remained on gears and pinions from a prior operation. The wash tank had a capacity of 1000 gallons, as did the rinse tank. The wash tank ran at 140^0 and had a pH of 13.

The problem: the washwater became contaminated with oil and grease and consequently contaminated the rinse tanks. In trying to control the oil and grease buildup and associated maintenance, the company's engineers instituted a continual overflow to their waste treatment and would dump the total volume of the tanks weekly. Subsequent to the weekly dumping, technicians had to clean out the heavy yellow grease from the bottom of the tanks. The labor associated with this was unacceptable to the company. Furthermore, the

continual overflow was never really monitored, so the volume discharged continually to waste treatment was at the discretion of the operators.

Two alternatives were considered for solving this problem:

1. The addition of another wash tank, which would almost double the size of the washer, taking up valuable space and costing an estimated $250,000. (This would extend the life of the rinse due to increased liquid volume, but the tank would still have to be dumped and cleaned quite frequently.)
2. Installation of an appropriate filtration system to control oil and grease levels in the washer, extending the fluid life and reducing the downtime and manpower required to clean the tank.

After evaluation, an ultrafiltration system was installed and pilot tested for over six months. A two-cartridge, hollow-fiber, high-temperature membrane system was used and operated on-line with no problems for the duration of the testing period. The dump cycle was extended to once per month. Due to the successful test and service history, an ultrafiltration system was purchased for permanent installation and has been in operation since.

Case 2: Keeping the Steel Industry 'Rolling Along'

The steel rolling industry, like the metalworking industries, faces many challenges in controlling costs and improving production quality. One major area of concern is how to effectively manage aqueous washwaters and rinsewaters, which are an integral part of the steel rolling process. The alkaline cleaning solutions from these facilities can be the largest component of the total wastewater volume generated, often totaling millions of gallons per year. Washwaters are traditionally discharged and replaced with new solution when contamination reaches a predetermined limit. At that level of soil loading, effective cleaning is inhibited and production quality is affected.

Dumping of large alkaline washwater tanks is carried out as often as once per week in some facilities. The contamination is primarily in the form of iron and sodium soaps from the fatty acids in the rolling oils, fatty acid carryover, and iron fines. Due to the high pH of the solution and nature of the contaminants, a licensed hazardous waste handler is often required to dispose of this waste stream.

The Cold Rolling and Coating division of Stelco's Hilton Works in Hamilton, Ontario, operates a wide range of facilities that annually produce more than 1.2 million tons of cold-rolled sheet, galvanized sheet, and tin plate. Before their washwater recycling program started, wastewater generated at this production level totaled nearly 3.2 million gallons per year.

More than 1.3 million gallons per year of alkaline cleaning solutions, used to remove rolling oils and other contaminants from the steel strip prior to further processing, was disposed of by Stelco at a cost of approximately $1 million annually.

In a quest to bring these costs down, Stelco conducted a series of seven demonstration trials on the cleaning lines using two types of hollow-fiber membranes. The results confirmed that ultrafiltration with adequate pretreatment and automation

would satisfy all of Stelco's goals.

An ultrafiltration system was used to remove residual oils and other contaminants from the cleaning solution in a manner that was unique to its application. Cleaning solution, with a pH of 12 to 13, was processed on-line (side stream) at a temperature of approximately 82°C.

Results were uniformly positive, from the first trial (a batch test on week-old alkaline cleaner) to the final test (a five-week run to determine potential long-term operating problems). Within hours after the ultrafiltration unit was connected, residual oil levels in the cleaning solution were driven below 8 parts per thousand (ppt) and often approached levels of no measurable oil at all. (The 8-ppt level is used as a guide to indicate if the solution has become contaminated to the extent that it should he drained and replaced.)

Tests showed that the residual oil content of the alkaline solution decreased by 70 percent in a 30-hour period. Total iron and iron fines decreased by more than 90 percent, and phosphates, which were at a very low level, were reduced by 10 percent (see **Figure 2,** page 16).

Because the system operated on a continuous side-stream basis, contaminants were kept at a low level, allowing the cleaning solution to work at maximum effectiveness. The fluid was clarified and returned to the cleaning tank at approximately 82°C and a pH of 12 to 13.

Since the start of commercial trials, residual oil content in the alkaline cleaning solutions has remained less than the critical 8-ppt level (see **Figure 3,** page 17). The low residual oil readings have enabled production to continue without interruption due to wash tank change-outs, thus gaining one shift of production per week (see **Figure 4,** page 17). The wash solution has been recycled continuously since start up.

Not having to dispose of the 361,000 gallons of spent alkaline solution represented a savings for Stelco's Cold Mill of over $600,000 for the first year. Reduced alkali purchases represented further annual savings of over $80,000. Actual yearly savings made possible by recycling the alkaline solutions on just two of Stelco's cleaning lines amounted to $687,000. 'The unit paid for itself in six months.

Ultrafiltration Works

Clearly there is potential for significant savings in chemical costs, reduced environmental impact and liability, and improved production quality control if aqueous solutions can be cleaned. The case reports discussed illustrate how an ultrafiltration system, with proper pretreatment and automation, can dramatically extend the life of cleaning solutions. This can be accomplished on-line and with minimal negative impact on the production process. Due to the direct savings of chemical and waste-hauling costs, systems can be justified by a return on investment of only a few months. ■

About the Author

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Mr. Mackey was the west coast regional sales manager for five years and holds a B.S. degree in Engineering from the University of Michigan.