An employee of Metco Metal Finishing unloads a rack of automotive parts after the plating process.

Electrodialysis System Extends EN Bath Life for Phoenix Jobshop

A metal finishing jobshop in Phoenix is using a re-purification system that reduces its waste by recovering and reusing spent electroless nickel solutions.

Metco Metal Finishing, Phoenix, AZ, is a medium-sized jobshop that offers a variety of different processes, including copper, tin electroless nickel (EN), zinc, anodizing, conversion coating, zinc phosphate and bright nickel. In the company's electroless nickel department at the time of the electrodialysis (re-purification) trial, there were three 170-gal EN plating tanks. Two tanks were used for plating, while the third was used for bath storage. The shop uses a proprietary phosphorus bath chemistry[1] that provides a bright, seven to nine percent phosphorus electroless nickel deposit.

Electrodialysis Trial

Prior to using the re-purification system (an electrodialysis process), each year Metco:

- Made up 71 new EN baths
- Used 9,120 gal of EN plating solutions
- Spent more than $37,000 for new bath makeups
- Spent more than $43,000 for chemical additions

The average EN bath was operated for five to six metal turnovers (MTOs) before disposal. The company shipped spent chemicals off site for treatment and disposal at a cost of $31,000 per year.

To determine the effectiveness of the electrodialysis technology, Metco performed a three-month trial with a demonstration unit.[2] The unit selected provided the capacity to reduce the contaminant level of a 100-gal bath used for five MTOs to a level corresponding to one MTO in a 48-hr period. During the trial, Metco generated and reused an EN bath six times and found no degradation of the bath or plating quality. The EN bath was used for four or five MTOs between regenerations for a total of 28 MTOs. Each regeneration of spent EN solution reduced its orthophosphite concentration from an average of 140 g/L to 28.

Batch Process

Electrodialysis is a batch process. The regeneration rate depends on the size of the electrodialysis unit and the volume and concentration of influent spent solutions. The unit has a meter that monitors the total dissolved solids (TDS) or conductivity of the EN solution. As the concentrations of orthophosphite and other by-products decrease in the EN bath, TDS levels and conductivity decrease proportionately.

The process typically produces a regenerated bath with 60 percent of the original bath volume. Most of the volume lost in the electrodialysis process is dissolved salts and water, but small amounts of desirable components, such as nickel, hypophosphite, buffers and complexors, are also lost to diluted waste stream.

After bath regeneration, replenishment chemicals are added to the bath to restore the chemical concentration and balance, and deionized (DI) water is added to restore the original bath volume. The dilute waste stream is generated at a rate of about 40–60 gal per 100 gal of EN bath regenerated. The dilute contains a low concentration of nickel and small amounts of chelators, and it can usually be bled into a conventional wastewater treatment system or disposed of off site.

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[1]*OMG Fidelity 9002, OMG Fidelity, Newark, NJ*

[2]*Zero Discharge Technologies, Inc., Chicopee, MA*

Full-scale Dialysis Implementation

Based on the results of the trial, Metco decided to install a full-scale electrodialysis unit. The unit selected has a total of 30 anionic and cationic cell pairs, and is designed with a regeneration capability of reducing the contaminate level of a 100-gal bath from a six-MTO equivalent to a one-MTO equivalent in 48 hr. It requires 21 amperes of electrical current and 380 watts per hr of electrical power.

Metco is using the unit to operate EN baths through 12 regenerations and five MTOs between regenerations, which provides more than 60 MTOs per bath. The shop now maintains four EN baths—two in operation, one in storage and one undergoing electrodialysis—to ensure the availability of regenerated EN baths for production.

Recycling Pays

Because of the increased EN bath life, Metco estimates that it will have to prepare only three baths per year, compared to 71 before changing over to the electrodialysis process. Additionally, EN bath regeneration and EN process chemical purchases have been reduced by 25 percent.

The system has also improved process efficiency by significantly decreasing "break-in" time for EN baths because the process provides the desired plating quality immediately. After dialysis and replenishment, most new EN baths achieve the desired quality after a short break-in period. Reject rates on the EN line have decreased by about 50 percent, and reject costs have dropped from $1,700 to $523 per month. Company officials attribute this to the more consistent plating quality provided by the dialyzed EN baths.

Metco's environmental technician checks on the operation of the electrodialysis unit.

Waste Stream Volume Drops

Another benefit realized with the system is the reduction in volume of waste stream by more than 3,800 gal per year. Based on the nickel concentrations in the spent EN bath and dilute waste streams, the total mass of nickel disposed has decreased by more than 320 lb annually. The amount of process chemicals used has dropped by 25 percent and EN liquid waste has decreased by 33 percent.

Metco ships the dilute waste stream off site for treatment at a cost of 77 cents per gal, compared to $2.63 per gal paid for disposal of spent EN solution. That gives the company a 77-percent reduction in total liquid waste disposal cost for its EN processes. Company officials say that even greater savings could be realized by treating the dilute on site in a conventional wastewater treatment system.

Metco's initial capital investment for the 30-compartment electrodialysis unit was $28,000. The company says it took only seven months for the unit to pay back the investment. P&SF

Mark Williams, quality control supervisor, tests a sample from the electrodialysis machine to check nickel metal and orthophosphite levels.