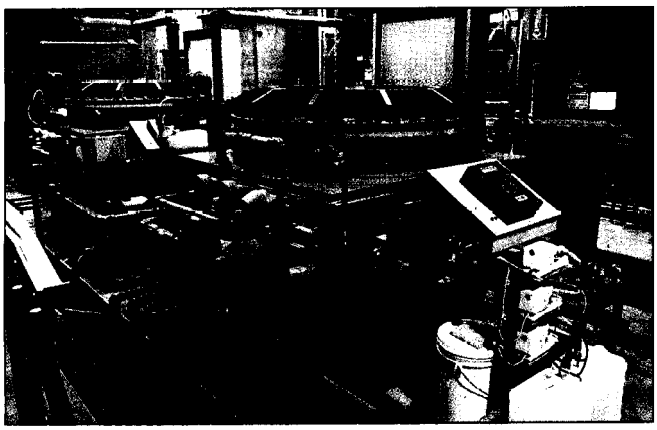
Sludge Reduction Waste Treatment

by Boyd A. Anderson

The good neighbor policy.



Unisys's copper recovery ion exchange units are capable of processing 180 gpm of waste.

In 1987, Unisys's printed circuit facility in Salt Lake City, UT, reached a turning point in its treatment of

PINPOINTING THE OPTIONS

The company evaluated three possible courses of action: developing its own technology, modifying its existing system, and installing a new system. The technology that Unisys wanted to develop was ion exchange. A local firm with extensive experience in this type of water purification worked with the company to determine if developing this technology was a viable option.

Ion exchange has the ability to process large volumes of low-copper-bearing water at minimal cost. Also, by using sulfuric acid as the regenerant, small volumes of copper sulfate can be plated out as copper metal in an electrowinning cell.

However, the time needed to fully develop this process wasn't available, and outside help from a company with experience in copper recovery technology would be needed. Unisys decided to move on to option two-modifying its existing system.

In evaluating the existing system, the company discovered that the pumps, pH adjust system, and electrical controls were all unreliable. The only reliable pieces of equipment were the tanks and sludge filter press. Unisys realized that modifying the existing system would never meet the plan goals.

To review the final option—installing a new waste treatment system—the company wrote a system specification and gave it to four vendors. It later reviewed the vendors' quotes. All four systems quoted by the vendors were sludge reduction systems. Sludgeless systems were not available due to economics and technology at the time.

Unisys determined that purchasing a new system was the best choice. A new system could be installed and started without any manufacturing downtime. It could be designed to meet all the plan requirements. And, although an addition to the building would be needed, removing the old system would free up prime manufacturing real estate.

SLUDGE REDUCTION VS. SLUDGELESS SYSTEMS

Even though a sludgeless system wasn't available, Unisys examined the differences between that type of system and a sludge reduction system before deciding the latter would better meet its needs. As the name implies, a sludgeless system doesn't generate any sludge. Ion exchange is the most common technology used in this type of system. Metal-bearing wastes are passed through a column of ion exchange resins, which selectively remove the metal ions from the solution.

The ion exchange resins are then regenerated with an acid to create a high metal concentrate, such as copper sulfate or tin-lead fluoroborate. The metal in this metal concentrate is plated out in an electrowinning cell.

The electrowinning cell operates on the same principle

as plating copper on a circuit board. An anode and a cathode are used. The metals are plated on the cathode in thicknesses of 0.25" to 0.5" and then peeled off in sheets.

Problems occur in electrowinning some metals. For example, the fluoride ion in tin-lead fluoroborate attacks the lead-calcium anodes in electrowinning cells. To solve this problem, the anode must be shielded by a membrane or made out of some exotic metal.

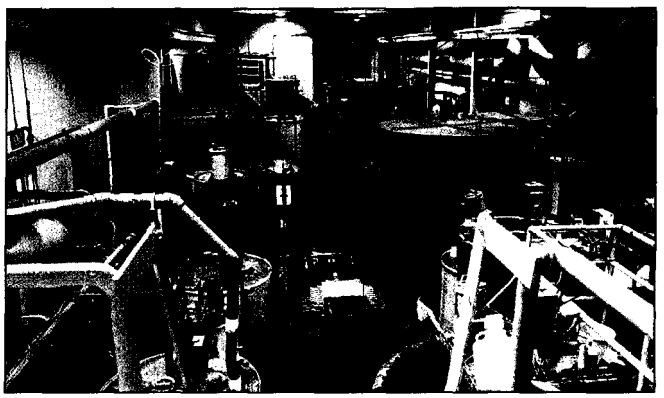
Sludgeless systems are expensive and have problems. In these systems, copper and lead are plated out together on the same sheet. Because the copper has lead in it, the scrap value of the copper is greatly diminished. In some cases, if there is enough lead, the copper-lead metal could be considered a hazardous waste.

A sludge reduction system uses the same ion exchange and electrowinning technology as a sludgeless system except its electrowinning cells use stainless steel as the cathode and lead-calcium alloy as the anode. This design is inexpensive compared to the electrowinning cell used in the sludgeless system.

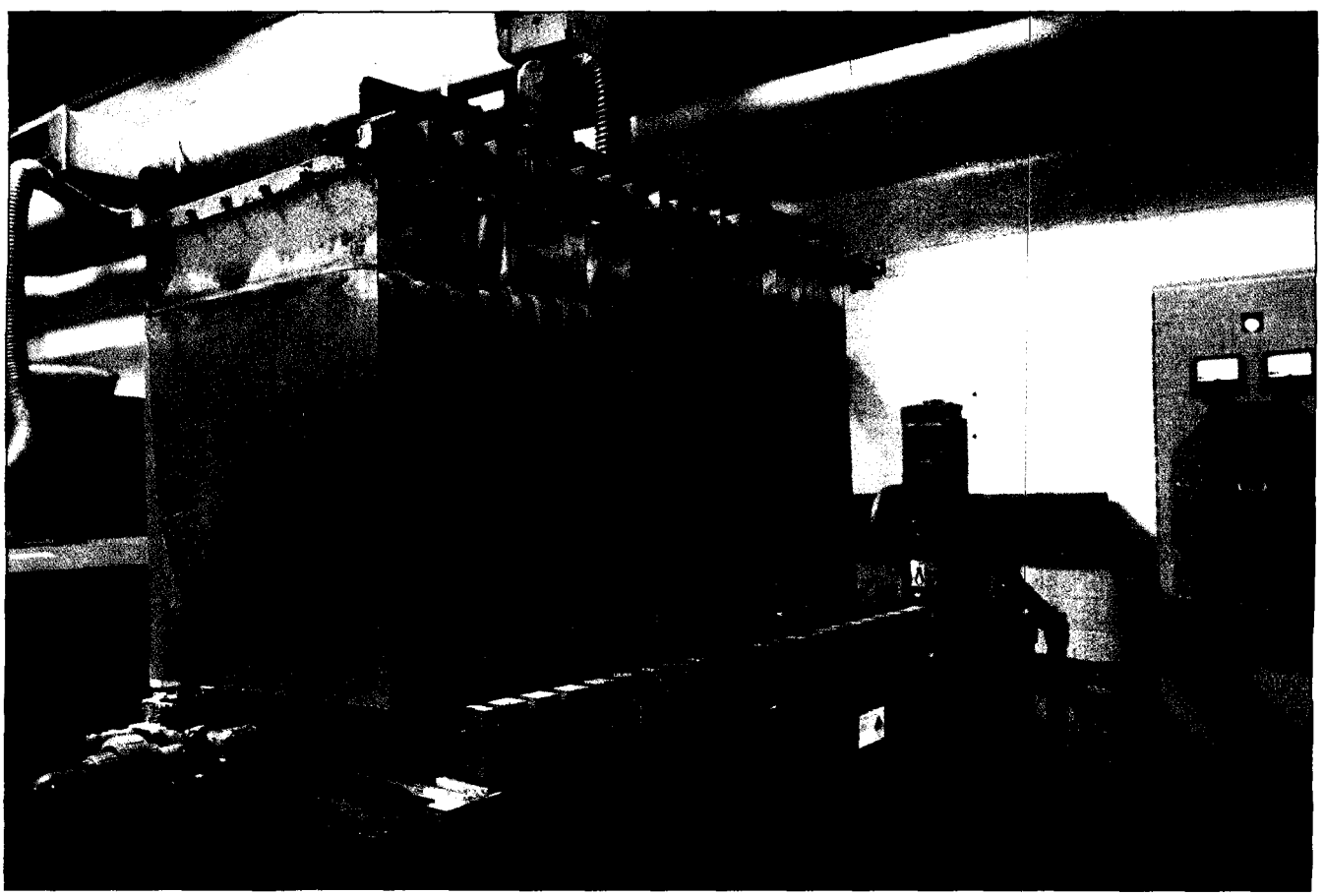
In a sludge reduction system, the copper waste streams are segregated from the lead streams. Thus, the ion exchange resins can be regenerated with sulfuric acid to produce copper sulfate. The copper sulfate is then plated out using the less expensive electrowinning process.

The system's drawback is that the lead and lead-copper waste streams have to be treated in conventional precipitation systems, creating hazardous waste sludge. But there are ways to recycle the sludge.

Some companies will take the sludge, break it down into



The entire copper recovery system at Unisys.



Each sheet removed from the electrowinning cell holds about 40 lbs. of copper.

its basic metals, and then recycle the metals through a smelting process. This method of recycling eliminates all liability.

Sludge reduction is a law. In Code of Federal Regulation 40, Part 262, Appendix Item 16, all generators of hazardous waste are required to have a waste minimization plan and must certify that they do on every manifest they sign.

Implementing such a plan is also a good business decision. The regulations on hazardous waste disposal are getting stricter, costs are going up, and liabilities are increasing. The cost for cleaning the average hazardous waste site is $200,000, In many cases this cost has bankrupted companies. And even then the costs don't go away, the managers or owners of bankrupt companies can still be liable for the clean up.

The sludge reduction system Unisys implemented contains several subsystems, including copper recovery, chrome recovery, and nitric acid recovery. Two other recovery subsystems are not yet operational. The new system has presented challenges for

The Unisys system has the following sludge reduction subsystems:

Copper Recovery

This system uses ion exchange and electrowinning to recover copper. The following waste streams are recovered:

- High copper concentration baths (microetches)
- Low copper concentration baths (predips)
- Copper-bearing rinse waters
- Byproduct from the nitrio recovery system

Chrome Recovery

This system uses ion exchange, atmospheric evaporation, and electrolytic regeneration. The following waste streams are recovered:

- Chrome rinse waters
- The chrome bath

Nitric Acid Recovery

This system uses ion exchange and atmospheric evaporation. The following waste s$tream is recovered:

- Nitric acid rack stripper

the company. One of the first was operator training. A sludge reduction system uses more sophisticated technology than conventional precipitation systems. A lot of emphasis was placed on training the operators.

Tin-Lead Recovery
Electrowinning on graphite granules (not operational). The following waste streams should be treated in this system:
- Tin-lead rinses
- Tin-lead plating bath

Copper (Electroless) Recovery
Electrowinning on graphite granules (not operational). The following waste streams should be treated in this system:
- Electroless copper rinses
- Electroless copper plating bath

Conventional Treatment
- Copper- and lead-bearing streams
- Floor spills
- Solder stripper bath and rinses

Soft Water ***System***
- Softens incoming water prior to circuit board rinsing

Another challenge was eliminating tin precipitate found in the copper ion exchange column. The tin precipitate does not do any long-term damage to the system, but it does decrease the flow rate. In trying to identify the source of the tin, the company discovered that it exists in levels of 0.1 parts per million. Although this level seems small, it adds up when large volumes of water are processed. The company still hasn't solved this problem.

Another problem also occurred in the electrowinning cell. Lead anodes were flaking away. After evaluation, the company found that either excess sodium or potassium persulfates were causing this problem. Unisys is looking into reducing these persulfates.

A very large challenge was created when the new system was set up. Management wouldn't permit any production downtime, so the old system had to keep operating while the

new system was installed and started up. The waste stream segregation was completely different between the two systems. To keep both systems operational, plumbing from the plating facility had to be shared, which created a plumber's nightmare.

SUCCESSES

All processes, with the exception of the tin-lead and copper (electroless) systems, are performing well. Work is ongoing to get the final two systems operational. The facility's production of sludge has been reduced from 600,000 lbs. annually to just under 100,000 lbs. annually. The total sludge reduction is 85%. The company is also recovering 18,000 lbs. of copper metal annually in its recovery process.

Unisys has realized annual operating cost savings of $118,000, or 35%. The effluent compliance results with the new system average less than 0.5 parts per million of copper per day.

THE GOOD NEIGHBOR POLICY

Being a good neighbor to state and local regulatory agencies, employees, and the environment needs to be the concern of every plating facility. In its effort to be a good neighbor, Unisys is consistently in compliance with effluent standards and is minimizing its generation of hazardous wastes. Before purchasing its waste treatment system, the company asked regulatory agencies to review and approve it. Unisys continues to involve them in the system by offering tours and advising them of any recent changes.

Unisys also told its disposal facility that the process was being changed and supplied the facility with a profile of the waste the new process generated. The new system is cleaner and more orderly, which appeals to the employees working with or near the system. And the company is no longer dumping hazardous waste into landfills. Instead Unisys is reclaiming natural resources that can be used again. ■

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