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Factsheet

Electrocoagulation Technology

Ace Plating, Part II

Electrocoagulation is a process of applying a direct or alternating current and voltage of varying strength to electrodes in contact with water. In theory, this contact causes the suspened and/or dissolved solids in that water to form into a floc or precipitate of sufficient size that it can be rapidly removed from the liquid by filtration.

Electrocoagulation technology vendors promote the ability of this method to reduce water usage and the amount of metals discharged to the sewer. Electrocoagulation vendors claim the process removes 75-99% of metals and 90-99% of suspended solids while reducing BOD and COD by 50-75%. Sometimes the process is also marketed as having the ability to reduce the amount of inorganic salts in the water being treated. These claims were based primarily on laboratory data only. The vendors also stated that this process not only improved water quality over other technologies, but did so with lower costs. Reportedly, electrocoagulation would eliminate adding expensive chemicals to the wastewater and would subsequently generate less solid waste, thus saving on disposal costs.

The Waste Management and Research Center (WMRC) investigated the electrocoagulation process to determine its effectiveness. If this technology could be proven to be as effective in actual process applications as reported in lab studies, it would be a valuable tool for cost-effective water recycling and reuse. WMRC worked with Ace Plating, an electroplater in the Chicago area that agreed to host a series of tests. WMRC engineers had previously worked with Ace to reduce their water usage, dragout, and metals discharged to the sewer (details about this project are available in WMRC publication TN99-066). The pollution prevention goal was to recycle the process rinse waters and eventually achieve zero process water discharge to the sewer. Equipment from two separate vendors was tested.

Laboratory Testing -- Vendor A

Wastewater samples were sent to Vendor A's test facility for preliminary screening. Initial results on the samples were promising (summarized at right). The low removal of dissolved solids was a concern, but multiple passes were expected to produce better results.

Vendor A: Laboratory Tests (ppm)

Parameter	Pre-Electro	Post-Electro
Cu	0.63	0.054
Ni	0.85	0.11
Zn	2.3	0.18
CN	1.4	0.01
TSS	28.3	7.8
TDS	2050	1850

Plant Testing -- Vendor A

The initial laboratory tests were successful enough to warrant a pilot study. However, results from this second phase were dismal. Metal concentrations in the water appeared to increase as additional wastewater was passed through the unit. In addition, the unit suffered from several mechanical failures. After three months of disappointing results, the vendor brought in a production-scale unit for testing. Mechanical reliability improved, but contaminant removal still did not approach the success of the laboratory tests. Typical results from the two pilot studies are summarized at right.

Vendor A: Pilot Unit Tests (ppm)

Parameter	Pre-Electro	Post-Electro
pH	9.60	7.84
Cu	2.17	2.45
Ni	0.40	0.46
Zn	0.60	1.11
CN	1.90	2.45

Plant Testing – Vendor B

WMRC had been in contact with a second vendor during the plant testing phase described above. This second supplier claimed that their unit functioned so effectively that, after removing metals and large particles, it would attack the next largest particle in the water. Other companies using this unit claimed great results. These testimonies, plus a money-back guarantee by Vendor B, convinced Ace to order this unit. Testing of this one produced inconclusive results.

Vendor B -- Initial Operation

Similar to the first vendor's equipment, this system operated at a pH of 7. This unit also consisted of an ultraviolet lamp, a current inducer and two sets of probes at the reactor tank. Although the water looked clear and clean, large concentrations of metal were still present, making the water unsuitable for direct discharge due to regulatory constraints. Recycling continued while attempts were made to improve system operation. After a month of operation, metals removal efficiency was still disappointing. Results at pH 7 are shown below.

Vendor B: Initial Operation (ppm)

Parameter	Pre-Electro	Post-Electro
pH (units)	9.51	7.44
Cu	0.76	0.17
Ni	0.84	0.56
Zn	8.90	4.80
CN	0.55	0.05 or less
TSS	70	30

Vendor B -- Modified Operation

After failing to control metal concentrations at neutral pH, traditional wastewater treatment techniques were applied. System pH was raised to 9.2, allowing regular chemical precipitation to occur. Metal concentrations immediately dropped to levels meeting current discharge regulations. At the same time, despite vendor claims to otherwise, other contaminant levels (sodium, sulfates, chlorides) remained unaffected by the electrocoagulation unit. Some water would still have to be discharged to prevent concentrations of dissolved solids from affecting plating quality.

The system had been installed with the expectation of closing the loop, and reaching zero discharge. Although metal concentrations when operating at higher pH were low enough to allow recycling, the levels of dissolved solids prevented zero discharge from being a practical reality. Water had to be batch discharged and replaced with fresh water at given intervals to ensure plating quality.

Vendor B: Chemical Precipitation Results (ppm)

Parameter	Pre-Electro	Post-Electro
pH (units)	9.52	9.42
Zn	3.8	0.25
CN	0.35	0.05
TDS	10,070	10,700

Although the system supplied by Vendor B proved reasonably effective at reducing metal concentrations and allowing recycling of process water, the effectiveness of the actual electrocoagulation unit itself remained an unknown. WMRC sampled process water at five points (P1 - P5 below) throughout the system, hoping to determine how much of the contaminant removal actually happened during the electrocoagulation step itself. Data from these sampling points indicate that very little change occurred during the electrocoagulation step (P4). Apparently other parts of the system were responsible for contaminant reductions.

Over the next two years, samples were taken to gauge the ongoing performance of the electrocoagulation unit, with the final set being taken in September of 1999. Laboratory analyses showed that sample metal levels were always within discharge limits, but that concentrations of all contaminants were at the same level as when the process reached its initial steady state.

It is interesting to note that theoretically, the electrocoagulation process relies on electrical current, but WMRC testing showed that current supply to the unit was not relevant. The entire system was apparently working so well that even when the current inducer was not functioning, the recycled process water remained high in quality as long as 1,000 gallons were discharged each week.

Conclusions

Vendor B: Electrocoagulation System Results, September 1999 (ppm at pH 9.2)

Parameter	P1	P2	P3	P4	P5
Cu	1.5	1.4	1.4	1.4	1.2
Ni	1.2	1.2	1.3	1.2	1.2
Zn	0.88	0.25	0.20	0.23	0.15

1. Electrocoagulation has not been shown to be superior to chemical precipitation.
2. Rinse water can be recycled and reused after passing through a series of conventional "cleaning" steps.
3. "Electro" coagulation is not necessary to achieve quality recycled process water. However, Vendor B's unit did require the UV lamp to limit bacterial contamination
4. For this type of closed loop system, a portion of the recycled process water must be discarded (or additional technology such as reverse osmosis must be employed) in order to maintain a high degree of water quality.

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