Appendix G – Capsule Report: Coventya Zn/Ni 3S Technology

Demonstration of the Coventya Zn/Ni 3S Technology

Introduction

This capsule report was prepared under EPA Grant Number 00E02050, funded through the EPA Source Reduction Assistance Grant Program. This program funds Pollution Prevention (P2) assistance projects that provide technical assistance and/or training to businesses/facilities to help them adopt source reduction approaches.

Various tasks have been performed under this EPA grant. The purpose of this particular project was to demonstrate the Coventya 3S Technology, which is a zinc/nickel electroplating bath maintenance system. The project focused on the potential reduction of water use, reduction of discharges to the wastewater treatment system, and reduction of energy use.

Background Information

The technology uses a porous barrier to divide the bath into an anode and cathode compartment. Electrolyte is recirculated through the anode compartment, which is maintained at a head slightly above that of the cathode compartment, allowing a slow continuous flow of electrolyte. In this configuration, possibly assisted by ion-selective permeability of the barrier, the migration of organic components present in the cathode compartment into the anode compartment is impeded. In ordinary zinc/nickel baths, these compounds are oxidized when they reach the anode, forming cyanide and undesirable carbonates. The 3S technology avoids production of these contaminants. In addition, preventing unwanted side reactions should increase current efficiency, and recirculating anode electrolyte should draw heat away from the bath, reducing power requirements of plating and cooling.

A plating facility, located in Chicago, had the 3S technology installed and by 2018 was fully operational. The same facility is still running a conventional zinc/nickel process on a nearby plating line, using a process designated “160” by the facility. Data were obtained concurrently from both processes, enabling a side-by-side comparison on several key performance factors, including generation rate of unwanted by-products, power requirements for plating and cooling, and water consumption.

Data provided by the Chicago facility include comparisons of power consumption, concentrations of selected bath components and contaminants, and water consumption between the 3S and the 160 processes, and the makeup rate for anolyte (sodium hydroxide solution circulating through the anode compartments). The data for each performance factor are presented in summary tables, followed by a brief discussion.

Power Consumption

Two test runs compared power consumption, normalized per pound of product, between the 3S and 160 processes. In both cases, the 3S process was found to have a measurable savings of 10-12% in total electric energy per pound of product required, compared to the conventional process.

Electrical (Amps/Lb.)		
Test Run No. 1		
	3S (315)	160
Load Size	221	194
Avg. Voltage used	13	13
Plate time (minutes)	117	117
Amp/Barrel Used	600	600
Amps/lb. (Barrel)	2.71	3.09
Amp-Hrs./Barrel Used	1,170	1,170
Amp-Hrs./Lb. Used (1 Barrel)	5.29	6.03
Power saved	12%	

Electrical (Amps/Lb.)		
Test Run No. 2		
	3S (315)	160
Load Size	251	226
Avg. Voltage used	13	13
Plate time (minutes)	117	117
Amp/Barrel Used	600	600
Amps/lb. (Barrel)	2.39	2.65
Amp-Hrs./Barrel Used	1,170	1,170
Amp-Hrs./Lb. Used	4.66	5.18
Power saved	10%	

Bath Composition

Sample Date	Carbonates (oz/gal)		Zinc (oz/gal)		Nickel (mg/l)		Cyanide (mg/l)	
Lab 1	315-3S	160	315-3S	160	315-3S	160	315-3S	160
7/20/2018	3.36	3.90	0.55	1.20	402	1,620	?	?
7/27/2018	4.20	4.50	0.90	1.01	850	1,880	?	?
8/2/2018	2.66	4.42	0.53	0.63	440	1,510	?	?
8/14/2018	2.83	4.60	0.61	0.91	1,010	1,990	?	?
8/23/2018	1.95	4.60	0.77	1.06	942	1,780	<49.4	148
8/29/2018	2.30	3.36	0.45	1.15	815	1,990	<49.4	98.7
mean	2.88	4.23	0.64	0.99	743	1,795		
std dev	0.80	0.50	0.17	0.21	259	198		

Lab 2	315-3S	160	315-3S	160	315-3S	160	315-3S	160
7/20/2018	8.0	8.1	1.2	1.6	530	1,470		36
7/27/2018	8.5	9.8	1.2	2.1	710	1,760	ND	10
8/2/2018	5.4	10.2	1.3	1.7	702	2,010	ND	51
8/14/2018	8.3	9.5	1.0	1.4	890	2,080	ND	8
8/23/2018	8.4	11.0	1.2	1.9	815	1,990	ND	25
8/29/2018	8.1	10.1	1.3	1.7	980	2,250	ND	
mean	7.78	9.78	1.20	1.73	771	1,927		
std dev	1.18	0.97	0.11	0.24	159	274		

Lab 3	315-3S	160	315-3S	160	315-3S	160	315-3S	160
7/20/2018			1.35	1.38	660	1,890		
7/27/2018			1.52	1.49	900	2,350		
8/2/2018			1.42	1.41	1,140	1,730		
8/14/2018			1.42	1.52	1,120	1,690		
8/23/2018			1.25	1.50	985	1,850		
8/29/2018			1.40	1.45	980	2,250		
mean			1.39	1.46	964	1,960		
std dev			0.09	0.05	175	275		

Both the 3S and the 160 baths were sampled on six occasions between July 20 and August 29, 2018. Samples were analyzed by three different laboratories (a commercial laboratory, Coventya, and the facility's in-house laboratory) for zinc and nickel, and by two of the laboratories for cyanide and carbonates.

Within each laboratory's data set, the data are generally consistent, and exhibit the expected differences between the two baths. Concentrations of all components are lower in the 3S bath. The primary reagents, zinc and nickel, are maintained at a lower concentration by design, and the contaminants, cyanide and carbonates, are being generated at a lower rate (in the case of cyanide, non-detectably) in the 3S bath, as intended.

When data from the laboratories are compared with each other, several questions emerge. If the samples sent to each laboratory were split from the same bath sample, closer quantitative agreement would be expected. The fact that each data set shows the same pattern may indicate, for example, a difference in reported units. More puzzling is the lack of correlation: if one laboratory's result for a particular sample date is particularly low compared to that laboratory's mean for all six samples, each of the other laboratories should also show a low value for that sample compared to its own mean for the six samples. That does not appear to be the case.

Water Consumption

When data from the laboratories are compared with each other, several questions emerge. If the samples sent to each laboratory were split from the same bath sample, closer quantitative agreement would be expected. The fact that each data set shows the same pattern may indicate, for example, a difference in reported units. More puzzling is the lack of correlation: if one laboratory's result for a particular sample date is particularly low compared to that laboratory's mean for all six samples, each of the other laboratories should also show a low value for that sample compared to its own mean for the six samples. That does not appear to be the case.

	315-3S		160		Gallons used per pound produced	
Date	Prod (lb)	gal	Prod (lb)	gal	315-3S	160
6/18/18 - 6/29/18	161,100	3,474,814	92,237	159,440	21.6	1.7
7/1/18 - 8/31/18	630,987	10,427,650	391,592	676,224	16.5	1.7

Potential Savings

Assuming that the production volume during the two-month period 7/1/18 – 8/31/18 in the water consumption table is representative of the annual production rate, yearly production of the 315-3S product would be 5,047,896 pounds. From these totals, it is possible to project annual savings in power consumption and wastewater treatment costs. The comparison will be based on the expected impact of producing 5,000,000 pounds of product using the 3S process with the corresponding impact expected had the same amount of product been produced with the 160 process.

For electric power, using test run #2 above for the more conservative estimate, annual production using 3S would consume 5,000,000 lb * 4.66 amp-hr/lb * 13V = 302,900 kWh, compared to 5,000,000 * 5.18 * 13 = 336,700 kWh, a savings of 33,800 kWh. The total average industrial rate for electric power in Illinois in 2018 was 6.04 cents per kWh[3], so that the total annual cost savings for power would be $2,042.

For wastewater, the estimate is complicated by the variety of factors that contribute to the cost of treatment and disposal. Different pollutants require different levels of treatment. Cyanide treatment requires an oxidation step, which can presumably be avoided if the wastewater contains no detectable cyanide. Because the 3S bath has half the nickel concentration and substantially lower zinc concentration than the standard bath, the wastewater would be expected to have correspondingly lower concentrations of both metals. The average cost for wastewater treatment and disposal as indicated by a recent survey is found to be $13.85/1000 gallons. Assuming the water consumption figure for the 160 process (1.7 gallon/lb) is representative of what the 3S process will ultimately consume, production of 5,000,000 pounds would require treatment and disposal of 8,500,000 gallons, at an estimated cost of $117,725. If the absence of cyanide and the lower metal ion concentration amounted to as little as 10% cost reduction, the total wastewater treatment and disposal cost savings would be over $10,000/year.

[3] Data from Edison Electric Institute, Typical Bills and Average Rates Report - Winter 2018, available at https://www.rockymountainpower.net/about/rar/ipc.html