Study Shows Acid Extender Really Works!

Two finishing job shops in New York have tested a proprietary product that was developed to treat and extend acid solutions used in surface finishing operations. The results of their studies proved that, when used as directed, the product was effective as an environmentally friendly acid life extender and cost savings technique.

The Project

Acids are commonly used in the manufacture of products in a variety of industries. The most common uses include deoxidizing, etching, pickling and cleaning of metallic surfaces.

In typical acid pickling operations, metals and organics build up in the acid baths and eventually render them ineffective, requiring replacement usually every two to four weeks. The spent acids are considered hazardous waste if transported for treatment off-site. On-site treatment for disposal to a publicly-owned treatment works (POTW) requires an extensive waste treatment system.

Treatment involves pH adjustment by reacting the waste with sodium hydroxide (a hazardous material). The solids are then removed with the aid of another chemical (a flocculent). The treated wastewater is sent by sewer to the POTW.

Solids removed from the waste are dried and disposed of as a listed hazardous waste (F006). In the event that the system fails (too low of pH and/or too high metals content), waste can flow directly through to the POTW resulting in costly fines, permit revocation, and potentially causing a failure of the biological treatment process (which could result in raw sewage discharging into lakes, streams and other sources of drinking water).

The project sponsor, Coating Technology, Inc. (CTI), is a metal finishing job shop in Rochester, NY, which employees about 30 people. The shop uses acids continuously in the preparation of steel, aluminum, stainless steel, copper and brass substrates for finishing. Finishing processes provided include electroless and electrolytic nickel plating, zinc plating, aluminum anodizing, chemical conversion coatings and passivation of stainless steel.

The acid life extender technology studied is a proprietary product.[1] At the time of the project, only a few metal finishers were using the technology, and performance data was mostly anecdotal. Without significant data, the PRO-pHx®, Wagner Environmental Technologies, Inc. Cornelius, NC technology seemed "too good to be true," with regard to its economic and environmental promises. CTI decided to collect hard data verified through an independent laboratory under controlled conditions to obtain "real world" results.

Organizing the Study

A proposal was made to Empire State Development to aid CTI with the project. While CTI could provide the labor resources and technical analysis, assistance was needed to fund the test site trials and independent laboratory analysis of test bath samples.

The technology is a non-hazardous, non-toxic, inorganic product. When added to acid baths, it allows the metals and organics to be filtered out in process. Removal of the metal and organic contaminants maintains the acid baths at nearly new condition. By maintaining the acid in this condition, new acid is needed only for replacing what is lost to drag-out.

Because the acids do not need to be replaced regularly, the volume of waste acids generated is eliminated or signifi-

[1] *PRO-pHx®, Wagner Envrionmental Technologies, Inc., Cornelius, NC.*

cantly reduced. This results in using less caustic soda and generates fewer hazardous waste solids.

The project studied the application of the technology in the metal finishing industry by conducting case studies of two plating facilities in western New York. The economic savings generated through the reduction of acids purchased and lower waste treatment costs were calculated. The environmental savings associated with the technology was also demonstrated.

Targets

The project had two learning targets:

1. What are the actual economic savings resulting from the application of the technology as measured in terms of return on investment, cost benefit analysis, labor savings and overall comparative economic advantage, and what is the value of the quality improvements resulting from improvements in acid pickling bath consistency?

2. What are the actual environmental advantages resulting from the application of this technology as measured in terms of tons of acid saved, caustic eliminated, hazardous solid wastes eliminated and change in generator status.

Methodology

Testing

To determine the efficacy of this technology, measurements were made for each test bath to determine the amount of metals dissolved over a period of time. Also, the volume of acid added to the bath to maintain the proper solution level and strength is logged over the same time period. Additionally, a record of the number of manufacturing defects attributable to the acid bath is maintained. A comparison is then made to determine how the bath operated previous to the application of the proprietary technology.

Two test sites were selected, and multiple process tanks were tested at each. The test sites were CTI and Anoplate Corp., of Syracuse. Life Science Laboratories, Inc. (LSL) of East Syracuse conducted metals concentration tests. LSL is an independent and accredited testing laboratory. Nine baths were examined. These included four muriatic acid baths at CTI; three muriatic acid baths at Anoplate; and two nitric acid baths at CTI.

The test metals were selected based upon industry standards, POTW wastewater testing requirements and bath performance requirements. For example, with muriatic acid baths, iron loading is of primary concern, while levels of chromium, copper, nickel and zinc would only affect the treatment of the waste material.

Also studied were the total organic carbon (TOC) levels in each bath, TOC's are created when oils or greases are introduced into acid baths. The acids hydrolyze these materials creating a tar like substance that results in a black or brown ring around the process tanks at the solution surface.

Bath Control

Traditional acid bath maintenance in the metal finishing industry uses a "dump and replace" cycle. When a bath reaches the end of its useful life (two–six weeks) the spent material is removed for waste treatment, the tank is cleaned and a new bath is made up. This cycle can result in variations in required process times and increased number of plating defects as the bath nears the end of its usefulness. In some shops that were consulted, it was found that they generated enough alkaline wastes that only a minimal need for additional chemical purchases is required to pH adjust their overall waste stream for treatment. In those instances, the proprietary product being studied was not cost effective. However, the majority of metal finishing shops in New York State operate similarly to CTI, where caustic must be purchased to neutralize waste waters.

The proprietary product studied is used by adding a small amount (1% by volume) to a new acid bath and installing a filter pump with replacement cartridges in the tank. The bath is monitored for acid concentration and regular additions of acid, water and proprietary product are made to maintain proper levels and replace material lost through drag-out. The filter cartridges are replaced only when clogged and flow is restricted. All titration results and chemical additions are recorded in a log for each bath.

Findings

Metals concentration data for each bath studied is shown in Figures 1 through 9. All of these baths remained functional during the course of the study.

It was learned that the proprietary acid life extender did minimize metals build-up and reduce metals concentrations in most of the baths. The drops in levels demonstrate this for many of the metals. If the metals were not being removed, the concentrations would only increase over time.

The study also found the minimization of organics in the test baths. In a typical acid bath, a heavy tar-like ring is generated around the tank at the solution surface. In none of the tests tanks did this occur and the TOC tests show little or no increase in levels.

Most important of the findings was the increase in bath lives. At CTI, all of the baths saw a minimum of 2X bath life. Several of the baths have seen life extensions of nearly 20X and were still in operation at the end of the study. At Anoplate, an 89 percent reduction in acid use was experienced in the baths where the proprietary product was used.


Filter cartridges are replaced only when solution flow is restricted.

With regard to quality improvements, no defects were traceable to poor acid quality in the test tanks at CTI. No quality data was available from Anoplate. However, the Anoplate line supervisors indicated fewer quality related problems resulting from the use of the aged acid baths in the test tanks.

Unexpected Outcomes

In many of the baths, something unusual was discovered during metals testing. It was found that the metals concentration of many of the baths increase substantially beyond the normally accepted operating limits. For example, in test bath #3, the iron levels increased to 5,000 ppm. This type of bath is commonly considered unusable for production at about 3,000 ppm, yet bath #3 showed no reductions in required work piece process times or cleaning ability. This also occurred in the nitric acid baths used for stripping nickel-plating tanks. In bath #4, the nickel concentration reached 47,000 ppm without the unacceptable reduction in stripping rate that typically happens around 30,000 ppm. This unexpected outcome was positive.

Economic Analysis

The analysis in Table 1 demonstrates the direct savings generated by the use of this technology on one of the test tanks. CTI saw a first year savings of $1,278 (28 percent) and a next year savings of $1,956 (42 percent) for just one test bath. A total of $4,950 first year savings was realized for all test baths at CTI, with anticipated subsequent annual total savings of $7,282.

Anoplate reduced acid usage in the test baths by 2,215 gal (89 percent).

Environmental Analysis

The environmental impact from the implementation of the acid life extender can be measured by the reduction in process acids used, less sodium hydroxide (caustic soda) used for pH adjustment, reduced demand on wastewater treatment systems (in plant) and potentially fewer pounds of F006 listed hazardous waste generated. Because shared resources are used at CTI for the treatment of wastes in-plant, the impact on these can only be estimated. Actual reductions in acid are calculated from the tank logs and historical data. Overall, a 58 percent first year, and 65 percent subsequent year reduction in acids and caustic was experienced through the use of the technology. Table 2 summarizes the environmental savings experienced at CTI as a result of implementing the technology. *P&SF*

Table 1—Economic Analysis of Acid Life Extender.[2]

Coating Technology, Inc.
Test Bath #1
Zinc Line
HCl Tank
250 gallons at 40%
Dumped every 4 weeks

Annualized Data

	quantity	$/per	Total	
Before PRO-pHx:				
Acid used (gallons)	1430	$ 1.44	$ 2,059.20	
Waste treatment ($1.25 for every $1)			$ 2,574.00	
Total			$ 4,633.20	
With PRO-pHx (first year)				
Acid Used (make up)	110	$ 1.44	$ 158.40	
PRO-pHx Used (make up)	2.5	$ 60.00	$ 150.00	
Acid Used (replenishment)	683	$ 1.44	$ 983.52	
PRO-pHx Used (replenishment)	23.89	$ 60.00	$ 1,433.40	
Waste treatment (none required)			$ -	
Filters (2/week @ $2.5 each)	104	$ 2.50	$ 260.00	
Equipment: Filter Pump	1	$ 370.00	$ 370.00	
Total			$ 3,355.32	
First Year Savings			***$ 1,277.88***	28%
With PRO-pHx (second year)				
Acid Used (make up)	0	$ 1.44	$ -	
PRO-pHx Used (make up)	0	$ 60.00	$ -	
Acid Used (replenishment)	683	$ 1.44	$ 983.52	
PRO-pHx Used (replenishment)	23.89	$ 60.00	$ 1,433.40	
Waste treatment (none required)			$ -	
Filters (2/week @ $2.5 each)	104	$ 2.50	$ 260.00	
Equipment: Filter Pump	0	$ 370.00	$ -	
Total			$ 2,676.92	
Subsequent Year Savings			***$ 1,956.28***	42%

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Table 2—Environmental Summary, CTI

Tank	Acid Gallons			Savings		Percents	
	With out PRO-pHx	With PRO-pHx		With PRO-pHx		With PRO-pHx	
		First Year	Subsequent Years	First Year	Subsequent Years	First Year	Subsequent Years
PEZ Line	1430	793	683	637	747	44.5%	52.2%
EN Production Line	1907	506	396	1401	1511	73.5%	79.2%
HCl Tank #7	480	166	126	314	354	65.4%	73.8%
HCl Tank #8	240	234	194	6	46	2.5%	19.2%
Totals	**4057**	**1699**	**1399**	**2358**	**2658**	**58.1%**	**65.5%**

Tank	Caustic Gallons, estimated			Savings		Percents	
	With out PRO-pHx	With PRO-pHx		With PRO-pHx		With PRO-pHx	
		First Year	Subsequent Years	First Year	Subsequent Years	First Year	Subsequent Years
PEZ Line	2860	1586	1366	1274	1494	44.5%	52.2%
EN Production Line	3813	1012	792	2801	3021	73.5%	79.2%
HCl Tank #7	960	332	252	628	708	65.4%	73.8%
HCl Tank #8	480	468	388	12	92	2.5%	19.2%
Totals	8113	3398	2798	4715	5315	**58.1%**	**65.5%**

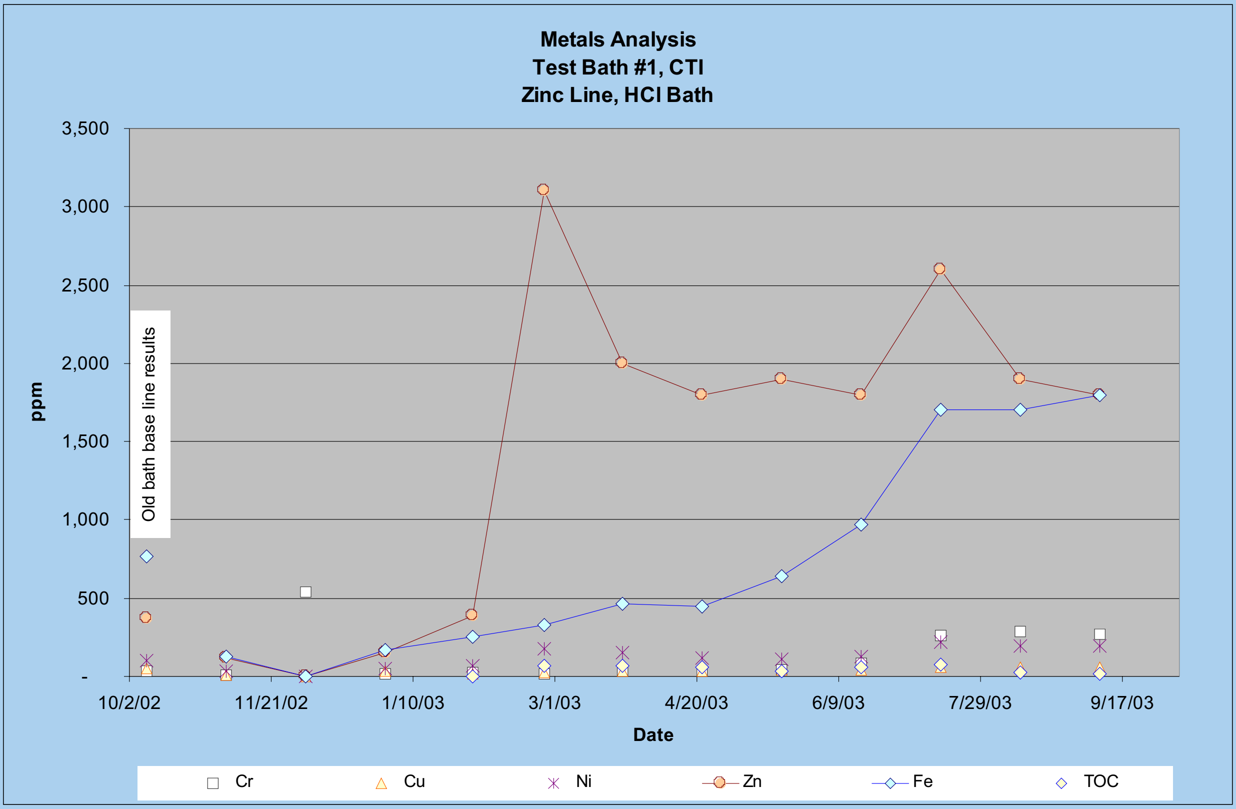
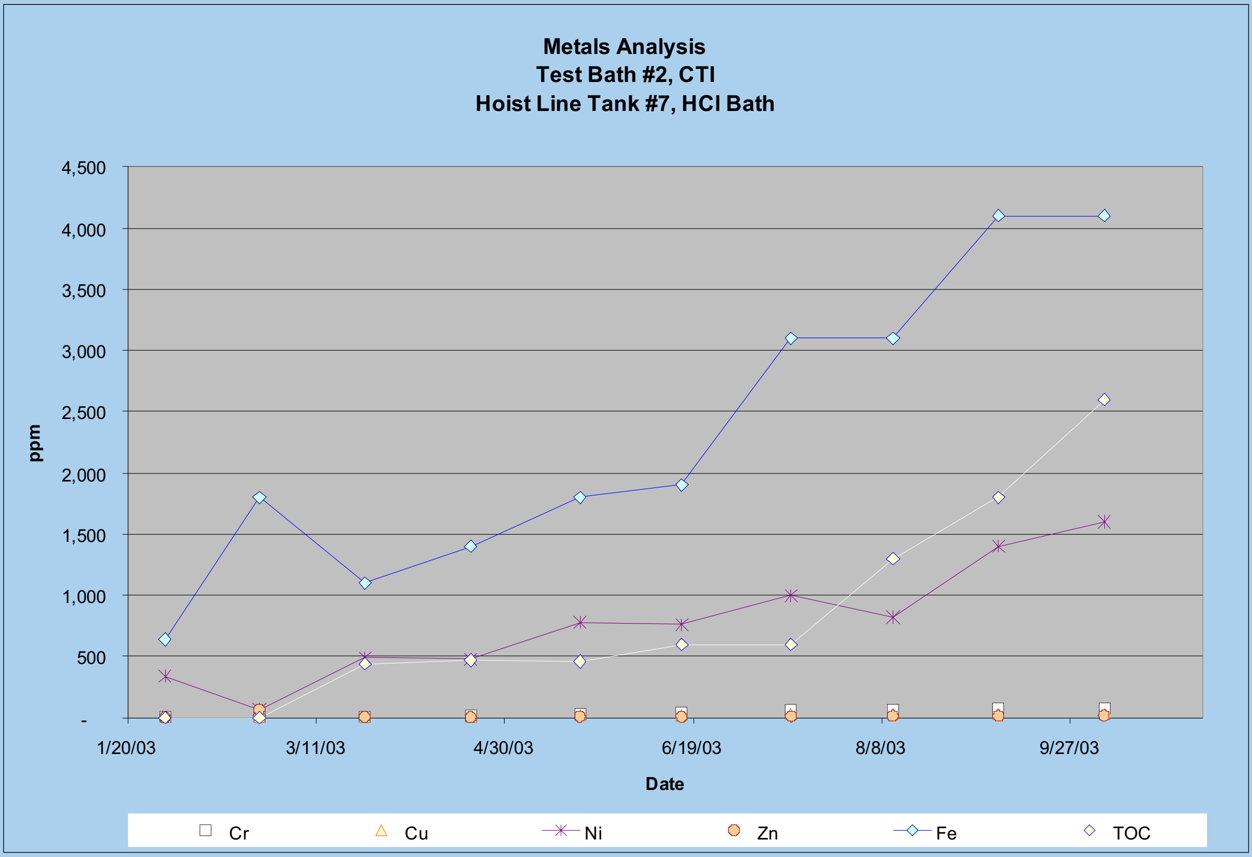


Figure 1



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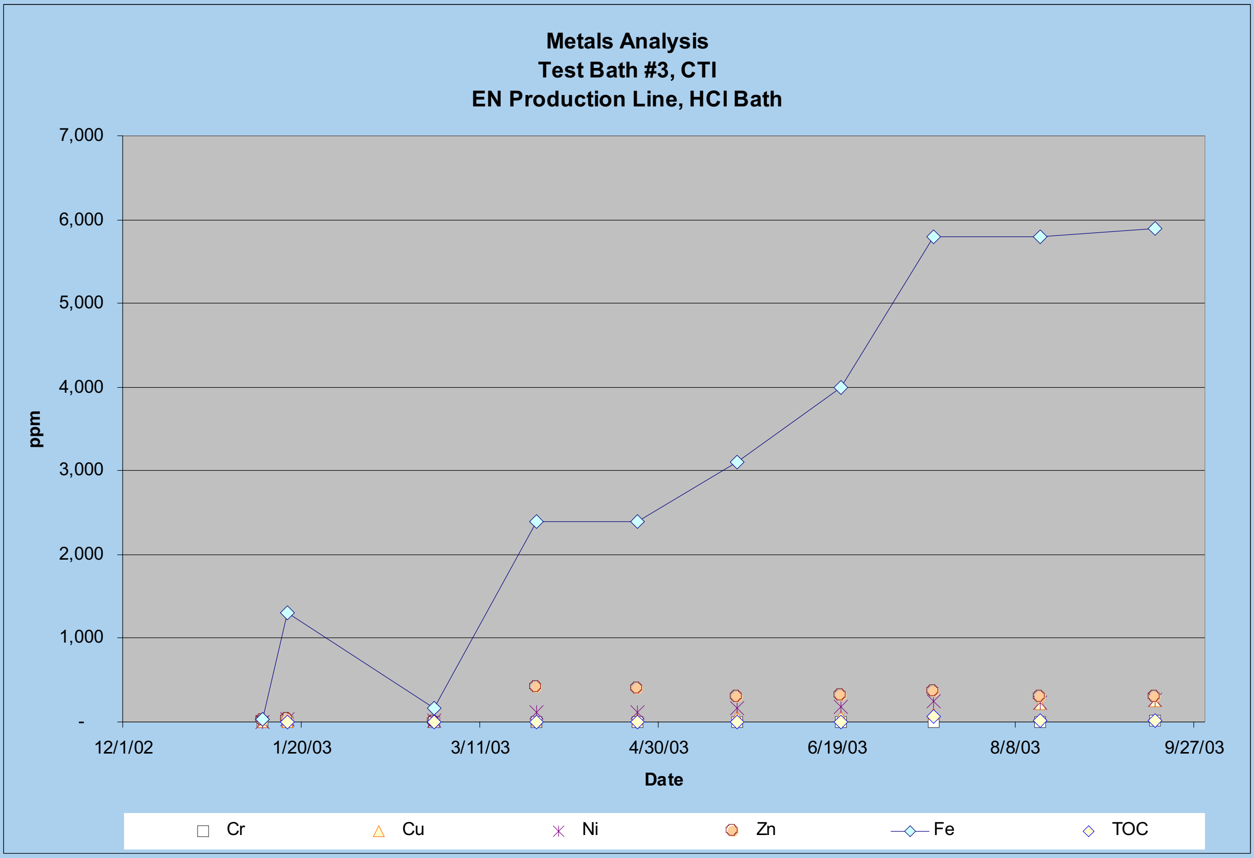

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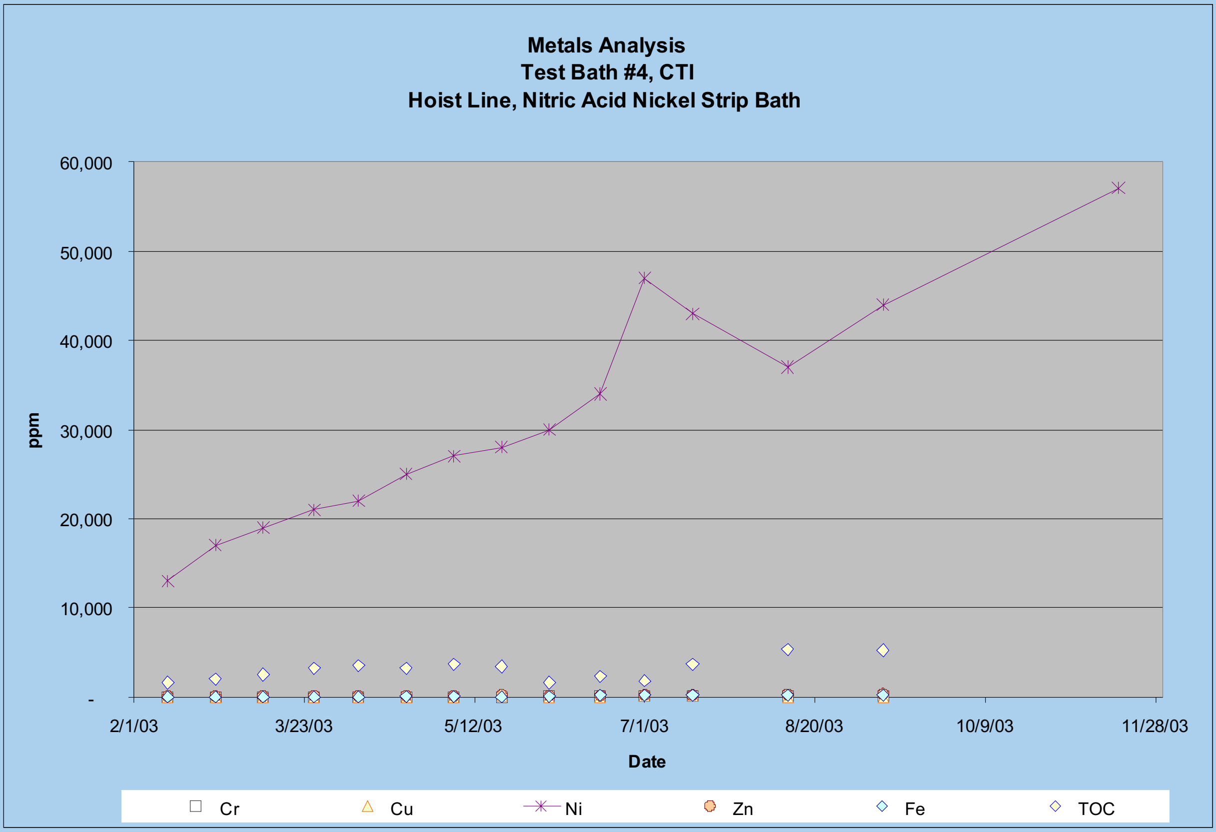

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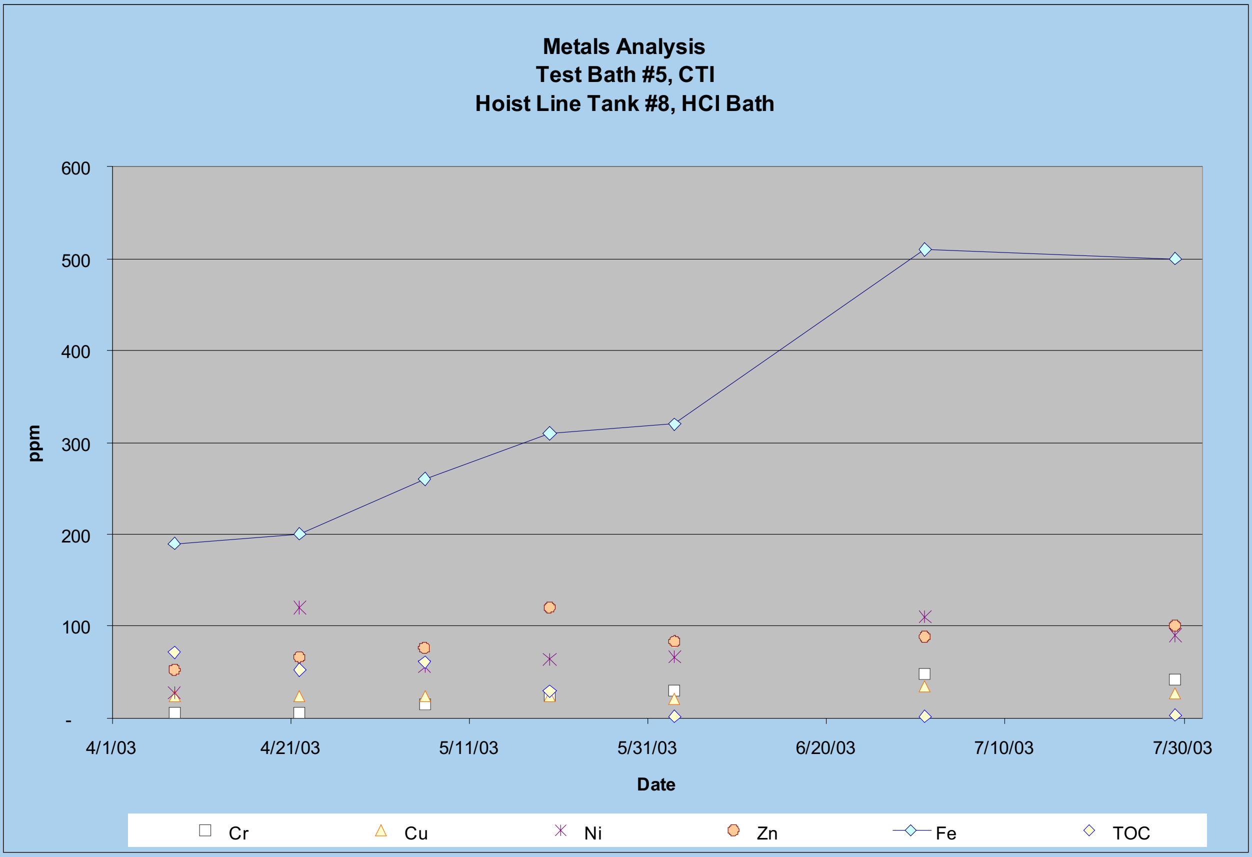

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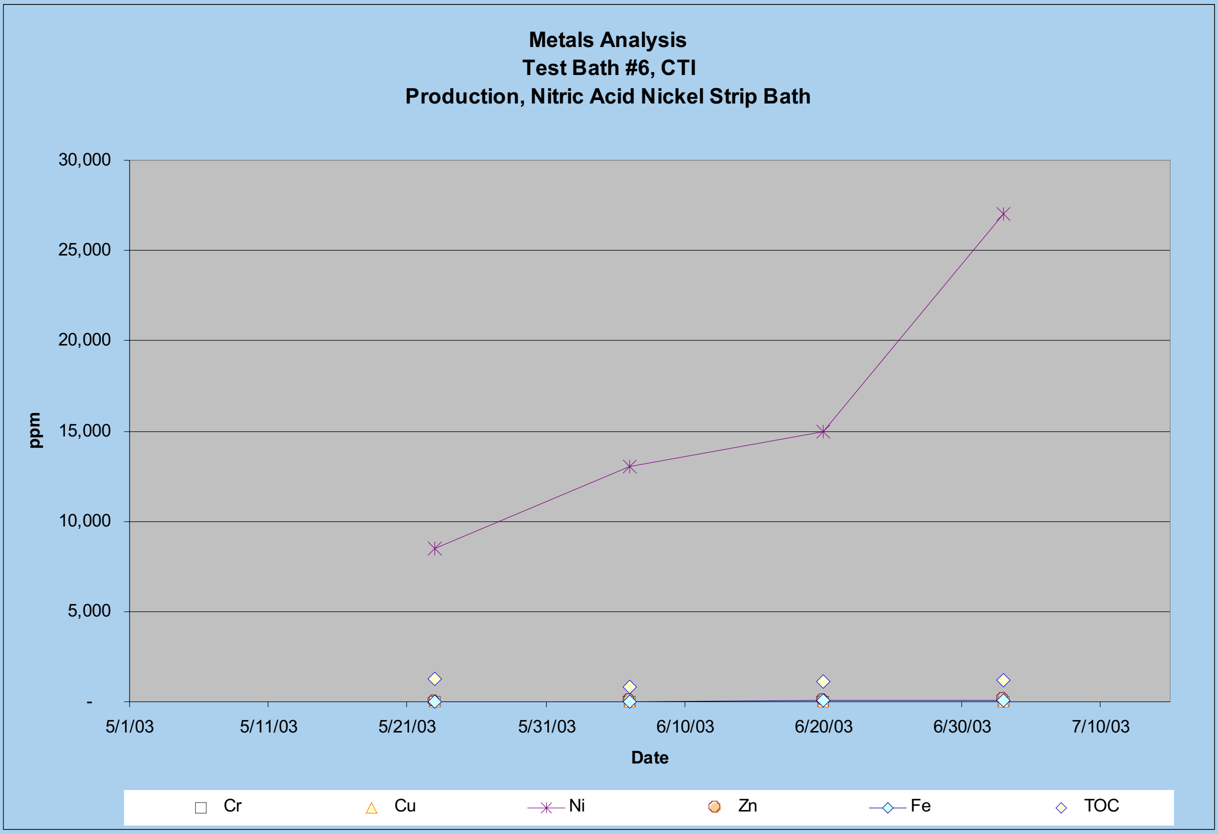

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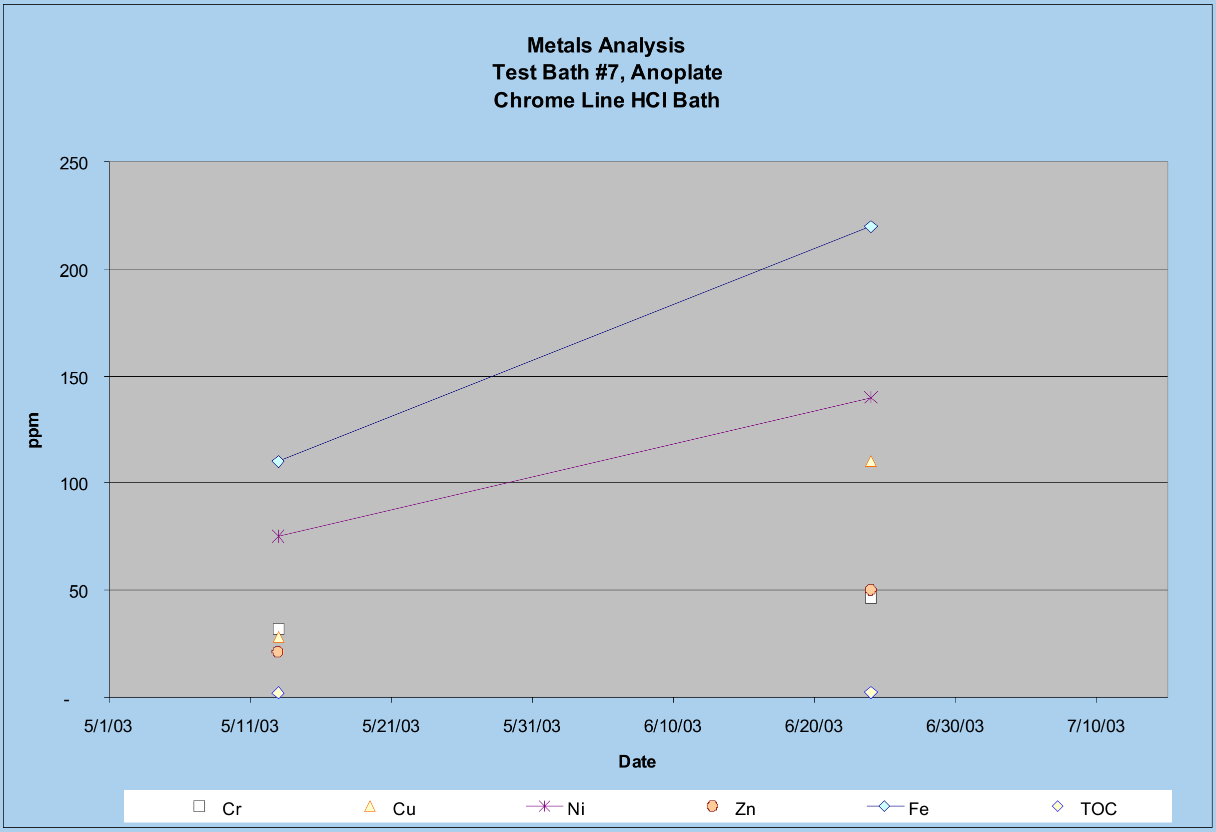

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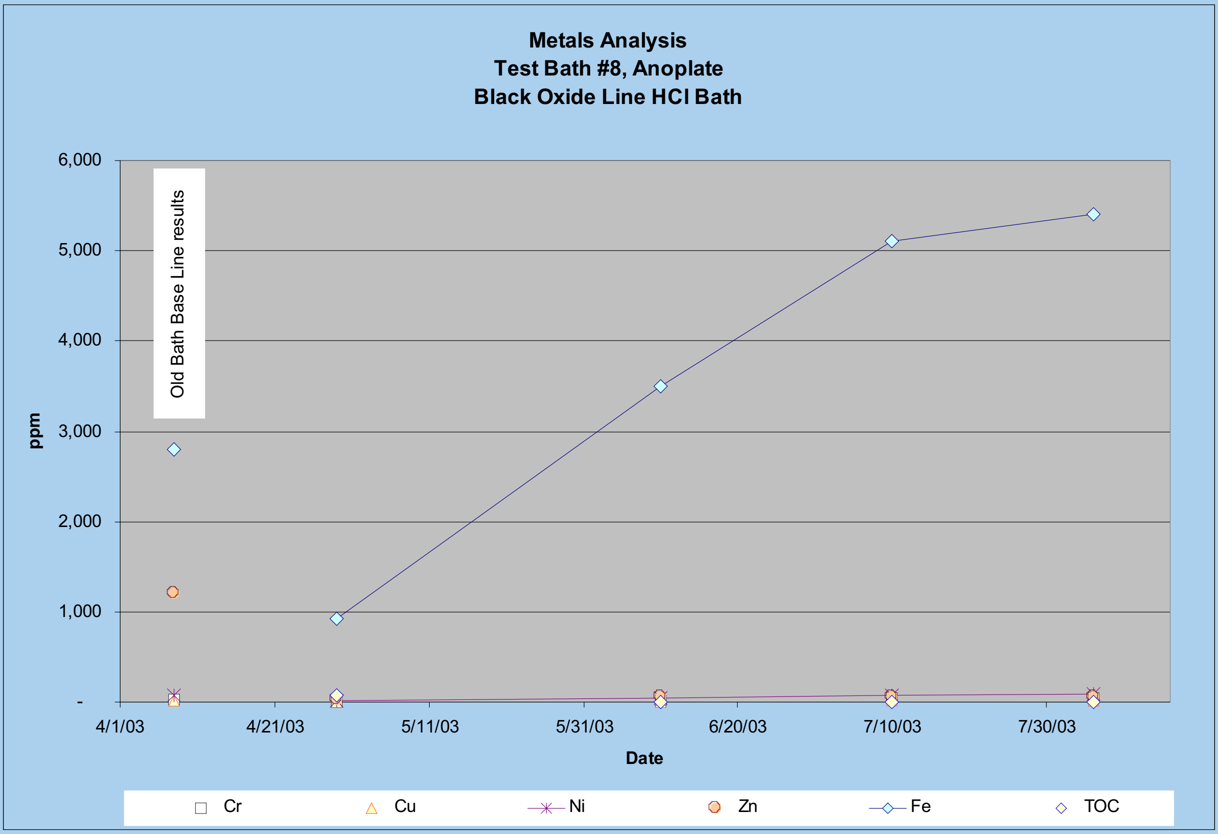

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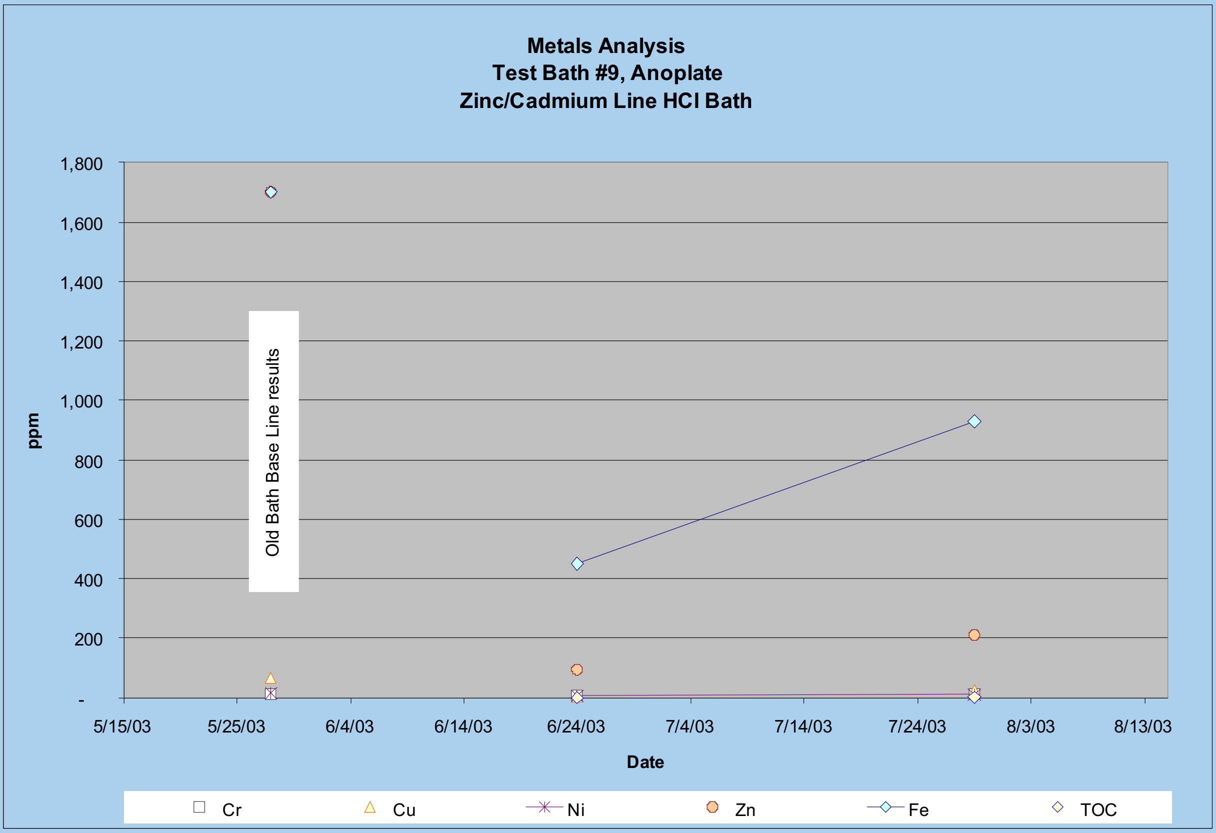

Figure 9