

# Use of Fume Suppressants In Hard Chromium Baths: Emission Testing

By T.D. Ferguson, B. Sprague, D. Brennan & J. Lutz

The EPA Common Sense Initiative (CSI) is a cooperative effort of government, industry, environmental, and other stakeholder groups to find “cleaner, cheaper, smarter” approaches to environmental management in industrial sectors. The purpose of the project is to assist hard chrome metal platers reduce plating tank emissions to comply cost-effectively with, or exceed, EPA’s Chromium Emissions MACT Standard. The major objective of this project was to investigate the efficacy of wetting-agent-type mist suppressants to reduce worker exposure and hexavalent chromium emissions from a hard-chromium plating tank. Further emission testing to meet the chromium MACT standard has been conducted to determine an acceptable surface tension number for regulatory use. Hard chromium platers may be able to report surface tension numbers much like that of decorative chromium, if and when regulatory change is implemented.

## Background

This Phase II project is an extension of work done in 1997, under sponsorship by the Environmental Protection Agency (EPA) and the National Institute of Standards and Technology (NIST)—referred to as Phase 1 of the Hard Chromium P2 Demonstration Project. Phase 1 evaluated various control technologies to meet the EPA MACT standard and tested wetting-agent-type fume suppressants (FS). Fume suppressants were added to three plating bath tanks with associated emission control devices and emissions were tested. Observations of these limited tests indicated dramatic results in terms of inlet and outlet emission reductions at relatively low cost.

The Phase I project led to an initiative by the EPA to conduct a follow-on focused study of FS effectiveness in meeting the MACT standard for hard chromium plating with additional study of worker exposure and quality concerns. Those familiar with the chromium emissions MACT standard are aware that chemical FS are identified as an existing MACT standard emission control option for *decorative* chromium plating. The required control test is verification of a

maximum surface tension level of 45 dynes (or less) per centimeter (dynes/cm) for the plating baths.

The emissions testing was divided into stack testing and non-stack testing. Non-stack testing included personal monitoring and area monitoring. The results of this testing is further described below.

## Stack Emissions Tests

Stack emissions tests were performed to obtain information on the effectiveness of FS to reduce air emissions to meet the 1995 chromium MACT standard. The MACT standard is currently 0.030 mg per dry standard cubic meter (mg/dscm) for small facilities and 0.015 mg/dscm for large facilities.

Three (two-hour duration) stack samples were collected. The samples were taken at sampling ports prior to emission control devices. Surface tension samples were collected on an hourly basis. The samples were measured with a tensiometer in accordance with ASTM D-1331-89. The surface tension of the plating bath varied between 28 and 30 dynes/cm. The production rate varied between 227 and 1,405 amp-hr for these three samples. The samples were analyzed for hexavalent and total chromium in accordance with EPA Method 306. None of the samples exceeded the MACT standard.

A second sampling event was completed about two months later. The surface tension of the plating bath during this test varied between 32 and 34 dynes/cm. The production rate varied between 3,973 and 5,652 amp-hr. The samples were analyzed for hexavalent and total chromium in accordance with EPA Method 306. Because regulations permit the reporting of either hexavalent *or* total chromium from stack tests, all of the samples met the MACT standard for small and large facilities when hexavalent chromium was used. Two of the three samples exceeded the MACT standard for a large facility, however, if total chromium was used.

A final sampling was performed some 10 weeks later (January 8, 1999). The surface tension of the plating bath for this test was targeted at approximately 30 dynes/cm. Because of an unexpected bath dump, however, 30 min before the test, the targeted surface tension could not be reached. The actual surface tension varied between 32 and 36 dynes/cm for this sampling event. The production rate varied between 4,000

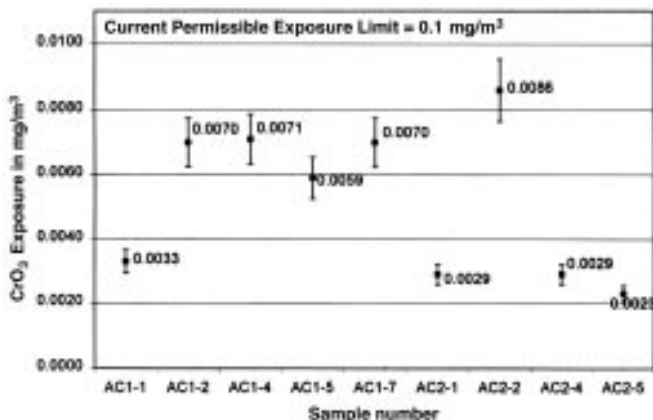


Fig. 1—Pre-FS Addition

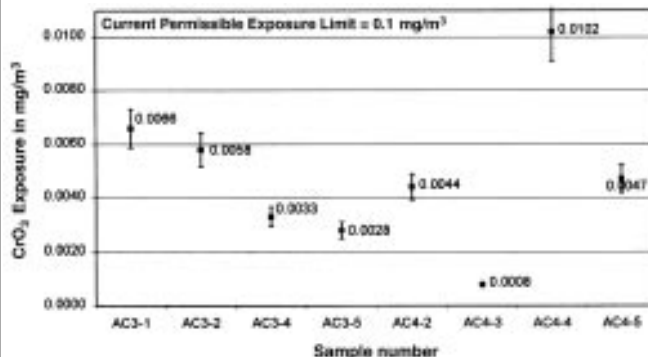


Fig. 2—Post-FS Addition

Table 1 Emissions Tests Results			
Surface Tension dynes/cm	Production Levels Amp-hr	Hexavalent Chromium Concentration mg/dscm	Total Chromium Concentration mg/dscm
<b>August 13, 1998</b>			
28-30	324	0.004	0.004
28-30	1,405	0.003	0.003
28-30	227	0.002	0.002
<b>October 22, 1998</b>			
32-34	3,973	0.009	0.021
23-34	5,652	0.009	0.020
32-34	4,680	0.009	0.014
<b>January 8, 1999</b>			
34-36	~4,700	0.017	0.016
33-34	~5,000	0.027	0.027
32-33	~5,000	0.012	0.014

and 5,000 amp-hr. It should be noted that the results from this test are questionable. An entrainment of chromic acid entered the duct work and contaminated the probe, causing an abort of the first test run. The probe was decontaminated using best available chemicals; however, the decontamination procedures outlined in the method were not feasible in the field. Also, during the second test run, an excessive amount of foam was formed as a result of the increased production activity. The foam entered the duct, possibly contaminating the sample probe. The probe was decontaminated for the third sampling. These samples were analyzed for hexavalent and total chromium in accordance with EPA Method 306. None of the samples exceeded the MACT standard for a small facility, but two of the three exceeded the MACT standard for a large facility. The results for the three sampling events are shown in Table 1.

#### Non-Stack Emissions Tests

Samples were also collected to determine worker exposure to hexavalent chromium during normal operations with and without FS. For the personal monitoring, personal sampling pumps were attached to the workers with the sampling cassette within the breathing zone of the worker. Two of the samples (AC3-2 and AC3-4) collected on Day 3 and two of the samples (AC4-3 and AC4-5) collected on Day 4 were hung at head level (approx. 68 in.) All sampling activities

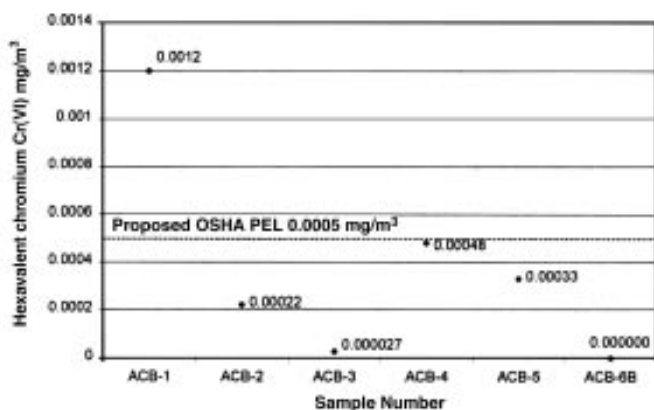


Fig. 3—Baseline Testing

Table 2 Area Monitoring Results				
	Duration hr	Location (inches above tank)	Hex Chromium $\mu\text{m}/\text{m}^3$ OSHA	Hex Chromium $\mu\text{m}/\text{m}^3$ NIOSH
Pre-FS	2	6 to 8	1685.36	2137.36
Post-FS	4	3 to 4	1.72	2.17

were performed in accordance with OSHA Method ID-215.

During personal sampling on Days 1 and 2, FS had not been added to the electroplating bath. Surface tension of the baths was approx. 60 dynes/cm. The FS was added on Day 3 and the surface tension was adjusted to approximately 30 dynes/cm. Actual levels varied between 28.7 and 30.5 dynes/cm for Days 4 and 5 when personal samples were again collected.

The results of the personal sampling collected prior to the addition of FS are shown in Fig. 1 and after the addition of FS in Fig. 2. Each data point is a discrete eight-hour sample. Nine tanks are present at this facility and FS was added to only two of the tanks. The area in which the workers were stationed was not isolated from the rest of the facility, so the analytical results do not show a significant difference in the concentration of hexavalent chromium before and after the addition of FS. The working conditions during this sampling event are actually what the workers are exposed to during a normal eight-hour period. The results indicate that all of the sample concentrations, before and after the addition of FS, are below the current permissible exposure limit of 0.1 mg/m³ but above the proposed permissible exposure limit of 0.0005 mg/m³ for Cr(VI).

Samples were also collected from the facility to determine what the baseline concentrations were for hexavalent chromium. The baseline test was performed under the following conditions:

- No workers were present
- No parts were being plated
- Scrubbers and agitation were off
- Make-up air handling system was on-line
- Tanks were at production temperature (130 °F)

The sampling cassettes attached to the personal sampling pumps were hung at head level in each major section of the facility. Samples were collected over an eight-hour period. Filter media and samplings pumps were chosen and calibrated in accordance with OSHA Method ID-215.

The samples were analyzed by the OSHA Salt Lake Technical Center in accordance with OSHA Method ID-215. The results of the sample analysis are shown in Fig. 3.

Area samples were also collected before and after the addition of FS. The cassettes for these samples were mounted directly over the electroplating bath and would represent more than a worst case scenario for worker exposure, inasmuch as the cassettes were less than 10 inches from the surface and close to the local ventilation slot. The sample cassettes (prior to the addition of FS) were mounted approximately 6 to 8 in. above the tank and remained for approx. two hr. The sample cassette (after the addition of FS) was mounted approx. 3 to 4 in. above the tank and remained for approx. 4 hr. The results, using two separate analytical methods, are shown in Table 2. The analytical results show the significance of adding FS to decrease exposure to hexavalent chromium.

## Conclusions

The following conclusions can be drawn from the activities of this project regarding the air quality issues on stack emissions and personal monitoring in the presence of FS:

1. Fume suppressants can be used to comply with the MACT standard for large and small facilities without any additional control technologies.
2. The concentration of hexavalent chromium and total chromium in stack emissions increases as the surface tension level increases.
3. During normal operating conditions, workers at the tested facility on the days tested were exposed to hexavalent chromium below the current permissible exposure limit of  $0.1 \text{ mg/m}^3$  but above the proposed permissible exposure limit of  $0.0005 \text{ mg/m}^3$  for Cr(VI). No conclusions can be drawn with regard to the effect that FS aids in the compliance with OSHA standards.
4. Under baseline conditions (*i.e.*, no workers present, no operations, scrubbers and agitation off, and make-up air handling on), hexavalent chromium concentrations are below the current permissible exposure limit of  $0.1 \text{ mg/m}^3$  but some of the samples are above the proposed permissible exposure limit of  $0.0005 \text{ mg/m}^3$  for Cr(VI).
5. Using OSHA and NIOSH sampling methods, the concentration of hexavalent chromium in the airspace directly above the electroplating tank decreased three orders of magnitude with the addition of FS.

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