INDUSTRIAL HYGIENE REPORT

Control of Hexavalent Cr in Welding Fume

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INTRODUCTION

Sentry Air Systems, Inc. manufactures equipment designed to capture welding fume and/or other air contaminants and, after filtering, return the cleaned air to the local environment. The equipment consists of an electric motor-driven fan that draws contaminated air through a flexible duct and pushes the air through a filter to remove contaminants. The filter typically consists of a HEPA (high-efficiency particulate) filter, activated charcoal or other adsorbent. This particular study was designed to evaluate the effectiveness of the Sentry Air Systems welding fume extractor (Model 300-WFE) when employed to collect fume created by inert-gas welding on 316 stainless steel. The specific purpose of the study was to monitor hexavalent chromium (Cr^{+6}), a human carcinogen that has recently been the subject of more stringent regulatory control by OSHA.[1] Hexavalent chromium is a higher oxidation form of chromium than the elemental chromium metal found as a component of stainless steel.[2]

[1] 29 CFR 1910.1026

[2] 316 Stainless Steel contains approximately 17% chromium by weight (see attached MSDS).

Experimental Design of Study

The welding machine used in this study was a Lincoln Electric Power MIG 215 electric welder that employed an inert gas mixture of 75% argon and 25% carbon dioxide to blanket the work. A material safety data sheet (MSDS) for the inert gas is attached to this report. Coupons (or "blanks") of 316 stainless steel were employed as the substrate upon which beads of 316 stainless steel wire was laid down by the welder. Fifty coupons were utilized in the morning for about 4 hours of welding, followed by another fifty coupons in the afternoon over another 4 hour period. Samples of the ambient air were collected about 2 feet from the welding site, and also in the breathing zone of the welder. The Sentry Air Systems welding fume extractor (Model 300-WFE) was not operated during the first four-hour period of welding. After this initial period of sampling, the cassette filters were replaced with new ones. In addition to the ambient air sample and the personal air sample on the welder, sampling filters were placed in the inlet and outlet of the welding fume extractor (see Photographs #1 & #2, respectively).

The welder wore a half-face air-purifying respirator beneath his welding hood during the morning portion of the study, but did not wear the respirator in the afternoon. The ambient levels of particulate matter (primarily welding fume) were checked using a Particle Scan Pro™ airborne laser particle counter meter. This instrument measures airborne particles larger than 3 microns in diameter. The particle count measurements obtained were as follows:

Table I
Particle Counts in Ambient Air in the Welding Room

Time, hrs.	Particle Count, mm/cu. ft.
0820	6.5
0910	77
1020	85
1100	85
1235	9.0
1315	9.4
1347	8.5
1535	5.5

Results

The six filter cassettes, plus a blank, were analyzed by an AIHA certified laboratory for hexavalent chromium. The data are displayed in the following table:

Table 2
Samples Collected during Welding on 316 Stainless Steel

Sample No.	Location	Sampling Rate, l/min	Sampling Time, min	Hex Cr Found, micrograms	Hex Cr Conc'n., $\mu g/m^3$
RFA-001	Ambient Air, am	2.598	232	26	43
RFA-002	Welder	2.910	233	31	46
RFA-003	Exhaust	2.630	213	0.08	0.1
RFA-004	Inlet	2.572	216	52	94
RFA-005	Ambient Air, pm	2.816	220	0.17	0.27
RFA-006	Welder	2.998	220	0.87	1.3
RFA-007	Blank	----	----	0.11	----

As can be seen from the table above, there was a 99.3% reduction in the concentration of hex chrome in the ambient air near the welder from morning to afternoon. Likewise, the potential exposure of the welder was reduced by more than 97% by the Sentry Air Systems welding fume extractor. The comparison of the inlet and outlet samples taken on the Sentry welding fume extractor during the welding operation documented a reduction in hex chrome of 99.9%. Photo #3 shows the welding fume extractor in operation during the welding process.

DISCUSSION and CONCLUSIONS

During welding, some of the metallic chromium in stainless steel is vaporized and converted to a higher oxidation state (Cr^{+6}) by the heat of the welding arc, in spite of the blanketing protection by the inert gas. The primary reason for using inert gas shielding during welding is to prevent oxidation of the metal being welded and also to minimize the formation of the irritant gasses such as nitrogen oxides and ozone. The vaporized metal cools rapidly and forms a finely divided dispersion in air called a fume. Hex chrome fume, because of its small particle size and toxicity, can represent a serious health hazard if inhaled. OSHA has promulgated regulations limiting the exposure of workers to a maximum of 5 micrograms per cubic meter of hexavalent chromium as an 8-hour time weighted average (TWA). Therefore, it is very important to identify and utilize effective techniques to control the release of hexavalent chromium into the workplace air. The Sentry Air Systems Model 300 welding fume extractor was shown to provide outstanding performance in the control of hexavalent chromium in welding fume, under the conditions of this study.

The particle count measurements of the ambient air showed a rapid buildup during the welding operation. When the Sentry Air Systems welding fume extractor was turned on, the ambient air particle counts dropped below the original level seen in the morning before welding was started. We conclude that the fume extractor actually cleaned the air to a particulate concentration well below the initial level observed in the morning.

If you have any questions or comments regarding this report, please contact me at 713-983-7910 or by e-mail at BobCIH@aol.com.

Respectfully submitted,

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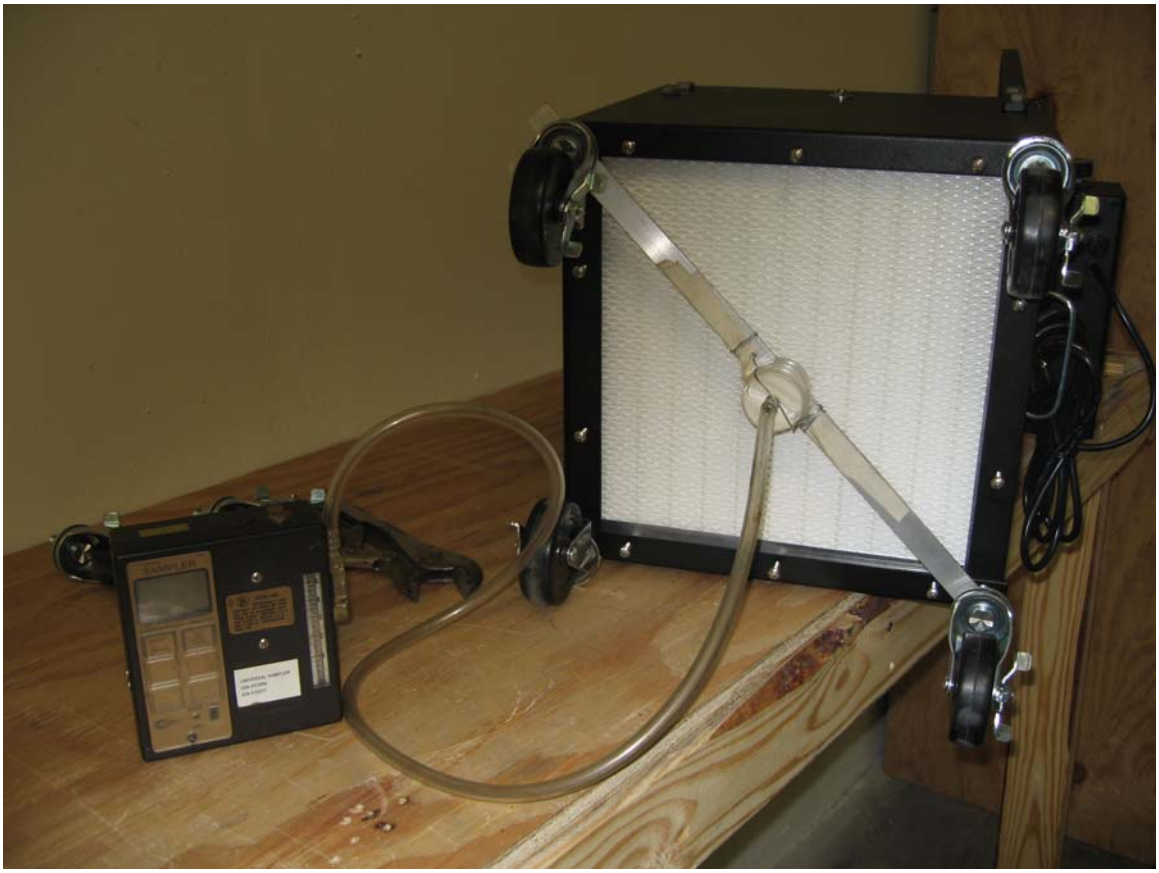

Photograph #1: The exhaust area of the welding fume extractor is shown above, modified to hold a sampling filter cassette. Note the battery-powered sampling pump.

Photograph #2: The sampling filter cassette is shown above, mounted on a support brace to hold the cassette in the exhaust stream from the welding fume extractor. A hole was drilled in the brace to allow the cassette to sample the exhaust air stream.

Photograph #3: The inlet duct of the welding fume extractor is shown above. The sampling filter cassette was wired in place to permit sampling of the air being drawn into the extractor.

Photograph #4: The Sentry Air Systems Model 300 welding fume extractor is shown in operation above while the welder is welding 316 stainless steel. Air sampling pumps can be seen on the work table as well as at the inlet and outlet of the fume extractor. The Welder is also wearing a pump and sampling cassette to measure Cr^{+6} in his breathing zone.