

BOHS Conference 2010 Carcinogen Exposure in Surface Engineering

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Scope of presentation

Background

Aims and objectives

Survey design

Current position

Emerging findings

Remaining work



Background

Surface Engineering Industry, major users of carcinogens :

- **Hexavalent chromium**
- **Nickel compounds**
- **Cadmium**
- **Sulphuric acid - process generated mist**

HSE accept that there are practical problems with large scale substitution, hence a need for a high standard of exposure control.

Industry size & shape



Still a major UK manufacturing industry

Approximately 500 UK companies

Approximately 3,000 exposed workers

Partnership project between HSE and Surface Engineering Industry

Aims and objectives



To build on work already conducted between HSE and industry

Assess control standards across the industry

Use of biological monitoring for quantitative exposure assessment

Use of other measurements to investigate exposure routes

Identify exposure mechanisms and provide advice on control

SEA/HSE guidance

Prevention of Exposure and Control of Chromic Acid Mist

Soluble hexavalent chromium compounds, and in particular chromic acid (chromium trioxide, an extremely used as electrolyte in electroplating and anodising in those processes the burning of small bubbles of gas generated by electrolysis causes the formation of mists (fine droplets of electrolyte). These are commonly referred to as chromic mist/mists and can be inhaled.

The amount of mist produced depends on a number of process variables, particularly concentration of chromic acid in solution, surface area of the article treated, current density and the length of time current is passed through the solution. An intractable period can also be caused through inappropriate use of compressed air to blow-off plating solution - this practice should be forbidden.

If, however, you are not allowed to use substances like chromic acid if it can be readily substituted by a safer option, specifically, it may be possible to use trivalent chromium chemistry for decorative chromium finishes and for passivation.

Control

Where an employer can demonstrate that substitution is not a realistic option, adequate control of chromic and mist must be achieved by other means. The first option required by law is total enclosure of the process and handling systems. This is used as an approach in large and must be used in all installations where it is reasonably practicable. Total enclosure is likely to be more realistic for new installations rather than retrofitting, though there may be scope for greater use of removable lids.

If total enclosure is not possible, it is necessary to achieve adequate control by providing efficient local exhaust ventilation (LEV) and/or by treating the electrolyte plating solution with a strip suppressant to limit the emission of mist or mist into the workplace atmosphere. Because of the cancer concern from inhalation, it is better to prevent mist being created than to try and capture it with LEV. Fluorinated surfactants (as based on H2SO) provide better protection because they are much more stable than other types. Unfortunately, H2SO is currently under scrutiny because it can build up in the environment and may prove to be more hazardous than was originally thought. If H2SO is removed from the market, adding LEV must be re-evaluated or suitable LEV installed.

Extract ventilation is usually provided in the form of lip extraction along each side of the bath to avoid impeding the process operators, themselves the process can be enclosed.

Extract ventilation should still be provided at the enclosure to prevent build up of explosive gases. The extraction should be sufficient to ensure that there is movement of air into the enclosure where any access points to the enclosure are opened for purposes of process control, so preventing emission of chromic acid mist into the workplace atmosphere.

It is important to understand that the effectiveness of LEV is dependent on the level of freestream air flow. The greater the freestream the more efficient the capture of mist. Turning down for LEV an significant and increasing freestream and reducing LEV flow rates can give substantial savings. Freestream should be at least 10times on working tanks - preferably 20times or more. The greater standard should apply to all new installations but there is scope to increase freestream on some existing plant simply by building up the sides of the tank.

When the LEV is initially set up, the freestream needs to be recorded as well as the duct velocity at various positions, maintaining these levels is vital.

Setting up the system

The control system should be set up to ensure that adequate protection is given under worst case conditions, eg greatest electrolyte depletion (lower freestream), highest current density, greatest chromic acid concentration, longest plating time. The surface tension (surface, previously greasy), the board distance (measured between the lead of electrolyte and the top of the tank), and average capture velocity from a representative sample of measurements taken at the duct opening in the lip extraction need to be recorded before and after the air sample above the bath is taken. Surface tension should be measured using a tensiometer and must not exceed the upper limit specified by the supplier of the mist suppressant (tensidopromoters are not only difficult to obtain but they are also less accurate).

Sufficient air samples should be taken to establish a reliable benchmark of exposure under three conditions (ie at least two if they are consistent) room if they differ significantly. If the amount of mist emitted from the tank is below the maximum exposure limit (MEL) of 0.05 mg/m³ (8 hour time weighted average), it is likely that adequate control is being achieved at the time of the test.

Maintenance of equipment and solutions

Chromic acid solutions are extremely corrosive so ventilation plant and equipment should be constructed of corrosion-resistant materials. They will need to be visually checked at least weekly and thoroughly maintained and tested by a

Nickel and Nickel Alloy Plating Operations: Controlling the Risk of Inhaling Mist Containing Nickel

Health risks

Soluble nickel compounds used in plating operations include nickel sulphate and nickel chloride. Inhaling mists containing such compounds can cause serious health effects such as asthma and there is also evidence to suggest an increased risk of cancer and harm to the unborn child.

Nickel sulphate, carbonate and other nickel substances are likely to be included in 2002 air substances which 'may cause cancer by inhalation'. The Control of Substances Hazardous to Health (COSHH) Regulations 2002 require a number of additional precautionary measures to be applied where exposure to a carcinogen cannot be prevented. These measures need not be applied if you can keep these compounds in a non-inhalable form. A nickel plating solution does not require additional controls if a mist is not created.

Control

Agitation is required in most nickel plating operations to ensure consistent supply of metal at the work surface and to disperse hydrogen and heat. The most common way used method is air agitation of the plating solution, although alternatives such as mechanical cathodic rod movement (usually at 25 revolutions/minute) per minute, and pumped flow systems are also used. Air agitation produces a mist containing nickel when the resulting bubbles burst at the plating solution surface. Bubbles of hydrogen and oxygen generated during electrolytic nickel plating also contribute to this mist.



Agitating using flow system



Agitation

The law requires that you address a number of issues in relation to nickel exposure. The first option to consider is substituting nickel for a less hazardous material. It must also be likely to be available but one alternative may be substituting bright anode for bright nickel plating.

If substitution of a nickel-plating operation is not an option and exposure cannot be prevented, the law requires that exposure is adequately controlled and:

- the process is totally enclosed unless this is not reasonably practicable;
- exposure is less than the workplace exposure limit (WEL) of 1 mg/m³ (as noted as an eight hour time weighted average), and
- exposure is reduced to as low a level as is reasonably practicable.

Total enclosure is not usually an option but it is clear that a room from air agitation to either cathodic rod movement or an air jet system will considerably reduce exposure. Other benefits of a total enclosure system include heat savings and improved quality for a relatively small capital investment.

Local exhaust ventilation (LEV), usually in the form of lip extraction or suck-off systems, may also be required to ensure adequate control. It is almost always needed when air agitation is used. Issues that should be addressed when LEV is used are:

- ensuring that the minimum freestream distance between plating solution surface and the top of the plating tank is at least 150mm on working tanks although 200mm or more is preferred;
- the freestream standard should apply to all new installations but the freestream on working tanks can be increased by building up the sides increasing the freestream and reducing the air flow rate can give substantial savings;
- maintaining the required freestream using a visual indicator, alarm or automatic dosing;
- checking LEV plant visually at least once a week;
- checking manometers or gauges weekly to ensure that they give acceptable readings (refer to the user's manual);
- supplementing the weekly tests with monthly visual observation of smoke patterns from a smoke generator;
- keeping a log book of checks;
- ensuring that a competent person (thoroughly trained and tested LEV plant at least once every 14 months).



To be updated to take account of findings

Survey design



Approximately 100 SEA member companies suitable for visits

Provide detailed written feedback to each site visited

Re-visits where necessary

Follow on BM 6 and 12 months post-visit

Regular liaison with industry via SEA

Current position



45 sites visited as of April 2010, 10 sites revisited

Some use of video visualisation to study task specific exposures

BM follow-on in progress at a number of sites

1150 BM samples received from over 300 different workers

In-house guidance values developed for hand and surface contamination

4 Industry seminars held to date

Visits to date

Hard Chrome platers

Decorative plating with trivalent and/or hexavalent chrome

Polishing and fettling

Anodising (sulphuric acid and chromic)

Nickel and cadmium plating

Etching and plating of plastics

Speciality chemical suppliers to plating industry

Urinary chromium

UK BMGV 10 $\mu\text{mol/mol}$

380 samples from chrome platers,
75 results above the BMGV

750 samples from other workers,
45 results above the BMGV

Urinary nickel

No UK BMGV, guidance value derived from HSL data 24 $\mu\text{mol/mol}$, agreed with industry

300 samples from nickel platers, 60 results above the guidance value

830 samples from other workers, 50 results above the guidance value

90th percentile of urinary nickel results from project so far is 24 $\mu\text{mol/mol}$

Air sampling



Conducted at approx. 10 sites

Inhalation exposures \ll WELs.

Hexavalent Chromium exposures range from not detected to 0.01 mg/m^3 (WEL 0.05 mg/m^3)

Soluble nickel exposures range from not detected to 0.02 mg/m^3 (WEL 0.1 mg/m^3)

Not giving the full picture regarding exposure

Surface contamination

Measured using wipe sampling in production areas and notionally clean areas

Significant contamination in canteens linked to high BM results

Wearing and storage of contaminated PPE in canteens and inadequate hand washing are principal causes



Hand contamination

Measured by hand washing into water

Detectable levels of contamination on workers hands

High levels indicate failure of PPE and are linked to elevated BM results



Other exposure groups

Urinary chromium for polishers using negative pressure RPE is 5 times higher than those using powered RPE.

Potential for very high urinary chromium and nickel amongst maintenance workers and site chemists

Urinary chromium/nickel approximately double for maintenance workers who do not wear chemical protective gloves.

PPE and individual working practices especially important for these groups.

Unrecognised exposures

Exposure potential not recognised during :

- Manual washdown of plated items
- Direct handling of contaminated items



Common failings

Include :

- Poor housekeeping
- Transfer of contamination to 'clean' areas
- Inadequate provision of workwear and laundering facilities
- Poorly maintained controls (LEV, mist suppressant, PPE)
- Polishing/fettling without adequate RPE
- Some manual handling issues identified

Nickel exposure



Inadequate control
commonplace

Recently reclassified
as carcinogen, long
recognised
asthmagen

Air agitated nickel
tanks without LEV
not unusual

Other planned research

To investigate and quantify efficacy of :

- Lip extraction (effect of freeboard)
- Chemical mist suppressants
- Eductors (alternative to air agitation)
- Tank covers



Remaining work



- Remaining site visits to be completed by Summer 2010.
- BM follow on work to run until Summer 2011.
- Research report late 2011.
- Improved industry guidance

Further information

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