This sheet provides advice to employers and workers in companies carrying out nickel plating.

Nickel and Nickel Alloy Plating Operations:

Controlling the Inhalation Risk

Introduction

Soluble nickel compounds used in plating operations include nickel sulphate, nickel chloride, nickel sulphamate, nickel acetate and nickel hydroxycarbonate. Inhaling mist containing such compounds can cause serious health effects such as occupational asthma. This guidance advises on the necessary inhalation control measures required in the nickel plating industry including associated measures such as training and health surveillance.

Effects on Health

Nickel can be absorbed via inhalation, ingestion or through the skin.

Inhaling air/mist containing nickel may cause occupational asthma. It appears to be the more water soluble nickel compounds (found in electroplating) that have produced most of these cases.

Several soluble nickel compounds are classified as carcinogenic. There is definite evidence in humans showing carcinogenicity by inhalation for some nickel compounds. Additionally, these compounds may also have mutagenic and 'toxic to reproduction' effects. There is only limited evidence in humans for the carcinogenicity of metallic nickel and nickel alloys. For a full list of the classifications and associated hazard/risk phrases see Appendix 1 of EH60 Nickel and its inorganic compounds: Health hazards and precautionary measures.

Nickel and its inorganic salts are among the commonest causes of metal allergic contact dermatitis and the most common of all causes of skin sensitisation (see separate Joint SEA/HSE guidance sheet Controlling the risk of skin exposure).

What the law says

The Control of Substances Hazardous to Health Regulations (COSHH)

COSHH requires employers to carry out an assessment of risks to health arising from a work activity such as electroplating. The information below will inform the COSHH assessment process. COSHH requires that you consider a number of issues in relation to nickel exposure eg substitution, engineering controls, monitoring and health surveillance.

COSHH requires that exposure to hazardous substances is prevented, or where this is not reasonably practicable, adequate control is achieved. For a carcinogen/asthmagen like nickel, adequate control means reducing exposure to as low a level as is reasonably practicable (ALARP) below the Workplace Exposure Limit (WEL). The WEL for Nickel is 0.1 mg/m3 (8 hour time-weighted average). See HSE Guidance note EH40 Workplace exposure limits.

There are additional specific requirements for control of carcinogens in Regulation 7(5) of COSHH which are in addition to applying all the "principles of good practice for the control of exposure to substances hazardous to health" (Schedule 2A of COSHH). These control measures need not be applied if these compounds are maintained in a non-inhalable form ie additional controls are not necessary if the mist does not contain Nickel compounds.

Prevention and Control of exposure

Substitution

COSHH first requires that consideration is given to substituting nickel for a less hazardous material. You should keep aware of research into new plating technologies as this will enable considered and timely substitution decisions.

Where prevention of exposure and / or substitution are not reasonably practicable, safe working practices should be established to minimise exposures. Mist generation should be minimised or the mist captured to minimise inhalation exposure. This mist also deposits onto surfaces which can then result in skin exposure and subsequent ingestion. All areas where skin exposures may potentially occur (directly and indirectly) need to be properly managed; from storage, to safe handling and use, through to disposal.

Mist Generation

Agitation is required in most nickel-plating operations to ensure a constant supply of nickel at the work surface and to disperse hydrogen and heat. Air agitation of the plating solution is most commonly used which produces a mist containing nickel when the resulting bubbles burst at the plating solution surface. Bubbles of hydrogen and oxygen produced during electrolytic plating also contribute to generating this mist. The higher temperatures in electroless plating (80-90 oC) also produce more mist. This is one reason why lip extraction is normally provided.

For manual plating lines an eductor system or a cathode rod movement will considerably reduce exposure compared to air agitation (from inhalation and a reduction in surface contamination reducing skin and ingestion risks). Eductor systems may also lower operating costs and improve quality for a small capital investment.

AIR AGITATION [NOTE CONTAMINATION OF TANK AND ADJACENT SURFACES.]

Engineering Control

For automated plating lines total enclosure with extraction ventilation would be expected. For new and current manual plating lines consideration should be given to full or partial enclosure to reduce overall exposure.

Alternative methods of agitation include the use of pumped flow eductors and mechanical cathode rod movement. The suppliers of eductor systems should advise on the design and commissioning of these systems. Cathode rod movement (usually around 25 revolutions/oscillations per minute) is not commonly used in the industry because it is more difficult to set up and operate particularly for 'jobbing' companies who are required to process a wide range of items. However, both of these methods produce a mist which only contains small amounts of nickel (see photograph below) when compared with air agitation.

AGITATION BY PUMPED FLOW EDUCTORS [NOTE THE CLEAN ADJACENT SURFACES.]

Local Exhaust Ventilation

LEV will usually be lip extraction or push-pull systems. Issues that should be considered to ensure this is effective include:

- ensuring that the minimum freeboard (distance between plating solution surface and the top of the plating tank) is at least 150mm on existing tanks (300mm or more is preferred),
  - the 300mm standard should apply to all new installations,
  - the freeboard on existing tanks can be increased by building up the sides (increasing the freeboard and reducing the LEV flow rate can give substantial savings),
- maintaining the required freeboard using an alarm, automatic dosing, or a level indicator on the side wall of the tank
- lids for existing plating tanks especially if longer plating times are worked (enabling cost savings to be achieved from turning down the LEV and reduced heat loss).
- lids should always be provided on new equipment.

LEV should be inspected and maintained to ensure its continuing effectiveness by

- regularly checking LEV plant visually (usually once a week), including checking manometers or gauges weekly to ensure that they give acceptable readings (refer to the user's manual),
- supplementing the weekly checks with patterns from a smoke generator,
- keeping a record of all the above checks,
- ensuring that a competent person carries out a thorough examination and test of LEV plant at least once every 14 months,
- keeping records of thorough examinations and test for at least five years.

See HSE guidance note HSG258 Controlling airborne contaminants at work - A guide to local exhaust ventilation and COSHH essentials guidance sheet G406 New and existing engineering control systems covering LEV systems.

Other Controls

Chroffles should be considered for longer plating times as they are thought to reduce the production of mist (see recent research[4]) above the plating liquid and provide heat insulation, [A current research project at the Health and Safety Laboratory is examining this control measure.] The use of plastic bubble sheeting should be avoided as although it may provide some insulation against heat loss it presents high risk of contamination to persons moving the sheet and contamination of other surfaces.

A maintenance and cleaning schedule should be prepared. Some personnel carrying out this cleaning and maintenance have been shown to have very high biological monitoring (BM) results in recent research[4] and therefore, it is important to consider how this work is undertaken. Safe systems of work should be implemented and appropriate equipment provided for carrying out this work. This includes providing personal protective equipment (PPE) as appropriate to protect against any residual risk.

Using compressed air or pressure washing should be avoided where possible, for example the process of 'blasting' built-up deposits around the tank area and adjacent surfaces as this produces a mist/aerosol containing nickel salts. For similar reasons the pressure washing or compressed air drying of newly plated products or of other equipment (eg anode baskets) should be avoided. If this is not possible, alternative methods for these processes should be explored including totally

totally enclosing these processes or carrying it out in an appropriately designed enclosure fitted with adequate extraction and using appropriate PPE.

Respiratory protective equipment (RPE) should only be considered as a last resort and only be relied upon where there is some level of residual risk which cannot be controlled by other means. RPE will be necessary where the work activity (eg using a pressure washer for tank clean down) generates a mist. You must also ensure that you comply with the legal requirements for RPE use. Your choice of RPE will be dependent on the circumstances of use and be proportionate to the risk.

See HSE guidance note HSG53 Respiratory protective equipment at work

Monitoring Nickel Exposure

Monitoring for nickel and its inorganic compounds will be required to demonstrate that adequate control of exposure is being maintained.

An initial programme of air sampling and analysis will be necessary as all manual plating lines produce a mist containing nickel. This programme is usually carried out by an occupational hygiene consultant according to HSE's methods for the determination of hazardous substances publication (MDHS 14/4).

Biological Monitoring (BM) based on the analysis of nickel in urine samples should also be carried out as it is an effective tool for assessing exposure and uptake by all routes of exposure (inhalation, ingestion and absorption through the skin). BM shows recent exposure to nickel (and its compounds) but it does not show any indication of any health effect.

The current advisory BM guidance level for nickel listed by the Health and Safety Laboratory is 23µmol/mol creatinine.

When initial monitoring is carried out you should:

- carry out the air monitoring under worst case conditions when maximum throughput and heaviest jig-loading,
- ensure LEV provided is performing as originally intended (i.e. to capture the mist containing nickel)
- take personal air samples to compare with the WEL,
- collect urine samples (BM) at the end of shift for analysis of nickel,
- allow employees to see their own personal air monitoring and BM results,
- keep a suitable record of the air monitoring (for personal exposures) and BM and retain it for at least 40 years, and
- keep other records which do not relate to individuals for at least 5 years, and
- carry out any recommendations made by your occupational hygiene consultant.

If the initial air monitoring results are well below the WEL (representing adequate inhalation control) and the relevant BM samples taken at the same time in worst case conditions show results below the current BM guidance level then it would be considered sufficient to continue with periodic BM, usually every 12 months.

Air monitoring and/or BM should be repeated where process conditions change which are likely to affect exposure from any route. Elevated air monitoring or BM results should initiate an investigation as to the reasons for the indicated higher exposure levels.

Further testing may also be necessary, for example, surface contamination testing (i.e. swabs), to help identify the routes of exposure and the reasons for any high contamination levels. Remedial measures and/or additional controls should be identified and implemented before appropriate re-testing is carried out to demonstrate adequate control has again been achieved.

For new starters working with nickel and its compounds an initial BM sample should be taken to check that exposure has not occurred and that work methods and processes are being followed correctly. This initial sample should be taken in the first two months, and again at six months. Elevated levels should be investigated. Once levels are comparable with other workers annual BM samples should be taken. Care should be taken to ensure that any BM sampling is representative of the worker's typical workload.

To ensure that results are interpreted correctly and appropriate remedial action is taken, suitable explanatory information should be provided by the laboratory or occupational health service provider administering the scheme.

See HSE guidance notes HSG 167 Biological monitoring in the workplace and HSG173 Monitoring strategies for toxic substances and COSHH essentials sheet G409 Exposure measurement - Air sampling

Health Surveillance

Health surveillance should be considered for occupational asthma and occupational dermatitis wherever exposure is considered significant for both respiratory and skin risks. However, health surveillance is not capable of being used to detect the early signs of cancer.

All employees where exposure is considered significant to inhalable nickel (i.e. mist) should be under suitable health surveillance for occupational asthma. An occupational health professional needs to be involved in preparing your health surveillance programme.

If the symptoms of occupational asthma are detected early enough and steps are taken to manage employee exposure you will minimise the long-term health consequences. Information from suitable health surveillance will also contribute to the assessment and review of the effectiveness of your workplace controls. Any improvements identified should be implemented and incorporated into updated safe systems of work.

A responsible person should be appointed to complete respiratory questionnaires for employees exposed to nickel. An occupational doctor or nurse should train the responsible person. Questionnaires should be completed for new employees upon starting employment, after six weeks, after six months and then annually. Examples of initial and follow-up questionnaires are provided in the Appendix.

See COSHH essentials guidance sheet G402 Health surveillance for occupational asthma and for more general information see HSE website Health surveillance

Information, Instruction and Training

Information, instruction and training are a key part of health risk management and without it the measures implemented as a result of the risk assessment will not be fully effective. They are best delivered as toolbox talks or classroom style rather than just printed material given to employees (although printed material can be used to supplement personal delivery).

Employees should be told about:

- the typical symptoms of occupational asthma (ie breathlessness, wheezing and chest tightness),
- who they should immediately report symptoms to,
- the WEL for nickel,
- the results of their exposure monitoring (air and BM),
- the collective results of any health surveillance, and
- what plating tanks contain and the hazard associated with the contents by means of appropriate labels.

The information provided must be under standable. Special provision may be needed for those with a limited comprehension of spoken and/or written English.

Induction training for new employees should cover:

- all risks to health arising from exposure to nickel and its compounds
- the correct use and maintenance of control measures,
- the work practices which prevent or reduce exposure, and
- the emergency procedures.

Information, instruction and training should be reviewed and updated whenever there are significant changes to the work. Consider summarising and documenting the key points, laminating the resulting page or pages and displaying them at appropriate points in the plating shop. The law requires that pipes and tanks containing nickel salts at concentrations greater than or equal to 0.1% should be marked with the contents and hazard.

An appropriate sign as required under the current Chemicals (Hazard Information and Packaging for Supply) (CHIP) Regulations is shown below.

The Globally Harmonised System (GHS) as required by the Classification, Labelling and Packaging Regulation is replacing the CHIP Regulations by June 2015. You can display the new warning pictogram which is shown below.

References and Further Information

1 **Control of Substances Hazardous to Health Regulations - COSHH**
Approved Code of Practice and guidance

2 **Nickel and its inorganic compounds**
Health hazards and precautionary measures
HSE guidance note EH60

3 **Respiratory protective equipment at work**
HSE guidance note HSG53

4 **Biological monitoring in the workplace**
A guide to its practical application to chemical exposure HSE guidance note HSG167

5 **Monitoring strategies for toxic substances**
HSE guidance note HSG173

6 **Exposure to hexavalent chromium, nickel and cadmium compounds in the electroplating industry**
HSE Research Report RR963

7 **Joint SEA/HSE Information Sheet - Nickel and Nickel Alloy Plating Operations:**
Controlling the Risk of Skin Exposure

8 **Joint SEA/HSE guidance sheet**
Prevention of Exposure to Hexavalent Chromium and Control of Chromic Acid Mist

9 **Joint SEA/HSE guidance sheet** Monitoring for exposure to Chromium (VI) arising from Electrolytic Hexavalent Chromium Processes

10 **Joint SEA/HSE guidance sheet** Prevention and Control of Skin Exposure Risks from Chromic Acid in the Electroplating industry

11 **HSG258 Controlling airborne contaminants at work** A guide to local exhaust ventilation

12 **COSHH essentials guidance sheet G406**
New and existing engineering control systems covering LEV systems.

13 **COSHH essentials guidance sheet G409**
Exposure measurement: Air sampling.

14 **COSHH essentials guidance sheet G402**
Health surveillance for occupational asthma

15 **Methods for Determining Hazardous Substances 14/4 (MDHS)** General methods for sampling and gravimetric analysis of respirable, thoracic and inhalable aerosols

Appendix

Initial questionnaire for surveillance of people potentially exposed to substances that cause occupational asthma

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