PREVENTION OF EXPOSURE AND CONTROL OF CHROMIC ACID MIST

Soluble hexavalent chromium compounds, and in particular chromic acid (chromium trioxide), are commonly used as electrolytes in electroplating and anodising. In these processes the bursting of small bubbles of gases generated by electrolysis causes the formation of mists (fine droplets of electrolyte). These are commonly referred to as chromium plating mists and can be breathed in.

The amount of mist produced depends on a number of process variables, particularly: concentration of chromic acid in solution; surface area of the articles treated; current density; and the length of time current is passed through the solution. (A breathable aerosol can also be created through inappropriate use of compressed air to blow-off plating solution – **this practice should be forbidden**).

By law, you are not allowed to use substances like chromic acid if it can be sensibly 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 acid 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 Europe and must be used in UK 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 spray suppressant to limit the emission of spray 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 (eg based on PFOS) provide best protection because they are much more stable than older types. Unfortunately, PFOS is currently under scrutiny because it can build up in the environment and may prove to be more hazardous than was originally thought. If PFOS is removed from the market, existing LEV must be re-evaluated or suitable LEV installed.

Exhaust ventilation is usually provided in the form of lip extraction along each side of the bath to avoid impeding the process operation. Even when 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 when any

access points in the enclosure are opened for purposes of process control, so preventing emission of chromic acid mist into the workroom atmosphere.

It is important to understand that the effectiveness of LEV is dependant on the level of freeboard: the greater the freeboard the more efficient the capture of mist. Running costs for LEV are significant and increasing freeboard and reducing LEV flow rates can give substantial savings. Freeboard should be at least 150mm on existing tanks - preferably 300mm or more. The greater standard should apply to all new installations but there is scope to increase freeboard on some existing plant simply by building up the sides of the tank.

When the LEV is initially set up, the freeboard 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 displacement (least freeboard), highest current density, greatest chromic acid concentrate, longest plating time. The surface tension (mN/m, previously dynes/cm), freeboard distance (measured between the level 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 (stalagmometers 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 these conditions (ie at least two if they are consistent; more if they differ significantly). If the amount of mist emitted from the tank is below the maximum exposure limit (MEL) of 0.05 mg/m^3 (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 examined and tested by a competent person (eg a ventilation engineer) at least once every 14 months. Freeboard levels should be constantly maintained through a combination of visual indicators (eg high level mark inside the tank), alarms and automatic dosing. The level of electrolyte should not be allowed to rise above the levels set.

Where spray suppressants are used to control chromic acid mist emissions the electrolyte solution must be properly checked and maintained in accordance with the spray suppressant supplier's instructions. Surface tension should not be allowed to rise above the level specified by the supplier and must be monitored

using a tensiometer at regular intervals. Initially, this should be every 4 hours of use. When the characteristics of the process are understood the frequency of testing can be adjusted as appropriate but should not exceed 40 hours of tank operation. A logbook should be kept showing surfactant additions together with a graph of surface tension.

Where surfactants are not used, LEV will need to be monitored, for example by measuring the duct velocity using an anemometer and checking against the standard specified by the plant manufacturer. Checks should initially be carried out daily (before electrolysis commences) but this can be extended to weekly intervals if consistent results are obtained. If flow rates drop more that 15% below the manufacturers specification, operation of the process should be suspended until the fault is remedied, and the frequency returned to daily checks. Again, a logbook should be kept.

'**Chroffles**'

Chroffles are similar to ping-pong balls and form a floating layer on the surface of the electrolyte. They have little effect on the level of mist created (their primary purpose is to reduce heat loss from the tank) and are not considered to be COSHH control measure.