The use of liquid dye penetrants containing the azo compound CI Solvent Red 164 in the detection of flaws or cracks in metal components

SIM 03/2008/10

Author unit / section: Metals and Minerals

Target audience: All HSE and LA visiting staff

Summary

HSE's Working Group on Action to Control Chemicals (WATCH) has recently reviewed the information available about the incorporation of the azo compound CI Solvent Red 164 within liquid penetrants used in non-destructive testing (NDT), and has advised that users should implement controls on exposure commensurate with the use of a suspect (category 3) carcinogen. Visiting staff should alert users to this advice and the appropriate control measures.

Purpose

Where, during visits, there is evidence that non-destructive testing is undertaken, visiting staff are invited to make enquiries about the use of liquid dye penetrants and alert users of liquid dye penetrants containing CI Solvent Red 164 to the advice given in this SIM.

Note

Foundries are due to be visited as part of the DRP LEV cross-cutting project being carried out over the course of the year (SIM 03/2008/05 refers)

Background

Aromatic azo compounds are synthetic organic chemicals which have strong colours. This makes them suitable for use as dyes.

Liquid dye penetrants which are used in non-destructive testing (NDT) of metal components may contain such dyes. Use of such liquid dye penetrants is a simple, reliable and low-cost technique to check for flaws or cracks in the surface of castings, forgings and welds.

CI Solvent Red 164 is a compound used in such dyes because of its strong and therefore easily visible colour.

The object to be checked is coated with the liquid containing the dye and any surface flaws or cracks draw the dye into them by capillary action. Excess dye is then cleaned away and the surface is coated with a developer which acts like blotting paper to draw the remaining dye away from the flaw or crack to reveal the defect.

The liquid can be applied by spray application (aerosol can or air gun) or brush or by immersion of the test piece into a holding tank containing the liquid dye.

Toxicology

Concern has been raised with HSE about health risks from the use of liquid dye penetrants containing CI Solvent Red for NDT purposes. It is known that some azo dyes can be metabolised in the body giving rise to o-toluidine, an aromatic amine, which is classified as a Category 2 carcinogen in the EU.

Manufacture of liquid dye penetrant containing CI Solvent Red 164 dye

There is no UK manufacture of CI Solvent Red 164 concentrate. Less than 3 Tonnes are imported per year for use in the formulation of liquid dye penetrants. Approximately 1 Tonne/yr of the imported concentrate is formulated into red azo dye penetrant for use in the UK. The remainder is exported.

CI Solvent Red 164 concentrate is delivered to formulators in 200 litre intermediate bulk containers (IBCs) and stored on site. When required the concentrate is transferred to a dye penetrant mixing tank either by pumped transfer or by gravity drain. The red azo dye penetrant solution is then transferred by pumped delivery to a filling point located in a ventilated cabinet in which 440ml aerosol spray cans are filled remotely. Alternatively, the solution can be transferred to a manual filling point for 25 litre or 5 litre tins.

It is estimated that formulators supply the UK user- industries with approximately 55,000 x 440ml aerosol spray cans of red azo dye penetrant each year, and 13,000 litres of red-dye penetrant in 25 litre or 5 litre tins for application by immersion, air gun or paint brush.

The formulation contains about 3.5% of CI Solvent Red 164 dye, the highest volume constituent of the penetrant liquid being kerosene (70-75%).

Exposure to CI Solvent red 164

Exposure may occur to workers in user industries e.g. foundries, steel works, fabrication shops, and to those surveyors and assessors employed by specialist sub-contractors and insurance companies.

There is no exposure data currently available for any workers employed to use red azo dye penetrants in NDT.

Usage can vary greatly from as little as two or three brief (less than ten seconds) aerosol spray applications per year to the use of at least two aerosol spray cans per week.

The British Institute of Non-Destructive Testing (BINDT) and the Welding Institute (TWI) estimate that about 60% of liquid dye penetrant testing is carried out using red azo dyes.

BINDT estimate there are 17,000 registered testers in Britain, most of whom will have worked with red azo dyes at some point. BINDT and the insurance industry Safety Assessors Federation (SAFed) indicate that liquid penetrant is used by many welders of which the ONS Labour Force Survey estimates there to be around 200,000 in GB, but a reliable estimate of the potential number of workers exposed cannot be provided.

However, the nature of the dye (brightness and permeability) makes any contact with the skin or clothing obvious and should encourage the worker to take immediate action to clean away any residue and seek to avoid further exposure.

WATCH recommendations

- Based on the limited hazard data available, it was appropriate to consider that this substance might have carcinogenic potential; it should therefore be subject to the same exposure control approach as for other suspect carcinogens.
- Exposure data were currently lacking to inform the degree to which current practices and associated exposures conform to these expectations.
- The issues required more attention from industry, both suppliers and users
- User companies should implement controls on exposure commensurate with the use of a suspect (category 3) carcinogen.

Control measures

Safety data sheets that have been reviewed advocate users to take a cautionary approach to the use of red azo dye containing penetrants and wear suitable respiratory, skin and body protection. This would include:

- Avoidance of all skin contact by changing the way the azo dye is used and wear gloves which are classed as suitable for use with organic chemicals;
- Frequent changes and good maintenance of gloves is essential. A specialist safety equipment provider should be consulted;
- Avoidance of spray application;
- Use of effective extraction systems where vapours or spray may be released
- Extreme care to be taken with disposal of contaminated material, cleaning off the dye from the test piece, maintenance of extraction system, etc.
- All workers carrying out these tasks, or working nearby to be informed of the need for particular care to be taken.

Substitution

There are 2 red non-azo dye-containing substitutes available and a third being developed. However, due to the paucity of published hazard and exposure information for both red azo dye penetrants and potential alternatives, it is not possible to state that these would be safer alternatives to use.

Alternative test methods are available including:

- Visual examination
- Use of fluorescent dye penetrants
- Magnetic particle inspection
- Radiography
- Ultrasonics
- Eddy current

Action by HSE

Manufacturing Sector has brought the above information to the attention of the Cast Metals Federation (CMF), Confederation of British Metalformers, UK Steel, EEF, BINDT, TWI, SAFED, Unite union and at Foundries Industry Advisory Committee (FIAC).

CMF intends to publish a safety alert advising member companies of the issues and interim recommendations.

Discussions are continuing with the formulators/suppliers including the adequacy of information provided on Safety Data Sheets

Action by visiting officers

Where visiting staff become aware of the use of NDT using azo dye penetrants, users should be advised to take precautions in accordance with COSHH 2002 and the associated AcoP and to contact their supplier(s) concerning appropriate precautions when using a dye penetrant containing an azo dye.

In particular users should be advised to minimise worker exposure to aerosols and through skin contact until further or alternative information becomes available.

Other uses of azo dyes

Azo dyes are used for other applications but the current advice from WATCH is particular to its use in NDT dye penetrants.

Contacts

For use of azo dye containing dye penetrants

- In foundries, and other molten metal industries: Dr Phil Smith, Manufacturing Sector, Stoke (VPN 512 2337)
- In forges, welding/fabrication: Peter Woolgar, Manufacturing Sector, Birmingham (VPN 510 6254)

For use in other applications

- John McAlinden, Occupational Hygiene, Bootle (VPN 523 4545)