CASE REPORT

Carbon disulphide absorption during xanthate reagent mixing in a gold mine concentrator

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A xanthate reagent mixer at a gold mine concentrator was exposed to carbon disulphide by extensive skin contamination with xanthate powder and solution during the reagent mixing process. Absorption of carbon disulphide was confirmed by the detection of urinary 2-thiothiazolidine-4-carboxylic acid (TTCA). Drager colorimetric tube testing during subsequent mixing recorded a maximum concentration of at least 60 ppm carbon disulphide. An illness consisting of predominantly gastrointestinal symptoms began 20 h after the exposure. Although this may have been due to carbon disulphide toxicity this is by no means certain. The need for engineering controls, impervious protective clothing and full-face respirators with particulate and organic vapour cartridges is discussed. This episode occurred at another mine site, unrelated to Mount Isa Mines Limited.

Key words: Carbon disulphide; concentrator; mining; ore; TTCA; xanthate.

THE PROCESS

Xanthates are chemical reagents commonly used during the processing of metalliferous ores in mine concentrators. They are added to ore which has been crushed and ground into a fine particulate and mixed with water. Xanthates coat the valuable mineral particles, rendering them water repellent and thereby promoting their adherence to air bubbles which are blown in from the base of flotation cells. The mineral particles thus float to the surface and are separated from underlying waste material.

When solid xanthates are mixed with water they evolve gaseous carbon disulphide. Aqueous xanthate solutions can also liberate carbon disulphide by decomposition. Aqueous xanthate solutions are commonly prepared at mine sites for use in concentrators. Drums containing 110-120 kg of powdered xanthate, or bulker bags containing 500-700 kg of pelletized xanthate are added to water in mixing tanks to prepare the solutions. Commonly drums are handled manually or rolled into the inversion cradle of a hopper, which is used to invert the drum and discharge the contents. At some sites drums are inverted over chute openings by modified forklifts, where jets of water help wash out the contents. Bulker bags are lifted by crane into a hopper containing spikes which pierce the bag and discharge the contents. The mixing task involves the risk of exposure to carbon disulphide which can be minimized by the use of engineering controls (mechanized drum handling or the use of bulker bags), respiratory protection and impervious protective clothing.

THE CASE HISTORY

A 32-year-old male reagent mixer was using an inversion cradle to discharge powdered xanthate from a drum into the hopper of a mixing tank at a gold mine. This particular drum's contents had become severely compacted in the lower third and he resorted to hammering the drum, scraping out the xanthate and washing the inside of the drum with hose water. In the process he was covered in xanthate powder and aqueous xanthate solution. He was wearing disposable paper overalls over the top of cotton overalls, PVC gloves, and an acid-gas/particulate full-face negative pressure respirator. On completion of the mixing task he went for a shower and discovered his skin stained green from the chest down. This degree of skin contamination was much greater than he had ever experienced previously.

Twenty hours later, on the following day, before any exposure to chemicals, he developed epigastric ‘burning’, central abdominal ‘tightness’, anorexia, nausea, vomiting,
fatigue, headache and felt 'faint'. He went home to rest, the vomiting ceased and he was able to eat later that evening. He remained nauseated and fatigued and his sleep was disturbed by acid reflux and epigastric/retro-sternal discomfort. He denied visual disturbances and did not complain of weakness or numbness of the limbs or of psychotic symptoms. Somewhat surprisingly he did not experience skin irritation except for some mild pruritus at the wrists. He never developed diarrhoea. His symptoms resolved gradually over the next four days, at which point he returned to work. His previous medical history was unremarkable, his pre-employment health assessment denied nausea, indigestion or other gastrointestinal symptoms. He was taking no medication and had not been prescribed NSAIDs within the last year. He last consumed alcohol 36 h before he became unwell, having four litres of beer on a Saturday night. He lived alone and did not have contact with anyone who had a similar illness. Unfortunately I did not see him during his acute illness and was not in a position to examine him. However a urine sample was obtained 48 h after the onset of his illness and was sent for 2-thiothiazolidine-4-carboxylic acid (TTCA) analysis. TTCA is a metabolite of carbon disulphide used for biological monitoring purposes. Two methods of TTCA analysis were used but unfortunately the one with the lowest detection limit was technically unsatisfactory. However the analyst concluded that there was TTCA present at a concentration close to although less than 4 mg/l (ACGIH BEI: 5 mg/g, German BAT: 8 mg/l).2

Following this episode, spot measurements of the air concentration of carbon disulphide were taken with Drager colorimetric tubes during the mixing process. During the addition of xanthate to the tank a level of 15 ppm was obtained, while immediately after this the water level was rising in the tank, a Drager tube registered its maximum concentration of 60 ppm with just five of the 11 pumps specified. (ACGIH TLV: 10 ppm TWA, OSHA PEL: 4 ppm TWA, 12 ppm STEL).3

The presence of TTCA in this case confirmed the absorption of carbon disulphide. Previous biological monitoring of xanthate mixers at this site had not detected TTCA. This suggests that normally the exposure to carbon disulphide in this job is low and that the unusual and very extensive skin contamination which occurred in this case was the most likely cause for the carbon disulphide absorption. Carbon disulphide is readily absorbed through the skin and would have been generated at the skin surface by the decomposition of both solid and aqueous xanthate. The need for impervious protective clothing and work procedures or engineering controls which avoid splashing is clear.

Although skin contamination was probably the major contributor in this case, it is possible that inhalation may also have contributed, because spot air levels beyond the STEL were obtained after the event, and the respiratory protection did not include an organic vapour cartridge. It is interesting to note however that he did not experience irritation of the eyes, which suggests that the level of carbon disulphide within his full-face respirator was probably not very high.

The maximum spot air level obtained after the event was more than 60 ppm, which is significantly greater than the highest previously published level I am aware of — 16 ppm. This level was recorded while water was being added to a tank in which the xanthate had been deposited. After a change in procedure, whereby the tank was filled with water before the addition of xanthate, the air levels were reported to be below 10 ppm.

The air levels that were recorded following this episode indicate the potential for excessive carbon disulphide inhalation and the need for control measures in this job. Possible control measures include the use of mechanized drum handling, enclosed drum inversion and irrigation, bulk bags, pellets rather than powder, ventilation and appropriate respiratory protection. Respirators should be full-face and include a high grade particle filter (at least P2) and an organic vapour cartridge (such as type A or AX).1

Although many of the symptoms described in this case are consistent with acute carbon disulphide toxicity,4 this diagnosis is by no means certain, because of the delay of 20 h from exposure to the onset of symptoms, the relatively low TTCA and the differential diagnosis.

Although the literature contains many papers on carbon disulphide exposure in the viscose rayon industry, this appears to be the first report of carbon disulphide absorption in a xanthate reagent mixer at a mine site.

REFERENCES