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Workplace Exposures to the Corrosion-Inhibiting Chemicals from a Steam Humidification System

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Editor's Note: The case studies approach has long been a staple of occupational and environmental hygiene education and practice. Case studies allow us access to approaches that have been attempted by others. As such, they may or may not represent every state-of-the-art, but they do tell us more about the actual state of practice.

Every case study must have an objective, and each invariably includes observations. From these observations, an evaluation may emerge. Most case studies include recommendations. When recommendations are made, it should be remembered that they are made at a single point in time and are likely to apply at that time but may become less applicable as more effective methodologies emerge.

"Case Studies" is a regular feature of *Applied.* Dawn Tharr is the column editor. We welcome submissions from our readers of appropriate case studies.

On December 5, 1988, 70 of 84 employees working as assemblers in a Cincinnati, Ohio, electrical components manufacturing firm developed a variety of symptoms including nausea; vomiting; dizziness; and eye, nose, and throat irritation. Their symptoms occurred shortly after employees detected an odor (described as musty, pungent, ammonia-like, and radiator-like) that coincided with the introduction of steam for humidification which was derived from the plant boiler. The work area was evacuated, and 40 employees were evaluated by the company nurse. Eleven were seen at local hospitals and released. The steam was turned off to most of the work areas 90 minutes after the first symptoms appeared. Investigators from the National Institute for Occupational Safety and Health (NIOSH) were contacted three days later when the reintroduction of boiler steam for humidification resulted in the same pungent odor, causing the company to evacuate the affected areas. NIOSH investigators discovered that in mid-September two corrosion-inhibiting chemicals, diethylaminoethanol (DEAE) and cyclohexylamine (CHA), had been added to the boiler at 4 times normal strength. During the next 2.5 months, the boiler sat idle.

On December 5 when boiler steam was introduced, the risk of illness (the presence of at least two of the symptoms listed above for those persons working in the humidified area) was 4.33 (95% confidence interval 2.06–9.13) when compared with employees in another area of the plant which was not humidified by the steam. On December 9, after workers had left for the day, steam was reintroduced into the work area, and samples of boiler water and air were collected and analyzed for the amines according to NIOSH Method No. 2007.[1] No DEAE or CHA was detected, possibly because of dilution in the system during the preceding four days. Most boilers require fresh water daily to make up for losses from escaping steam and drained condensation. The Occupational Safety and Health Administration (OSHA) Permissible Exposure Limit (PEL) for DEAE and CHA is 50 mg/m^3 (10 ppm) and 40 mg/m^3 (10 ppm) respectively.[2]

Background

DEAE and CHA become airborne in steam and can result in inhalation and dermal exposure. Significant exposure is more likely if these chemicals are added to the steam-generating system in one large dose, rather than in small continuous amounts. DEAE and CHA are both strong irritants. In one case report, a laboratory worker exposed to an estimated concentration of 480 mg/m^3 (100 ppm) DEAE for less than 30 seconds became nauseated and vomited within 5 minutes.[3] Data on human health risks of long-term, low-level airborne exposure to these amines are not available. However, DEAE may be converted to a nitrosamine, and nitrosamines are suspected of being carcinogenic in humans.[4]

NIOSH has investigated three other incidents of illness related to exposure to boiler steam that contained corrosion-inhibiting chemicals. In 1981, 24 employees in the office area of a production building reported skin rashes with some complaints of dry throat, headache, and chest tightness.[5] NIOSH investigators concluded that the dermatitis resulted from exposure to a condensation or reaction product of DEAE added to the air handling system. In 1982, employees in a museum where DEAE had been added to a humidification system complained of eye irritation and dermatitis.[6] Two air samples had DEAE concentrations of 0.05 and 0.04 mg/m^3. In 1988, nurses in a Portland, Oregon, hospital had complaints of eye and upper respiratory tract irritation after the introduc-

tion of CHA and morpholine into the boiler water used to humidify the nursery and the newborn intensive care unit.[7]

The OSHA PEL was promulgated for the protection of industrial workers. It was not intended to provide a margin of safety for the general public.

The use of amine corrosion-inhibiting chemicals in boiler steam to humidify occupied buildings should be discontinued. At least one major supplier of corrosion-inhibiting chemicals has recognized the potential health hazards of DEAE and, in 1983, warned all of its customers against such use.[8] customers against such use.[8]

More information may be obtained by contacting the authors at the following address: NIOSH, Hazard Evaluations and Technical Assistance Branch, 4676 Columbia Parkway, Cincinnati, Ohio 45226; 1-800-35NIOSH.

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