K43 Five Fatal Occupational Injuries Due to Gas Inhalation Occurred During Truck-Tank Washing Operation: Environmental Findings

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After attending this presentation, attendees will be briefed on five cases of fatal asphyxiation at work, which occurred during a truck-tank washing operation.

This presentation will impact the forensic community and/or humanity by demonstrating how fatal deaths were caused by gaseous hydrogen sulfide (H_2S), a byproduct of the chemical compound being shipped, and that the accumulation of toxic gases in a closed space can induce asphyxiation in a matter of minutes.

During a routine truck-tank washing operation, a worker got into the empty tank through the upper pothole and in a few minutes fell unconscious. Assuming an accident happened, a second worker went into the tank where he also fell unconscious. The last three men died trying to remove their co-workers out of the tank. Before the washing operation, the tank had previously contained sulfur liquid. All five workers had been in good health and had had a mean age of 37.6 years (range 20-64).

To clarify the cause of death and identify the factors involved in asphyxia, it is crucial to identify the fatal compound(s) and its/their origin. Therefore, several specimens from the tank were characterized and a simulation on two analogous truck-tanks was also carried out.

Dregs of a blackish liquid and a yellowish granular solid from the tank bottom were analyzed using headspace/GC-MS technique. Air samples were analyzed using commercial available color dosimeter tubes and H_2S quantitative determination was also performed in liquid sulfur. Thiosulfate, was measured in blood samples by GC/MS technique after derivatization with pentafluorobenzyl bromide.

Analyses confirmed that the dregs of yellowish solid samples were composed of sulfide. The blackish liquid was a mixture mainly consisting of liquid sulfide and H_2S as contaminant (2.5 mg/l). The absence of hydrocarbon-aliphatic compounds and solvents together with its almost neutral pH (7.6) demonstrated that the workers had not used detergents or basic compounds.

Air monitoring at the third opening inside the tank (one week after the accident), revealed high H_2S concentration (> 60 ppm) while sulfur oxides were negligible, which excluded a sulfur combustion induced by the workers. At the fourth opening (one month after the accident), H_2S air concentration was less than 0.25 ppm. This depletion was due to the continuous opening of the porthole during the rescue operation and the following inspections, as demonstrated by the strong characteristic odor of rotten egg that could be smelled in the area outside the truck-tank. The high H_2S concentration in the air inside the tank was ascribed to the contamination of the original liquid sulfur, produced by Claus's process, the most significant industrial process used to recover elemental sulfur from gaseous hydrogen sulfide.

To support the hypothesis that H_2S rising from liquid sulfur was responsible for the deaths, two similar truck-tanks used for liquid sulfur transport, and the sulfur itself were also tested. Before loading liquid sulfur, air inside the tanks contained only O_2 (20.9 % v/v). During the loading phase H_2S air concentrations were 41 and 71 ppm, respectively and became 80.9 and 600 ppm when the tanks were fully loaded.

The liquid sulfur analyzed revealed high contaminations of H_2S: 85 and 108 mg/Kg.

According to Henry's Law (K_H=0.087 Pa•m^3/mol), H_2S tends to pass towards the gas phase. This evaporation is favored by the movement of the liquid (e.g. during the shipping) that increases the kinetics of evaporation. Therefore, after liquid sulfur had been removed from the tank bottom, H_2S remained in the gas phase causing the asphyxiation of the workers, as confirmed by the pathological and toxicological findings. In fact, abnormal concentrations of thiosulfate, the major metabolite of H_2S, from 0.023 to 1.63 mmol/l (average value: 0.38 mmol/l) were revealed in all *postmortem* blood samples.

Environmental and biological results confirmed that H_2S fumes were responsible for the multiple deaths and no other adverse reactions that happened inside the tank. This report presents valuable findings in correctly identifying the cause of death in gas asphyxiation cases.

Asphyxia, Hydrogen Sulfide, Occupational Accident

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