Subject: Hydrogen Sulfide and its Health Effects - from oil to hog farms

Most of the reportedly measured sulfur compounds are assumed to hydrogen sulfide gas with some mercaptans and carbon dissulfide (CS2) in lower concentrations. Therefore comments will address the effects of hydrogen sulfide (H2S).

The state of Texas since the 30-minute ground level property line standard is 80 ppb, which is too high in my opinion. Therefore a 24-hour H2S level of 108 ppb represents 48 violations of the 30-minute Texas standard.

HYDROGEN SULFIDE'S HUMAN HEALTH EFFECTS ARE WELL KNOWN INCLUDING AS A NEUROTOXIN IN THE LOW PART PER BILLION RANGE OF ROUTINE EXPOSURE

General information about the toxicity of hydrogen sulfide (cites listed at end)

Hydrogen sulfide is similar to cyanide in toxicity. It interferes with the enzyme cytochrome oxidase, which is necessary for cells to make use of oxygen (1, 2). How does H2S enter the body? There are three routes: inhalation-from breathing vapors absorbed through the lungs; oral-from ingestion of contaminated substances (especially water), absorbed through the intestinal tract; and skin-from contact with contaminated substances (such as air), absorbed through the skin. The main route of absorption of H2S is through inhalation.

Animal studies of H2S show widespread distribution in the body after inhalation exposures (3, 4), with a selective distribution to the brain stem compared with other areas of the brain (5). Research in animals has identified more than forty health effects of H2S. Data demonstrates that numerous similar health effects occur in human exposure to H2S. Metabolism takes place by three pathways: oxidation to sulfate, methylation, and reaction with metallo- or disulfide- containing proteins. This last appears to be the main pathway for toxicity (6).

Human populations most sensitive to H2S are assumed to be the fetus (animal data only), children (7), persons with heart disease (8), individuals with asthma (9), individuals who metabolize organosulfides differently (10, 11, as reviewed in 12), and persons consuming alcohol (13, 14).

Medical information about H2S toxicity and chronic exposure at low level concentrations Hydrogen sulfide's toxicity at the 800-1,000 parts per million level (and higher) is well documented as being instantaneously lethal to exposed human beings. Hydrogen sulfide works by rapidly interfering with the brain's respiratory command center (sending nerve signals to the lungs) and poisoning the blood's oxygen carrying ability, but long-term, low-level or chronic exposures have been generally considered to be less toxic and less harmful.

The driving regulatory assumption has been that if an exposure to H2S is not fatal, there are few, if any, lasting health effects. But that assumption is medically outdated. Four public health scientists-including Kaye Kilburn, Ph.D., University of Southern California School of Medicine, and Marvin Legator, Ph.D., University of Texas Medical Branch-Galveston-participated on an H2S panel at the American Public Health Association's annual meetings November 11, 1997, in Indianapolis, Indiana, to present and discuss groundbreaking research demonstrating the extraordinarily toxic nature of H2S at the chronic, low levels to which communities across the nation are routinely exposed. These public health findings support the thesis that exposure to hydrogen sulfide, even in extremely low concentrations, can cause lasting damage to the nervous system.

Dr. Kilburn has been conducting research on the health effects of exposure to H2S for many years (18, 19, 20). Describing a new study, he unequivocally stated at the conference that "H2S poisons the brain, and the poisoning is irreversible" (21, 23). Demonstrable symptoms of chronic exposure include pronounced deficits in balance and reaction time, as well as such ailments as dizziness, insomnia, and overpowering fatigue.

Dr. Legator and his research associate Chantele Singleton have been using a carefully designed "symptom survey" to evaluate adverse health effects associated with H2S (1, 21). In one study, they administered the survey to 97 residents living within four miles of a large geothermal electric power plant in Hawaii, the Puna Geothermal Venture (PGV). PGV produces electricity from subsurface volcanic heat and releases hydrogen sulfide as a waste byproduct. Eighty-six percent of the subjects indicated that they had experienced central nervous system impairment of the sort described by Dr. Kilburn's research. But only 26% of those in a control group-people who live some 20 miles away from the plant-reported such problems (1, 21, 22).

According to the several studies of these researchers, in chronic, low level exposures, one may observe abnormal neurobehavioral functioning and altered mood states (e.g., depression, fatigue, tension, vigor) (1). In addition, numerous CNS-brain effects occur including: changes in brain density, headache, memory loss, reduced sense of smell, loss of balance, dizziness, sleep difficulties, and fatigue (1). Numerous cases reported in the literature support the CNS toxicity of H2S (1). Many of the effects are persistent (15, 16, 17).

Children's exposure to hydrogen sulfide

Children are more vulnerable than adults to H2S, first because they breathe more rapidly, taking in significantly more pollution per pound of body weight than do adults. A resting infant, for example, inhales twice as much air, relative to its size, as does a resting adult. Second, national data show that children spend an average of about 50% more time outdoors than adults. Third, children are three times more active while outdoors than adults, engaged in sports and other vigorous activities; this increased activity raises breathing rates and significantly increases inhalation and in some cases swallowing of pollutants. Fourth, children are particularly vulnerable to toxic substances because their bodies are immature and rapidly growing. Fifth, children are in their prime learning years and H2S exposure causes brain damage. The impairment of mental faculties in a child amounts to a lifetime of harm.

Diurnal variation measured in hydrogen sulfide concentrations

Researchers have confirmed what citizens in impacted communities have known for years: The odor of H2S in neighborhoods is significantly worse at night (24). Tarver and Dasgupta conducted field studies on variation in H2S from day to night. They observed:

At all locations, H2S concentrations consistently exhibited a strong diurnal pattern, with nighttime maxima in the range of 1-5 ppbv followed by rapid abatement at sunrise. By 10-11 AM, H2S levels fell below the instrument detection limit of 200 pptv (24).

Like other polluting gases, H2S generally does not disperse as efficiently at night, with its cooler air temperatures. For residents in impacted communities, this diurnal pattern carries the implication that by far the worst H2S exposures are occurring when families are most likely to be at home and windows may be open (often because many houses in low-income communities lack air conditioning). Night also tends to be the time when state and local regulatory agencies are least likely to be available to verify nuisance conditions, conduct H2S ambient air sampling, and attempt to track down the H2S source in efforts to obtain compliance.

Public health scientists now recognize that hydrogen sulfide is a potent neurotoxin, and that chronic exposure to even low ambient levels causes irreversible damage to the brain and central nervous system. Children are among the most susceptible to this poison gas. It is unacceptable for communities to have to continue suffering the ill effects of H2S when the technology to control H2S emissions is available and affordable.

REFERENCES

1. Morris, DL, and MS Legator: Hydrogen Sulfide, October 1996, privately circulated draft presentation.
2. Smith, RP, and RE Gosselin: 1979, J Occupational Medicine 21:93-7.

3. Nagata, T, et al: 1990, J Forensic Science 35:706-12.
4. Voight, GE, and P Muller: 1955, Acta Histochem 1:223-39, as reviewed by Beauchamp, RP Jr, et al: 1984, CRC Crit Rev Toxicol 13:25-96.
5. Warenycia. MW, et al: 1989, Biochem Pharm 38:973-81.
6. Beauchamp, RP Jr, et al: op cit.
7. Dales, RE, et al: 1989, Am Rev Respir Dis 139:595-600.
8. Jappinen, P, and S Tola: 1990, Br J Ind Med 47:259-62.
9. Jappinen, P, et al: 1990, Br J Ind Med 47:824-8.
10. Mitchell, SC, et al: 1984, Br J Clin Pharm 18:507-21.
11. Harris, CM, et al: 1986, Lancet 1:492-3.
12. Guidotti, TL: 1994, Int Arch Occup Env Health 66:153-60.
13. Beck, JF, et al: 1979, Toxicol Lett 3:311-13.
14. Poda, G,and SC Aiken: 1966, Arch Env Health 12:795-800.
15. Wasch, et al: 1989, Arch Neurol 46:902-4.
16. Tvedt, B, et al: 1991, Acta Neurol Scand 84:348-51.
17. Tvedt, B, et al: 1991, Am J Ind Med 20:91-101.
18. Killburn, KH: 1997, Panel on Hydrogen Sulfide, American Public Health Association's annual meetings, November 11, 1997, Indianapolis, Indiana.
19. Kilburn, KH,:1993, Am J Med Sci 306:301-5.
20. Kilburn, KH, and RH Warshaw: 1995, Tox Ind Health 11:185-96.
21. Legator, MS, and C Singleton: 1997: Panel on Hydrogen Sulfide, American Public Health Association's annual meetings, Indianapolis, Indiana.
22. Morris, J: New alarm over hydrogen sulfide-Researchers document lasting damage to human nervous system. A three-part investigative report, Houston Chronicle, November 1997. See archives of the Houston, Texas Chronicle newspaper at http://www.chron.com
23. Borda, B: 1997, Panel on Hydrogen Sulfide, American Public Health Association's annual meetings, Indianapolis, Indiana.
24. Tarver, GA, and PK Dasgupta: 1997, Environ Sci Tech 31:3669-3676.

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