Tap Water's Toxic Touch and Vapors

Almost all U.S. drinking water contains toxic contaminants. Whether they actually pose a health risk depends upon the extent to which they get into a person's body.

To date, health analysts have tended to base their risk assessments on how much tap water people drink, observes Robert R. Vanderslice, a toxicologist with the Rhode Island Department of Health in Providence. But a pair of new studies indicates that ingestion may not prove the toxicants' primary route of entry. Moreover, the current focus on ingestion may actually hinder recognition of which of the body's organs are most vulnerable.

Consider sewage workers, who sometimes complain of dizziness or trouble maintaining their balance. Such anecdotal claims piqued the curiosity of Amit Bhattacharya, a biomedical engineer at the University of Cincinnati. He had been quantifying balance difficulties in children as a subtle gauge of lead's impairment of the central nervous system (SN: 1/28/89, p. 54).

Like lead, most organic solvents can depress central nervous system responses. Because many toxic chemicals can volatilize out of water, Bhattacharya's group decided to look at postural sway in 28 apparently healthy wastewater-treatment workers.

In the just-released January JOURNAL OF OCCUPATIONAL AND ENVIRONMENTAL MEDICINE, the researchers report that volunteers with the greatest occupational exposure to volatile organic chemicals (VOCs) exhibited the most sway. While cautioning that the study was small and preliminary, Bhattacharya notes, "we were very impressed to see any statistically significant association."

Inhalation probably provided the greatest source of the workers' exposures, though skin contact can't be ruled out. In fact, another new study demonstrates that absorption through the skin can be as effective an exposure route as inhalation for waterborne VOCs such as chloroform, a byproduct of chlorination.

Clifford P. Weisel of the Robert Wood Johnson Medical School in Piscataway, N.J., has been working to tease out what share of the VOCs in tap water enters the body from ingestion, inhalation, and skin contact. From activities such as drinking and bathing, equivalent amounts of volatile contaminants enter the body, on average, by each of the three routes, he and Wan-Kuen Jo of Kyungpook National University in Taegu, South Korea, conclude.

However, their study indicates that those alternative routes don't pose equivalent risks. By measuring the VOCs exhaled in the breath of 11 exposed adults, they learned that ingested VOCs are metabolized immediately. Because the liver breaks down these chemicals, it is the target organ for toxicity.

VOCs that are inhaled or absorbed through the skin can circulate in the blood for 4 hours or more—permitting them to be distributed throughout the body, Weisel and Jo report in the January ENVIRONMENTAL HEALTH PERSPECTIVES.

Though neither of the new human studies found evidence of disease, their findings validate a decade of animal studies and computer models that had suggested ingestion would not be the dominant source of human exposure to toxic VOCs in tap water, says Thomas E. McKone of the University of California, Berkeley. Unfortunately, he contends, outside of California, regulators "still tend to take the view that if you have a water problem, you worry about ingestion."

Jennifer Orme-Zavaleta, chief of the human risk assessment branch in the Environmental Protection Agency's Office of Water in Washington, D.C., agrees. But, she adds, that view is about to change. Her agency recently entered into a cooperative agreement to bring together experts "to give us ideas on how you'd factor exposure information from inhalation and dermal data into an overall picture of risk for contaminants in drinking water."

She expects a report of their findings to be published later this year. While it may not directly affect allowable contaminant concentrations in water, she said, it could "certainly have an effect on whether [communities with seriously contaminated water] will be told to boil water before they drink it," a procedure that greatly increases inhalation risks. Ironically, Orme-Zavaleta adds, "that's often the guidance given for volatile contaminants." *— J. Raloff*

How water reacts with solid catalysts

Almost like magic, a good catalyst can provoke a slow-cooking chemical brew into a rapid-fire reaction. Stir the potion, sprinkle on a dash of catalytic powder, and off goes the chemical transformation.

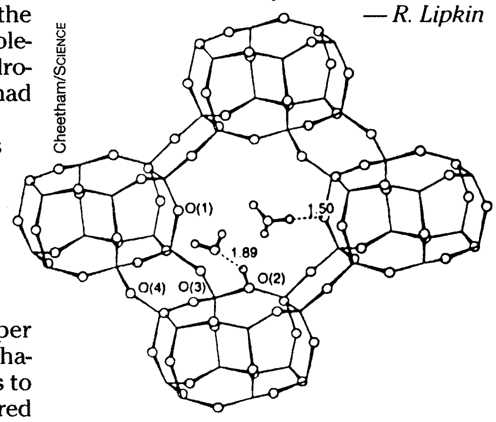
In the petroleum industry, zeolites—porous solids used to refine crude oil into fuels—serve as the catalysts of choice. Zeolites have structures called acid sites on their surfaces that facilitate charge transfers between molecules, thereby accelerating chemical reactions. Anthony K. Cheetham, a chemist at the University of California, Santa Barbara, and his colleagues have now shown precisely how the acid sites accomplish this key proton transfer—at least among water molecules.

His team describes in the Feb. 9 SCIENCE results from an analysis of a synthetic solid catalyst, HSAPO-34, similar to the naturally occurring zeolitic mineral chabazite. The researchers used neutron diffraction and infrared spectroscopy. Their findings confirm the presence of two types of reactions. In the first, a water molecule forms a hydrogen bond with an acid site on the catalyst. In the second, a water molecule picks up a proton, creating a hydronium ion (H_3O^+). Computer models had predicted both reactions.

"What's important here is that this is the first time that anyone has actually detected the proton being transferred to the water," says Antonio Redondo, a physical chemist at Los Alamos (N.M.) National Laboratory.

Cheetham speculates that deeper understanding of the catalytic mechanism might someday enable chemists to design catalysts with carefully tailored acidities, which would increase their effectiveness in particular chemical reactions.

"Understanding the cooperation of the active site and its environment in tuning the acidity of the system is a fundamental chemical problem," says Joachim Sauer, a chemist at Germany's Humboldt University in Berlin. *— R. Lipkin*



Cheetham/SCIENCE

Solid catalyst HSAPO-34 bonding a water molecule (left) and creating a hydronium ion (right).