Science & Society

Chemical controversy goes underground

The Environmental Protection Agency (EPA) last week proposed new rules for the disposal of hazardous wastes in underground wells. At least one environmental group immediately threatened to sue the EPA, arguing that the new standards would allow poisons to contaminate drinking water sources. The rules would apply to the approximately 7 billion gallons of hazardous chemical wastes that are disposed of each year in "injection wells" — mile-deep underground chambers lined with cement, steel and rock.

The controversy centers upon interpretation of the Resource Conservation and Recovery Act, amended by Congress in 1984. The act provides a timetable for ensuring that injection wells allow "no migration of hazardous constituents" into the ground. The EPA wants to define acceptable levels of hazard by balancing safety concerns with the high cost of completely preventing groundwater contamination. Environmentalists argue that such a "cost-compromised" standard is not what Congress intended, and that such a standard will allow dangerous levels of wastes to leak into the ground.

Workplace safety rules expanded

The U.S. Labor Department, under threat of contempt of court, posted new regulations requiring employers to notify workers about hazardous materials in the workplace. The new rules expand current "right to know" requirements to include every industry in which workers are exposed to hazardous chemicals. Previously the rules applied only to the chemical and manufacturing industries.

Under orders from the U.S. Court of Appeals, the Occupational Safety and Health Administration (OSHA) will require employers in such nonmanufacturing areas as agriculture, construction and health care to fully inform workers of any hazardous substances used on the job, and to train workers in the safe use of those substances. The rules are expected to cost employers $687 million in the first year, and more than $100 million annually after that. The new standard, OSHA says, should reduce by 20 percent the number of chemically related injuries, illnesses and deaths among the 18 million employees who are exposed to toxics at work.

Eco-bucks: Going for the purse strings

Environmental groups are gaining some clout in the international banking world. Under pressure from several environmental organizations, the United States last week abstained from a vote to recommend a controversial international loan to Botswana. Despite the U.S. abstention, the loan was ultimately approved by the African Development Bank, of which the United States is a member. But it was the first time the United States has on environmental grounds failed to support a loan to an African country.

The $7 million loan — earmarked for a slaughterhouse — was opposed on the grounds that it would encourage farmers to raise more cattle, thus worsening the country's severe overgrazing problem. There are concerns that the loss of grasslands in Botswana may worsen ecological imbalances in the area.

Meanwhile, the Inter-American Development Bank has suspended a $40 million loan for an Amazon road-paving project pending an environmental review of the work to date. The move follows a warning by a U.S. Senate appropriations subcommittee — itself under pressure from environmental groups — that U.S. funds for the bank might be cut off unless environmental concerns are adequately addressed. At issue is Brazil's alleged noncompliance with conditions of the 1985 loan, which required that the country adhere to an Environmental Action Plan aimed at mitigating road-project-related deforestation, land speculation and Indian displacement.

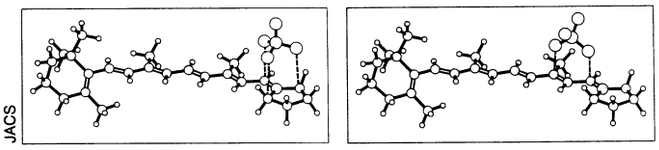
Technology

Visions of an invisible aircraft

Research on the chemistry of vision has led to the identification of a set of compounds that absorb electromagnetic waves at radio frequencies. These compounds, called Schiff base salts, when applied to the surface of a military aircraft, may significantly lower the aircraft's tendency to reflect radar signals. A coating of this type would make any object practically invisible to radar.

Chemist Robert R. Birge of Carnegie-Mellon University in Pittsburgh and his colleagues made the discovery accidentally while studying a group of compounds that mimic some of the properties of rhodopsin. Rhodopsin is a chemical substance found in light-sensitive rods in the retina at the back of the eye. Light entering the eye appears to trigger a slight change in the structure of rhodopsin molecules. That alteration sets off a chain of chemical events leading to the transmission of a signal to the brain.

To understand better how rhodopsin molecules can be so sensitive to individual photons of light, researchers have studied simpler molecules that appear to have similar properties. One such analog is the retinyl Schiff base salt known as ATRSBS. One piece of the salt consists of a long chain of carbon atoms, with alternating double and single bonds and a nitrogen atom interrupting the string near one end. The chain carries a positive charge, associated largely with the nitrogen atom. A negatively charged perchlorate "counterion," made up of four oxygen atoms and a chlorine atom, sits nearby, weakly connected to the chain. The substance itself is a fine black powder physically resembling graphite.



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Birge and his group found that the perchlorate counterion prefers to sit in one of two locations near the chain (see diagrams). A single photon easily dislodges the counterion from one location and forces it into the other. A short time later, the molecule relaxes, and the counterion returns to its original position. These results were reported earlier this year in the JOURNAL OF THE AMERICAN CHEMICAL SOCIETY (Vol.109, No.7).

What Birge noticed was that the energy required to shift the counterion in a Schiff base salt of the right structure is very small. Even radio waves of the right frequency would do the job. Thus, a coating containing a Schiff base salt could absorb radio waves, then dissipate the energy as heat. A mixture of carefully engineered Schiff base salts, each sensitive to a particular radio frequency, would provide a coating that responds to a wide range of radar signals.

The possibility of combining sensitivity to a wide range of radar signals with relatively low weight suggests an attractive alternative to methods now used to reduce a military aircraft's radar signature. Last week, the Department of Defense classified research on the application of Schiff base salts to radar-absorbing coatings. Future research will be conducted in secret. One of the problems that must be solved is the difficulty in dissolving these salts in materials such as polyurethane plastic, which are usually applied to aircraft surfaces.

Ironically, the Carnegie-Mellon research showed that ATRSBS is not a correct or realistic model for what goes on in rhodopsin, says Lionel P. Murray, now at the National Institute of Diabetes and Digestive and Kidney Diseases in Bethesda, Md. Nevertheless, he says, related research has clarified how the chemical signal responsible for vision gets started, although a few issues concerning the details of the process remain to be settled.