Environment

Need 'greener' solvents? Go to PARIS

From paints and degreasers to pesticides and drugs, "it's hard to look anywhere and not see where a solvent has been used," observes Heriberto Cabezas.

Yet many solvents have taken heat lately for hurting the environment. Some may foster global warming, ozone depletion, or smog formation. Toxic solvents can pose a direct health risk during use or a delayed one as they collect in soil and water. Faced with regulations that would restrict the continued use of these materials, many manufacturers and users are desperately seeking alternatives.

Cabezas and his team at the Environmental Protection Agency's National Risk Management Research Laboratory in Cincinnati are trying to help. Over the past 2 years, they've worked with engineers at Research Triangle Institute (RTI) in Research Triangle Park, N.C., to develop PARIS—the Program for Assisting in the Replacement of Industrial Solvents. If they can find a software company to market it, Cabezas says, PARIS could be commercially available by year's end.

The program "allows you to custom-design solvents," he says. A manufacturer might want to scrap the entire solvent or just alter one ingredient or property. "Though our interest has been to help people find solvents that are more environmentally benign," Cabezas says, the program that's emerged "may find solvents that actually work better."

Given the composition of a solvent, the Windows-based software estimates the agent's physical properties. The user then specifies which features to preserve or change. PARIS compares these needs with the properties of some 1,600 industrial chemicals in its database and ranks alternative compounds or designs novel mixes from them.

Until now, finding an alternative solvent has been a matter of trial and error in the lab—and has taken months or years, points out Subba R. Nishtala of RTI. If PARIS performs as expected, however, it "could accurately narrow the choices down to two or three solvents in less than an hour," he says. —*J.R.*

Superfund sites and birth defects

A new audit finds that the Superfund program, which has rehabilitated only about 100 of the more than 1,400 hazardous waste sites on its list, has become seriously bogged down.

The evaluation of each nonfederal site that was added to the Superfund list last year took an average of 9.4 years, according to a new report by the U.S. General Accounting Office, an investigatory arm of Congress. That figure greatly exceeds the 5.8-year average during the late 1980s—and it is more than double the period allowed under federal law. Admitting federally owned sites to the cleanup list in recent years has been only slightly quicker, 8.3 years.

Cleanup of sites once they've made the list has been running at about 10 years for nonfederal sites and 6.6 years for federal ones—again, well beyond the 3.9 years typical of the late 1980s and EPA's own "expected" timetable of 5 years.

This sluggish pace takes on added seriousness in light of a new study finding that women living within a quarter mile of untreated Superfund sites face an increased risk of having babies with serious birth defects. Lisa Croen and her coworkers at the State of California Birth Defects Monitoring Program in Oakland detected the disturbing trend while analyzing data on more than 2,000 live births.

In the July EPIDEMIOLOGY, they report that the small number of women, less than 1 percent of those studied, living close to Superfund sites had eight babies with neural tube defects (twice the expected number) and three babies with serious heart defects (four times the expectation). No increased risk was seen in families living more than a quarter mile away, nor were the elevated risks associated with any particular pollutant. —*J.R.*

Physics

Diffusing to forget

People aren't the only entities that can take advantage of short-term memory to forgive and forget. Researchers have discovered a simple mathematical model of a physical system that "remembers" a sequence of impulses. Those memories gradually fade, however, and the system eventually "forgets" nearly all of them. Physicist Susan N. Coppersmith of the University of Chicago and her collaborators describe this remarkable model in the May 26 PHYSICAL REVIEW LETTERS.

The model represents a type of diffusion in which particles can move only in discrete steps. It can be imagined as an array of balls connected by springs on a corrugated surface that resembles a washboard, all immersed in a thick fluid. Tilting the surface repeatedly causes the array of balls to slide across the channels. At the end of each tilt, the location of each ball relative to the peaks and troughs of the washboard reflects the effects of previous tilts. As the number of balls increases, memory is retained through a larger number of tilts. Adding noise (random vibrations) to the system also appears to keep the transient memories from decaying, by counteracting the role that diffusion itself plays in erasing the memories.

"Now that we understand the mechanism much better, we believe [this phenomenon] should be ubiquitous," Coppersmith says. "The tricky thing is the experimental signature. How would you know if this is happening? What do you measure?"

Researchers have already observed both learning and forgetting when applying a train of repeated voltage pulses to a solid, which responds in such a way that an electric current passing through the material at a later time displays features that correspond to the original pulse train. John P. McCarten and his coworkers at Clemson (S.C.) University have found that they can "train" a sample of niobium triselenide to synchronize with four-pulse sequences, which means that the system can remember more than one thing at a time. —*I.P.*

Plasma sparks from a hot gas bubble

When intense, high-frequency sound waves bombard a gas bubble in water, they can induce the bubble to generate brief, brilliant flashes of visible and ultraviolet light. Known as sonoluminescence, this conversion of sound into light occurs during the rapid, violent contraction of a bubble as it oscillates in step with the sound wave (SN: 10/5/96, p. 214). Now, William C. Moss and his colleagues at the Lawrence Livermore (Calif.) National Laboratory have applied techniques from nuclear fusion research to model the behavior of the gas inside a luminescing bubble. The researchers report their findings in the May 30 SCIENCE.

The team assumed that a collapsing bubble generates an intense shock wave, which compresses and heats the gas to create a partially ionized, light-emitting plasma of ions and electrons. Computer simulations of the behavior of such a plasma reveal that accelerated electrons produce the flash, and rapid changes in the plasma's transparency limit its duration. Moreover, both the duration and the spectra of flashes are very sensitive to the maximum bubble radius, which could explain the puzzling variability of experimental results. The team's calculations also show that only the argon component of the gas is involved in the process.

"Although it remains to be confirmed experimentally that shock waves or plasmas are present in a bubble undergoing [sonoluminescence], no other model of which we are aware has been able to explain such a broad array of experimental data," Moss and his coworkers conclude.

The results also suggest that finding a way to increase the maximum bubble radius significantly might lead to thermonuclear fusion inside an oscillating bubble, say Lawrence A. Crum and Thomas J. Matula of the University of Washington in Seattle. —*I.P.*