Air pollution: No place like a mobile home

A mobile home may feel cozy, but its tight construction seals in air pollutants better than most conventional homes. Adding to the problem, the pressed wood products typically used in mobile homes give off noxious formaldehyde gas. Many mobile home residents have complained of "sick building syndrome." Now researchers suggest that even those who don't complain may experience health effects – and at lower levels of formaldehyde than previously documented.

Scientists at California's Indoor Air Quality Program in Berkeley monitored formaldehyde levels for two one-week periods in more than 500 mobile homes and collected health information from more than 1,000 uncomplaining occupants. The study found a strong statistical association linking eye, skin and upper-respiratory irritation with exposures to formaldehyde just below the 0.1 parts per million (ppm) level that the Environmental Protection Agency (EPA) has considered a threshold for irritation.

"This is the first study to show irritating effects at such a low level," says Kai-Shen Liu, who led the study.

The research team measured from 0.01 ppm to 0.46 ppm formaldehyde in the homes' air, then calculated weekly exposures. Though mobile-home residents averaged 9.9 ppm-hour (the concentration times the number of hours exposed in a week), some homebodies inhaled more than twice the weekly 20 ppm-hour federal worker-exposure standard.

Burning eyes proved the best indicator of irritation, and its incidence rose linearly with increasing low-formaldehyde concentrations, Liu's team reports in the just released August ENVIRONMENTAL HEALTH PERSPECTIVES. Overall, persons with chronic respiratory and allergy problems experienced a higher rate of symptoms, suggesting that formaldehyde exacerbates existing respiratory conditions, the researchers say.

A variety of chemicals can pollute indoor air (SN: 9/28/85, p.198). Although the State of California scientists can't prove what caused the irritation, "I'm pretty sure it's formaldehyde," says Liu. "No other chemical we know of is so uniformly found in mobile homes."

This study could widely influence safety standards for formaldehyde exposure, according to James A. Frazier of the National Academy of Sciences in Washington, D.C. In fact, EPA has already cited it in a June report that summarizes recent research and attempts to reassess formaldehyde health risks.

Irritation alone can lead to disease, Frazier notes. Formaldehyde impairs the upper-respiratory tract's mucous-based defense system, which protects against foreign particles and bacteria. "By definition, irritation is an inflammation process," Frazier says. "Anytime you inflame, you're susceptible to an invasion of bacteria, and to other chemicals." He adds that formaldehyde is also a suspected carcinogen and that no one knows at what level it might induce cancer.

Liu says that with 10,000 mobile homes sold annually in California alone, many people nationwide may suffer formaldehyde irritation. Joseph A. Cotruvo, who directs EPA's health and evaluation division, however, downplays the study's significance: "We're talking small percentages of people and mild effects."

Formaldehyde isn't all that threatens air quality in mobile homes. Another study reports that particulates and carbon monoxide emitted by kerosene space heaters exceeded EPA's outdoor air standards in four of the eight mobile homes surveyed. Moreover, heaters in five homes spewed mutagenic organic compounds. Judy L. Mumford of EPA in Research Triangle Park, N.C., and her team report their findings in the October ENVIRONMENTAL SCIENCE & TECHNOLOGY.

EPA has yet to set any safety standards for indoor air quality. Cotruvo told SCIENCE NEWS the agency has plenty of scientific data showing indoor pollution requires action, but it needs new legislation to better define the roles EPA and other agencies should take. *– K. Schmidt*

Laser spotlight pinpoints atoms in motion

Physicists who like to push atoms around may soon be able to tell exactly where those atoms went.

Adapting principles from magnetic resonance imaging, Kevin D. Stokes and his colleagues at Duke University in Durham, N.C., developed an optical method for determining the precise position of atoms moving in a beam. It provides greater resolution than any other approach, the researchers report.

Earlier this year, other researchers announced the development of atomic-interferometry techniques for deflecting beams of atoms ever so slightly (SN: 9/7/91, p.158). Although scientists can pinpoint the location of unmoving atoms, such as those in a solid surface, tracking the locations of moving atoms in a deflected beam has proven much more difficult and required the use of mechanical grids or slits. Such techniques "are relatively crude," says John E. Thomas, who heads the Duke group.

Over the past few years, he theorized a better way to locate moving atoms. First he'd overlay a series of parallel lines onto the area to be searched, with each line corresponding to a discrete energy level in a magnetic field. Then he would "mark" atoms that crossed a specific spot while traveling along one of these lines, and tally them up.

In the Oct. 7 PHYSICAL REVIEW LETTERS, his team describes an experiment that puts those ideas into practice. It pinpointed atoms 1.7 micrometers apart – and holds open the prospect of one day resolving the location of atoms to within 7 nanometers.

This "is a widely applicable technique," asserts Harold J. Metcalf, a physicist at the State University of New York at Stony Brook. "It's capable of measuring atoms to a very high precision."

The Duke team establishes rows of energy lines by using two magnets to create a magnetic field whose strength varies. An energy gradient develops between the magnets, with the strongest at the top and the weakest at the bottom; all the lines run parallel to the magnets. Explains Thomas: the steeper the gradient, the more lines that get squeezed into a given space and the greater the technique's resolution. The researchers added two lasers to the setup, one atop the other, such that their light would cross the magnetic gradient.

When the scientists direct a beam of atoms through this gradient, the atoms – depending on where they are dispersed along the width of the beam – wind up traveling along different energy lines. An atom's position along the magnetic gradient – that is, which energy line that atom follows – determines the frequency at which it vibrates, Thomas notes.

The two paired lasers act as a spotlight to illuminate an atom passing through one particular point. The scientists direct this "spotlight" by tuning the lasers to slightly different frequencies so that the difference between the two frequencies matches the frequency of atoms traveling along just one line of energy, says Thomas. When an atom passes through the spot where that energy line and the lasers intersect, the atom resonates and changes its energy level slightly. This "marked" atom then travels downstream and passes through a third laser. This laser excites any atoms with altered energy levels. A detector registers the presence of these excited atoms.

Because the scientists knew precisely where in space they were looking, they can now know the exact location of any atom they saw there, says Thomas.

Metcalf predicts this method will not only improve the quality of experiments involving atomic beams, atomic fountains (SN: 8/19/89, p.117) and laser cooling (SN: 8/12/89, p.103) but also will help make possible the development of extremely precise atomic clocks and atomic gyroscopes. Indeed, he says about his current research with laser cooling, "What we do now is quite crude relative to John Thomas' technique." *– E. Pennisi*