Health effects of smog: Worse than thought

Tests used by the Environmental Protection Agency (EPA) to set standards for ambient ozone levels don't measure up, a new study indicates.

Biopsies of tissue from bronchial tubes show that exercising in ozone-laden air can cause moderate inflammation of these airways, even in healthy individuals, a California-based study finds. However, the primary criteria and tests used in setting federal ozone standards failed to identify this damage in at least seven of 12 affected volunteers, notes study leader Robert M. Aris, a pulmonary specialist now at the University of North Carolina School of Medicine at Chapel Hill.

According to Judy Graham, associate director of EPA's environmental criteria and assessment office in Research Triangle Park, N.C., EPA based its National Ambient Air Quality Standard (NAAQS) for ozone primarily on two criteria: symptoms in exposed people, such as difficulty breathing, and how much air exposed people can exhale in 1 second. The latter is measured by a Forced Expiratory Volume-One (FEV_1) test.

However, FEV_1 "is not a reliable indicator of ozone-caused toxicity" and does not predict ozone-induced inflammatory changes, Aris says. Moreover, people can have ozone-induced inflammation yet show no external symptoms, he adds. Indeed, EPA may "need to reassess the NAAQS for ozone," he and his colleagues write in the November AMERICAN REVIEW OF RESPIRATORY DISEASE.

The agency based its current ozone standard on studies published before 1990. However, Graham says EPA is reviewing thousands of studies published since 1986 to see if the existing ozone standard needs revising. This review will include "more [long-term] animal studies and more literature on inflammation in humans and more multihour exposures" than earlier ones did, she adds. EPA expects to release a report on its findings for public comment early next year.

A federal Clean Air Scientific Advisory Committee concluded that studies published up to early 1989 "did not provide a sufficient basis for revising the standard," EPA reported in March.

While other studies have found that high concentrations of ozone in the air cause inflammation deep within the lung, Aris and his colleagues say they are the first to find inflammation in human bronchial tubes, where asthma and chronic bronchitis do their damage.

The authors are concerned about the increasing number of people who suffer from these ailments — particularly those living in cities such as Los Angeles, where ozone often exceeds allowable limits. Hospital admissions for asthma correlate with ozone concentrations, and both asthma deaths and air pollution are increasing, Aris and his colleagues note.

In their study, 18 healthy, athletic men and women age 20 to 40 exercised periodically for four hours in either clean air or air containing 0.20 part per million (ppm) of ozone. Many cities call a smog alert when ozone concentrations reach this level, Aris says. The federal ozone standard is 0.12 ppm.

Eighteen hours after exercise, each volunteer's left bronchial tube was rinsed out with a saline solution. The researchers examined the solution for indications of inflammation, such as excessive amounts of proteins or enzymes. They also biopsied the surface tissue of the bronchial tubes.

This study "suggests rather severe inflammation" occurs at fairly common concentrations of ozone, says Bart Ostro, chief of air pollution epidemiology at the California EPA.

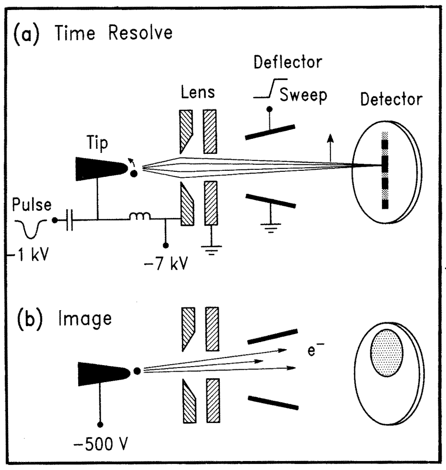
And while he observes that the 0.20 ppm exposure is high, "it is experienced in many metropolitan areas. Los Angeles has 30 to 40 days a year above that."

Epidemiological studies have documented increasing incidences of diseases, such as asthma, believed to be related to ozone. But, Ostro says, this study proved particularly useful in pinpointing where ozone does its dirty work in human airways. — *T. Adler*

Good vibes: Seeing a single molecule move

The quest to see a single molecule has long taunted physicists. How does one hold a barely detectable speck, bombard it with electrons, photons, or X-rays, and observe how it moves without disturbing, destroying, or sweeping the sample away?

But researchers now tell of a new technique for watching a single molecule move. Gary M. McClelland, Fumiya Watanabe, and Harry Heinzelmann, all physicists at IBM's Almaden Research Center in San Jose, Calif., report directly observing the vibrations of a single molecule — copper phthalocyanine — perched on a tungsten tip. Their report appears in the Nov. 19 SCIENCE.



McClelland/PHYSICAL REVIEW LETTERS

Femtosecond field emission camera: (A) A molecule placed on a tungsten tip and subjected to a pulsed electric field emits electrons, which are focused and swept across a detector screen. (B) A video detector then receives and records the emitted electrons, showing their point of origin on the tungsten tip.

In essence, the group has invented a new kind of instrument, called a femtosecond field emission camera, which combines the features of a video camera and an oscilloscope. "It operates much like a streak camera. We sweep a tightly focused beam of electrons from a tip across a detection screen. The tip itself [on which the molecule sits] is a single crystal that comes to an apex of just three atoms," McClelland says. "We observe the molecule's motion by recording the changes in the field emission intensity."

This new system provides the first "direct and continuous, high-resolution, real-time look at the motions of individual atoms and small molecules," McClelland says.

"We've actually recorded the vibration of a molecule as it oscillates back and forth at a particular site," he says. "It's the first time a record has been made with a single molecule in real time."

The physicists chose to observe a copper phthalocyanine molecule because it is relatively large, rigid, and stable — "something that would vibrate slowly, with a large amplitude," McClelland adds.

After sharpening a tungsten tip and cooling it to 80 kelvins, the researchers deposited a single copper phthalocyanine molecule on the tip's end. They then subjected the tip to roughly 20 sweeps of a pulsed electric field until "the molecule decomposed or diffused off the end of the tip," says McClelland. The team used a video camera to make single-frame recordings of the electrons emitted from each sweep — producing a sort of electronic snapshot.

In the end, they analyzed 270 such sweeps, comparing them to 100 sweeps of a clean tungsten tip, from which they recorded no large "peaks," or signals.

The ability to watch events taking place in single atoms and molecules while they are going on opens up "entirely new possibilities in molecular dynamics," the physicists state, adding that the technique allows them to observe spontaneous processes that cannot otherwise be seen.

"We think this is about as close as possible to directly viewing molecular motion," concludes McClelland. — *R. Lipkin*