When smog turns into airborne sulfuric acid

Synergisms between pollutants have not received nearly enough attention by researchers. It is sometimes difficult in the laboratory to study the chemical, biological or physical activity of a single pollutant, such as sulfur dioxide. Add heavy metals or photochemical smog or one of a hundred other pollutants that might co-exist with SO_2, and a real can of worms is opened. The researchers are not to be blamed; the money, time and trained personnel are not yet available for the detailed work needed.

Scientists have long been interested in the conversion of atmospheric SO_2 to SO_3 and thence to sulfuric acid, for instance. But estimates of the rate of conversion have ranged from 0.1 percent to 10 percent an hour. Obviously, the rate depends to some degree upon other pollutants that might intermediate in the oxidation of SO_2. Photochemical smog or certain components of smog are among the prime suspects for speeding up the reaction. Now three British scientists report in the Feb. 18 NATURE that under certain conditions, the smog-caused rate of oxidation—at moderate levels of smog—may be 10 percent.

The British scientists are D. H. F. Atkins, R. A. Cox and A. E. J. Eggleton of the Atomic Energy Research Establishment in Harwell, Berkshire. They report that ". . . Oxidation of the sulfur dioxide to sulfuric acid occurs at a significant rate even with concentrations of hydrocarbons and oxides of nitrogen [the major components of smog] typical of the levels (about 0.1 parts per million) occurring only in moderately polluted atmospheres." Their field studies of atmospheric reactions near Harwell confirm earlier laboratory results, they say.

The public health implications of the work are fairly obvious; sulfur dioxide alone causes respiratory irritation and damage at high enough concentrations, but sulfuric acid is far more corrosive to both plant and animal tissue.

That the basic reaction probably occurs is an old story to Los Angeles smog researchers, including Arie Jan Haagen-Smit of California Institute of Technology, known as the pioneer in the study of the chemistry of smog. But in Los Angeles, there is little high-sulfur fuel burned; according to Haagen-Smit, there is thus no serious public health problem there from sulfuric acid. The acid is fairly rapidly neutralized to calcium or ammonium sulfate. (Haagen-Smit says the sulfate may be a minor component of the Los Angeles haze.)

The major significance of the work reported in NATURE may be in Eastern and Midwestern industrial cities where high-sulfur fuels are burned and where, recent work has shown, smog levels are considerably higher than earlier measured. The higher measurements may be due either to actual higher smog levels or to earlier inaccuracies in measurement. Whichever is the case, the higher smog levels measured in the industrial cities, combined with the evidence that smog intermediates in sulfuric acid formation, reveal a public health problem which existed all along, or, alternatively, one which is growing worse. The problem could not be revealed empirically before, says a scientist at the Environmental Protection Agency, because only gross sulfur oxides, and not sulfuric acid, could be effectively measured. The sensitivity of the question and the bearing it will have on EPA's ambient air standards is reflected in the fact that the scientist declined to be identified.

The British researchers attribute the SO_2 oxidation they observed to ozone, a major product of smog, which they detected in significant amounts and which correlated with amounts of sulfuric acid measured. The EPA scientist believes, however, that other components of smog, as well, may intermediate in the reaction. And Haagen-Smit points out that heavy metals associated with some fuel-burning, such as vanadium and manganese, probably catalyze the reaction. On the other hand, says the EPA researcher, some hydrocarbons may slow it down. It is clear a great deal more research needs doing.

Using flame photometrics and gas chromatography, EPA is now measuring SO_2 levels with high sensitivity and specificity, however. The agency plans detailed testing of air in St. Louis—a city where EPA believes the SO_2-smog synergism is operating. But the EPA scientist notes that instruments still do not exist for the needed sensitive measurements of sulfuric acid. □

Alkali metal battery

The liabilities of batteries—their high weight or high operating temperatures—have hampered the feasibility of electric automobiles. Lockheed Missiles and Spacecraft Co. announced that it has developed a light-weight, low-operating-temperature battery that operates on water plus an alkali metal such as lithium or sodium. The normal violent reaction between water and alkali metals is controlled, says Lockheed, to produce electricity 100 times more efficiently than in lead-acid batteries, weight to weight. Both static and "dynamic" batteries can be made. The latter converts the electrochemical activity directly into mechanical output. □