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Effects of SO₂ and NO_x Emissions

Concern about acid rain continues to mount, ensuring efforts to enact legislation designed to curtail it when Congress meets again. Earlier, impetus for abatement centered around acidification of some lakes and around Canadian protests about transboundary flow of some of our emissions. Lately, attention has been drawn to possible effects of pollutants on forests. Pathology has been noted recently in trees at higher elevations along the mountains from the Northeast to Georgia.

The extent of the problem in the United States is minimal in comparison to that in West Germany. In just a few years observed occurrences of pathology in the forests there have increased from a few percent to more than 50 percent. The news from West Germany is alarming, and its impact is fueling a demand for action here.

One proposal is that SO₂ emissions should be cut in half. The Electric Power Research Institute has estimated that the cost of such a program would be \$10 billion a year for many years. In this country, the contribution of SO₂ to the formation of hydrogen ions is about two times that of the nitrogen oxides. If the target of an effort is solely to diminish the acidity of rain, reduction of SO₂ emissions is a logical objective. However, if the goal is to avoid possible pathological effects on forests, the focus of abatement efforts probably should be NO_x. The nitrogen oxides do much more than give rise to nitric acid. They are involved in photochemical reactions that lead to oxidants such as ozone that are highly toxic to plants and trees. Some of these effects have been noted for many years in the vegetation of southern California. In that area, there are negligible amounts of sulfur oxides but substantial quantities of NO_x and photochemical oxidants. Damage from ozone to trees such as ponderosa pine has been extensive and can be seen in trees as far as 120 kilometers east of the urban centers. Studies have shown that chronic exposure to 6 parts per hundred million (pphm) of ozone results in visible damage to some conifers.

Pollution control in West Germany has lagged behind that in the United States. The Germans have no speed limit on their autobahns, and the vehicles do not have catalytic devices to minimize NO_x emissions. Vehicles are by far the greatest source of NO_x, and the total tonnage of NO₂ emitted by all sources is greater than that of SO₂. Measurement of ozone concentration in the Black Forest has yielded a value of about 9 pphm and a peak value as high as 27 pphm. Explanations advanced by German scientists for the pathology noted in their forests include effects of acid on foliage and roots, heavy metals, aluminum toxicity, insects, and diseases. The truth probably lies in a combination of all these, together with photochemical oxidants.

There are many gaps in our knowledge about pollutants. A major one is the relative effects of wet and dry deposition. The amounts of wet deposition are well known. They account, however, for only 20 to 30 percent of total emissions. What happens to the remainder is a mystery.

Another important unknown is the rate at which lakes are being acidified. Little evidence exists that many lakes are undergoing substantial change now. The Environmental Protection Agency is conducting measurements on 2000 lakes to establish a database. The magnitude (large or small) of the acidification problem should be evident in a few years.

Another unknown is the relation of sources to deposition. Many people believe that burning of coal in the Midwest is the source of acidification of lakes in the East. However, local sources are apparently also important contributors to acidification.

These are only a few examples of the lack of knowledge about the effects of pollutants. A determined effort is now being made in the United States and West Germany to better understand the phenomena and to learn how to cope with them. West Germany apparently needs to take quick action, but in the United States there is time to seek knowledge before committing to enormous expenditures that might prove misdirected.—PHILIP H. ABELSON