

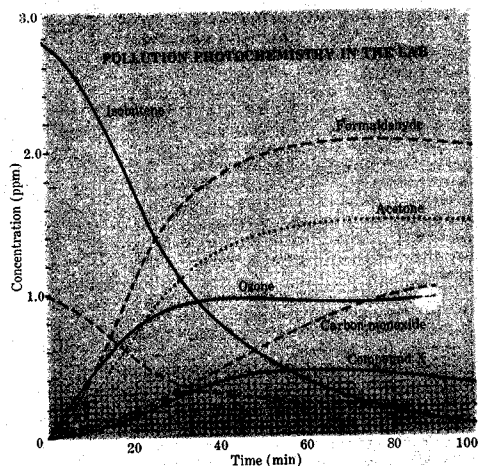


Fig. 10. Stanford Research irradiation chamber study of a few years back illustrates diversity and varying concentrations of substances produced, starting with isobutene and nitrogen dioxide. Compound X has since been tentatively identified by most workers as peroxyacetyl nitrate.

ppm; this limit is for 5-day-a-week, 8-hr-a-day exposures of healthy adult workers. A value of twice this amount or 10 ppm observed in a single measurement in ambient air in Los Angeles would result in a so-called "third alert" in which all-out community protection measures would be authorized. Most of the time the LA concentration of NO and NO₂—which are usually measured together since there appears to be no control purpose to be served in distinguishing between them in view of the rapid conversion of NO into NO₂—stays below about 1 ppm. One thing that may help keep NO and NO₂ well below more potentially dangerous levels most of the time is that during the daylight hours, they are continually used up in maintaining the series of equilibrium reactions with ultraviolet light and hydrocarbons. But some knowledgeable scientists, such as Philip Leighton of Stanford University and Albert Bush of UCLA, have warned that reducing hydrocarbons alone—especially to drastically low levels such as 100 ppm or less—may in fact raise the total of nitrogen oxides in the air over the long term, eventually perhaps to more dangerous levels. Hamming and most others discount this possibility, however.

Such fundamental uncertainties as these must have been what Dr. P. J. Lawther (then

of the British Medical Research Council Group on air pollution) had in mind, several years ago, when he said regarding British urban air pollution: "We have no more right to expect an easy solution than to overlook a simple answer. The field is bedevilled by paradox, not the least striking of which is the persistence with which we apply exquisitely fine techniques to crude problems and at the same time expect delicate mechanisms to yield to the hammer blows of our clumsier methods."

The British are plagued by pollution problems characterized more by SO₂ and its involved atmospheric permutations to SO₃ and sulfuric acid than by the automotive kind of smog. But this is changing, of course, as autos and traffic congestion increase, just as the SO₂-complex never was exclusively a British problem.

Sulfur dioxide in the air comes mostly from combustion of sulfur-containing fuels—coal and low-grade or residual fuel oils are the chief offenders. Natural gas and light petroleum fractions like kerosenes and gasolines are relatively low in sulfur or can be made so with little difficulty. Some SO₂ also comes from the smelting of sulfide ores. The ash constituents invariably present in the air help to catalytically oxidize SO₂ to SO₃, and hydration of SO₃ yields the sulfuric acid which is responsible for the blue color typical of SO₂-laden exhaust plumes.

The more difficult and critical transformation of SO₂ to SO₃ is probably accomplished photochemically by near ultraviolet radiation; this mechanism may be most effective in the presence of particles of manganese and iron salts or oxides, under the moisture-rich conditions available in most stack gases and during humid weather conditions more generally. No doubt the strongly oxidizing atmosphere created in typical photochemical (Los Angeles) smog also contributes significantly to this otherwise slow oxidation step. Both kinds of smog are invariably present to greater or lesser degree in urban atmospheres and their deleterious effects, as to some extent their photochemical histories, are intricately entangled, but distinguishable.

The U.S. Clean Air Act specifically recognized the sulfur problem too, and it directed Health, Education and Welfare to conduct a major R&D effort aimed at developing cheaper and better techniques for removing sulfur from the offending fuels. Much additional work is being done on an alternative potential solution—removing the sulfur compounds from exhaust gases before emitting them to the atmosphere. Several lines of development look promising here. Some involve adsorption of SO₂ on activated carbon char or reacting it with alkaliized alumina. Others approach the problem as the atmosphere itself does, by catalytically oxidizing the SO₂ to SO₃ and con-