into the atmosphere during the etching of metal with aqua regia and from combustion of fuel, especially in internal combustion engines. Oxides of nitrogen are of concern to the investigators in Los Angeles, as they are a component of the total oxidants found in that area. They may be of concern also in areas such as bus terminals, and in areas adjacent to those industrial plants where excessive amounts of nitrous fumes are emitted.

The West Virginia health department found a maximum concentration of 0.92 p.p.m. nitrogen oxide in Charleston, with the highest average at any one station of 0.20 p.p.m., and averages from the other five fixed sampling stations ranging to a low of 0.09 p.p.m.[26] In Los Angeles, investigators found the concentration of nitrogen dioxide on a clear day averaged 0.08 p.p.m. and on days of intense smog it increased to an average of 0.4 p.p.m.

A study of available data reveals that *ozone* is apparently a significant atmospheric pollution problem prevailing in the Los Angeles area, where chemical analysis of the air during smog periods reveals that the most characteristic property of the atmosphere is its oxidizing capacity. Haagen-Smit[27] states that ozone formation and peroxide formation are phenomena closely related to the eye irritation and crop damage in the Los Angeles area.

Ozone, because of its powerful oxidizing action, disintegrates rubber, corrodes, metals, and damages crops. There is voluminous literature on the toxicity of ozone to humans. Stokinger has given an excellent review of the literature on the subject, and shows the conflicting information to date.[28] The effects of ozone or total oxidants, and other pollutants on health are very well reported in the Los Angeles area. Ozone has been blamed for the eye irritation and/or causing skin irritation.

The economic loss due to ozone is probably best exemplified by the damage it does to rubber. In fact, rubber is so sensitive to ozone that the concentration of ozone has been determined by the rubber cracking test.[29]

Ozone and total oxidants are present in most communities in concentrations of approximately 0.01 p.p.m. In Los Angeles, however, the concentration of total oxidants (ozone, peroxides, and nitrogen oxides) reaches levels of 0.08 p.p.m. during periods of severe smog. An odor of smog begins to occur at 0.13 p.p.m. and eye irritation is recorded at 0.25 p.p.m., according to Haagen-Smit. Smith[30] reports that the normal concentration of ozone in the Detroit area is less than 0.01 p.p.m. On several occasions, during periods of smog, concentrations exceeding as 0.2 p.p.m. have been recorded there.

[26] *Atmospheric Pollution in the Great Kanawha River Valley Industrial Area, 1950–1960*. *Aug. 1961*. Bureau of Industrial Hygiene, West Virginia Dept. of Health.

[27] A. J. Haagen-Smit, Formation of ozone in Los Angeles smog, *Proc. Nat'l. Air Pollution Symposium, 2nd Symposium, Pasadena, Calif., 1952*.

[28] H. E. Stokinger, *Ozone Toxicity—A Review of Literature through 1953*. Div. of Occupational Health, U. S. Public Health Service, Cincinnati, Ohio, November, 1953.

[29] A. J. Haagen-Smit, Smog research pays off, *Eng. and Sci.*, **15** (May, 1952).

[30] R. Smith, personal communication.

Carbon monoxide is one of the most prevalent atmospheric pollutants. Although automobile-exhaust gas is considered the primary source of carbon monoxide in city streets, there are many industrial and residential sources of this contaminant. Bloomfield's study [31] of 14 cities in 1927 found an average carbon monoxide value of 80 p.p.m. The Bureau of Sanitary Engineering of the Department of Health, City of Chicago, in 1926 found carbon monoxide as high as 236 p.p.m. in that city. Cholak,[32] in 1952, showed an average carbon monoxide concentration in Baltimore of over 10 p.p.m.; in Cincinnati commercial and industrial areas, 9.5 p.p.m., residential areas, 4.0 p.p.m.; and in Donora, Pennsylvania, 5.0 p.p.m. Castrop, Stephens, and Patty [33] found in 380 tests in Detroit a maximum of 80 p.p.m. at the 5-foot level, with a mean of 28.9 p.p.m. in heavy traffic, 12.3 in medium, and 6.9 in light traffic. A similar number of tests in Los Angeles revealed a maximum of 160 p.p.m. with means of 58, 27.5, and 11.8 in heavy, medium, and light traffic. The mean for all tests on smog-free days was 6.7 and for tests during smog, 39.4 p.p.m.

Particle fall in large cities is very much higher than in the surrounding country. The monthly average deposit of from 31.7 to 54.2 tons per square mile, has been reported [34] whereas in the surrounding country the particle fall is 11.2 tons per square mile. In Detroit the monthly mean particle fall ranged from 10.5 tons per square mile in August to 82.7 in April.

Table 5 presents data tabulated by the California State Health Department[5] showing the highest values obtained for various contaminants in some California cities.

The United States Public Health Service has been periodically sampling the atmosphere for particulate matter in certain American cities. Tables 6, 7, and 8 present a summary of their findings to date.

Careful review of the available data reveals that little information is actually available on the pollutants in urban atmospheres, and virtually nothing is known of the physical or chemical state in which the pollutants exist in the air. Until these data become known, the progress on determining the effects air pollutants have upon a community will be slow.

V. Control Procedures

There are many methods for keeping the discharge of air pollutants to a level that is unobjectionable to the community. These are: (*1*) air-cleaning devices, (*2*) dilution, (*3*) substitution, and (*4*) zoning.

[31] J. J. Bloomfield and H. S. Isbell, The problem of automobile exhaust gas in streets and garages of large cities, *U. S. Pub. Health Repts., Reprint* No. **1217**, March 30, 1928.

[32] T. Cholak, The nature of atmospheric pollution in a number of industrial communities, *Nat'l. Air Pollution Symposium, 2nd Symposium, Pasadena, Calif., 1952*.

[33] W. L. Castrop, J. F. Stephens, and F. A. Patty, A comparison of carbon monoxide concentrations in Detroit and Los Angeles, *Am. Ind. Hyg. Assoc. Quart.*, **16**, 225 (1955).

[34] A. Allcut, *Eng. J. (Can.)*, **30**, 154, 164 (1947).