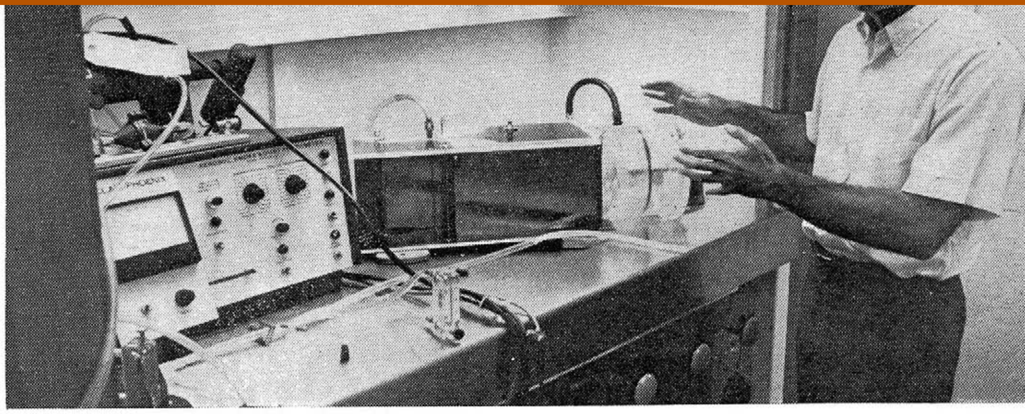
Scientists want to find out more about the nature of particulate matter



AEROSOLS. Dr. S. K. Friedlander is studying the nature of aerosols in smog

Smog aerosol study begins at Caltech

Members of President Nixon's Environmental Quality Council arrived in southern California last week to take a firsthand look at smog and to explore ways of effectively controlling it. They have come to the right place at the right time since this is the height of the smog season in California. Just the other week, a group of Los Angeles County citizens filed a multibillion-dollar lawsuit, naming as defendants all the polluters of the Los Angeles atmosphere. On the same day that preliminary hearings were under way (the case was turned down on legal grounds), a smog alert was being flashed out in neighboring San Gabriel Valley where the ozone concentration in the air had soared to 0.62 p.p.m.

Quite a bit is known about the gaseous components of smog, but comparatively little is known about the kinds and numbers of very small particles in it. A team of scientists is now working in an instrument-crammed room in the basement of California Institute of Technology's W. M. Keck Laboratory of Environmental Health and Engineering to learn more precisely the nature of the aerosols in the urban air (C&EN, Aug. 25, page 31).

The program was spearheaded by Dr. Kenneth T. Whitby, professor of mechanical engineering and director of the Particle Technology Laboratory at the University of Minnesota, Minneapolis. He is responsible for coordinating the work and reducing the analytical data. Heart of the project is the measurement of aerosol particles in the size range of five microns to 0.1 micron, using a GE nuclei counter, a Whitby aerosol analyzer, and a Royco optical counter. It is particles in this size range that are believed to be the most important as reactive centers and as carriers of toxic substances, Dr. Whitby notes.

The program under way is unusual on a number of counts, comments Dr. Sheldon K. Friedlander, professor of chemical engineering at Caltech. It will provide the first detailed analysis of smog aerosols. Moreover, he notes, it is the first time that experts from around the country are combining their efforts in a unified approach to the study. Whereas individual workers have been applying their own tests to air in different parts of the country for some time now, he points out, the current study may well mark the next level of approach to atmospheric research in the future.

Joining in the project are Dr. Robert J. Charlson, professor of atmospheric physics and chemistry at the University of Washington, Seattle; Dale A. Lundgren of the Air Pollution Research Center at the University of California, Riverside; Dr. Friedlander; Dr. Peter K. Mueller, chief of California's Air and Industrial Hygiene Laboratory, Berkeley; Dr. Kenneth E. Noll, who works with the California Air Resources Board; and University of Minnesota's Dr. Whitby and Dr. Benjamin Liu. Each of these principal investigators has set up a clutch of sophisticated instruments at Caltech. There, they are analyzing air sucked down through a pipe that extends 22 feet above the roof of the Keck Laboratory building. Funding for the work comes from a number of sources including the National Air Pollution Control Administration of the U.S. Public Health Service, the California State Department of Health, and the California Air Resources Board.

Gaps. There are still great gaps in our information about the nature of the aerosols in smog, Dr. Friedlander points out. "For instance, we don't know precisely the nature of the particulate matter, how these particles interact with one another and grow or decrease in size, or the effect of the photochemical smog reactions on aerosol behavior. Added to this is the distinct likelihood that small particles in the air may be detrimental to the health of man and his possessions either directly or by acting as carriers of toxic substances. Besides," he continues, "aerosols reduce visibility, lessen the aesthetic qualities of an area, and may even contribute to the gradual cooling of the planet by preventing sunlight from reaching the earth's surface."

The outcome of the present study, therefore, should have important sociopolitical as well as technical implications. It will, for instance, lead to a better understanding of the interplay between the chemical and physical constituents of urban air. This, in turn, should point the way to setting standards to improve the quality of the air in large urban basins, Dr. Friedlander points out.

Particles. The team will draw up size classification of smog aerosols by number and by weight. Size spectra will show the relative abundance of particles ranging from about 150 microns in diameter down to about 0.003 micron. Coupled with these spectra will be such data as temperature, humidity, and chemistry of the air, wind direction and velocity, atmospheric turbidity, the time that the readings are taken, and so forth. Also, particles in different size ranges will be collected and their chemistry studied. Measurement of the number of cloud condensation nuclei should provide insight into the important problem of inadvertant weather modification by smog. In some cases, the readings will be made continuously over 24-hour periods. In other cases, the experiments will be carried out during selected day-time intervals and nightime intervals.

All of the data will be logged on tape to be fed, eventually, to a computer. The final picture of the urban atmosphere that emerges should give us a better insight into how different components of the air fit together, Dr. Whitby declares.

Mass and composition. Some of the air that enters the laboratory at rates up to 15 cu. ft. per minute goes to a four-stage impactor that Dale Lundgren has developed. This instrument, now made commercially by Environmental Research Corp., in St. Paul, Minn., is based on the inertial separation of the aerosol particles as a function of their mass. In the first stage, particles greater than 15 microns in diameter lodge on Teflon tape that's attached to a drum revolving at a preselected rate. The next three stages capture particles in the 15- to 0.5-micron size range. Those smaller than 0.5 micron are trapped in a Teflon filter.

Each tape, bearing particles graded by their size, will be weighed and then sent to Dr. Mueller's laboratory in Berkeley for a detailed chemical analysis. Using techniques such as atomic absorption, flame emission spectrometry, x-ray fluorescence, and the like, the Berkeley team of chemists will look for lead (a component of automobile exhaust gases), vanadium (which may arise from burning of fuel oils), zinc, iron, magnesium, silicon, asbestos, and carbon both in the carbonate and noncarbonate forms. They will also analyze for nitrate, chloride, ammonium, and sulfate ions. In addition, samples will be studied under an electron microscope to check the particles' morphology, and to look for asbestos and free sulfuric acid.

Besides studying the particles' chemistry, Dr. Mueller will monitor some of the gas-phase pollutants occurring in the air at the time the aerosols are trapped. These include hydrocarbons, carbon monoxide, nitrogen oxide and dioxide, total oxidants expressed as ozone, and peroxyacetyl nitrate (PAN).

Classification of particles also will be made with three instruments that Dr. Whitby has set up. One of these is a General Electric condensation nuclei counter that will provide a total count of all particles down to 0.003 micron in diameter although it won't discriminate them by size. Another instrument, called a Whitby aerosol analyzer, now available commercially from Thermo-Systems, Inc., St. Paul, measures the electric mobility distribution of the particles and computes their size distribution in the 0.007- to 0.6-micron range. The third unit is a Royco single-particle optical counter. This will provide the size distribution of aerosols that measure 0.4 to 6 microns in diameter.

Large. To get a fix on the distribution of large particles that would automatically fall out of the air on the way down the pipe to the basement, Dr. Noll has designed an impactor which is mounted on the roof next to the air inlet pipe. Blades coated with grease and mounted on a rotor arm rotate at speeds up to 70 miles an hour. Particles 10 microns in diameter and larger that strike against the blades are trapped by the grease. Aerodynamic flow carries the smaller particles around and past the blades.

Dr. Noll has developed a novel technique for counting the trapped material and characterizing it by size. He has mounted a TV camera to a microscope that transmits an enlarged image of the blade onto a screen with a sizing grid. This enables him to make an accurate count of the particles while reducing eye strain.

Meanwhile, back in the basement, Dr. Charlson has set up three nephelometers. These instruments (the name is coined from the Greek word nephelos, meaning a cloud), provide visibility information by measuring the extinction coefficient of light by particles in the air. One unit gives automatic readings at four wave lengths—360 mμ, 436 mμ, 546 mμ, and 675 mμ—extending over the entire range of the visible spectrum. The second is set for measurements at 550 mμ, the wave length that matches the human eye's center of frequency. The third nephelometer is a broader-band instrument centered at about 500 mμ.

The data that Dr. Charlson accumulates will provide the wave length dependency of light scattering on the size distribution of the air particles. Also, because the instruments "see" what the eye sees when looking through a column of air, it should be possible to arrive at some idea of what the factors controlling visibility limitation are.

"It's conceivable that we will find a close correlation between the degree of light scattering and mass concentration in the air," Dr. Charlson conjectures. If this turns out to be so, then it would be possible to use light-scattering measurements as a convenient and accurate means of drawing up mass concentration indexes.

Models. Data accumulated by different experiments will provide detailed baseline information on smog, Dr. Friedlander observes. This will be useful in making future comparisons of air quality, he believes. He also will use the information to compare it with chemical reactor models for urban basins that he and his associate Dr. John Seinfeld have been working on.

Division holds special symposium

The Division of Biological Chemistry is sponsoring a special symposium on the "Relationship of Science and Society" to be held during the ACS national meeting on Wednesday afternoon, Sept. 10 in the East Ballroom of the New York Hilton. In sponsoring this symposium, the division is adding to its traditional role as sponsor of technical symposiums and discussing some of the broader questions being raised regarding science policy.

These questions fall into four general areas and provide the theme for the symposium. These areas are (a) the moral dilemmas arising from discoveries of science, (b) the assessment of priorities between science and other areas of pressing national concern, (c) the civic responsibilities of scientists in the procedures of science, and (d) the assessment of priorities within science, for example, between basic and applied research.

A group of noted speakers will gather for the occasion. They are Dr. George Wald of Harvard University and Nobel Laureate in biochemistry; Dr. Philip Handler, newly elected president of the National Academy of Sciences; Dr. Philip Abelson, editor of *Science;* and Rep. Emilio Daddario (D.-Conn.), chairman of the House of Representatives Subcommittee on Science Research and Development.

CAS to hold open forum at national meeting

The Chemical Abstracts Service open forum, normally held on Tuesday evenings at ACS national meetings, will be held on Sunday evening at the 158th national meeting. The change was necessary to avoid conflict with the Council meeting scheduled for Tuesday evening during the New York meeting.

The topic of discussion at the forum, which will begin at 8 P.M. in the Beekman Room of the New York Hilton, will be CAS's plans for the next five years. Dr. Fred A. Tate, CAS assistant director, will be the speaker.

The New York Academy of Sciences will hold a meeting on Federal Support of Scientific Research and Education on Wednesday, Sept. 10, 9 A.M.–5:30 P.M., during the ACS national meeting in the building of the New York Academy of Sciences, 2 E. 63rd St., New York City. The academy will also have the first Open House for chemists, 3–3:45 P.M. on the same day.