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The PETROLEUM INDUSTRIES' Air Pollution Control Program*

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I want to tell you gentlemen right at the start that I am *not* an air pollution expert. Such experts were nonexistent as little as ten years ago. They're still as scarce as hen's teeth—which is one of the reasons I'm here today.

I won't belabor this point because I remember the occasion when Thomas Mann first visited America. While talking with the novelist one of our well-known authors emphasized again and again that he was a mere hack whose work was not to be mentioned in the same breath with that of the master. Mann listened with infinite patience. But when the party was over he turned to his host and said; "That man had no right to make himself so small. He's not *that* big."

With that point in mind, I'll confine myself to saying that, if you start shooting technical questions at me when I finish, I'll probably have to refer a lot of them to "higher authority."

Although not an air pollution expert, I *am* familiar with communication methods. For the past 15 years, part of my company job has been to generalize highly technical data to the point where average folks can distinguish the scientific forest from the trees. More recently, as chairman of the Information Committee of the American Petroleum Institute's Smoke and Fumes Committee, I have had to make myself acquainted with basic air pollution problems, and with methods being developed to find solutions for those problems. So what I'm going to do is try to give you the broad picture.

When the API decided, in 1952, to sponsor a program of research in the field of air pollution, the Los Angeles smog problem had, as you know, been in the headlines for several years. That's not to say the problem was a new one. Far from it. In 1834, Richard Henry Dana, famed author of "Two Years Before the Mast," wrote in his diary: "I have this day returned from the plaza at Los Angeles and did go to

the sick bay with eyes smarting. The pharmacist's mate tolde me this was not unusual, and the navigator said there was a dammed inversion."

And even as early as 1542, only 50 years after Columbus discovered America, the Spanish explorer, Cabrillo, noticed that smoke from Indian fires spread out over the Los Angeles basin and obscured the mountains . . . You might say those Indians were sending up smoke signals to warn future generations about the hazards of air pollution!

The rapid growth of Los Angeles during and after World War II aggravated its longstanding smog to a point where the public began insisting that something be done immediately to abate a nuisance that was reducing visibility, irritating eyes, damaging plants and causing runs in women's hosiery. In 1950 the Los Angeles County Air Pollution Control District was organized and placed in charge of a man who had occupied a major role in cleanup campaigns conducted at St. Louis and Pittsburgh.

The District authority embarked at once on a program to clean up Los Angeles by methods that had been effective in these other two cities. The results are well known. The smog got worse and the public outcry became more and more vehement.

In short, when the American Petroleum Institute entered the picture the public was in a highly excited emotional state, the newspapers were strident, and even the scientists were puzzled.

API Looks at Problem

It was at this point that West Coast oil people who had been working on the problem decided that an expanded, objective study of air pollution was essential. Because the tension showed signs of spreading to urban centers in other parts of the country, they brought the problem to the American Petroleum Institute.

Discussions in API reached the conclusion that the whole petroleum industry has an interest in community air pollution abatement because its instal-

lations operate in hundreds of urban centers. While many oil men felt their operations were not major contributors to the pollution problem they recognized that their national trade association furnished a mechanism by means of which they could attack the problem from every angle.

The decision to tackle this complicated and highly controversial situation was made at the end of 1952, and, by the middle of 1953, a comprehensive program of research was started. This program was based on the following assumptions:

First: Urban air pollution is disturbing to people but few are aware of its cause or cure.

Second: Scientists have advanced many conflicting theories on the subject, but there are few available data to support any theory.

Third: Effective abatement measures can be adopted only after the nature of the problem is understood.

The API set out, therefore—not on a crash program—but upon a long-range basic research study designed to find out, if possible, just what chemicals or trash go into the air and what happens to them after they become a part of our environment and how these facts relate to our troubles and irritations.

The answer to this question obviously required the establishment of many projects to look into the chemistry of polluted air—projects conducted by the best scientists and research institutions available.

The nature of chemicals identified by such projects eventually indicated that a major source of urban air pollution might well be the exhaust gases from motor vehicles. This conclusion was supported by a number of general observations, such as formation of smog clouds over main arteries of traffic in the Los Angeles basin. The same phenomenon was observed elsewhere. But there is no major city in the United States where the ventilation is so limited as it is in Los Angeles and very few that are subjected to such intense ultraviolet. Thus the effects of many chemical reactions that take place in

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urban atmospheres are less dramatic in other areas than in Los Angeles.

Similar observations, none of which should be credited entirely to the API, called attention to the fact that the sources of air pollution were not to be found exclusively in industrial plants. They result, as well, from the activities of every man, woman, and child in this country.

Such findings made it necessary for the API, and other organizations that had started air pollution studies, to conduct more precise investigations into the content of motor vehicle exhausts. The API was assisted in this work by the Automobile Manufacturers' Association through a long-established joint research organization known as the Co-ordinating Research Council, Inc. It was immediately found that the most formidable problem faced by scientists seeking to separate exhaust gases was that of developing tools with sufficient precision to make detailed analyses.

Long before such tools could be developed, automobile companies recognized that they were faced with an equipment problem. They set about the development of scavenging devices that would clean up materials that fail to burn in engine cylinders.

This work on scavenging devices such as afterburners is progressing steadily. There are at least 40 organizations in the race to develop a low-cost effective afterburner. You can be confident that the problem of automobile exhaust eventually will be solved. It will *not* be solved quickly enough to please some, but I believe we can agree that the present situation still presents no basis for grave concern and unsound abatement measures.

Sponsors Many Investigations

While the above developments were in progress the API sponsored a number of other investigations. I will return to these later but right now I want to talk about the creation of entirely new scientific tools for research. You see, it wasn't enough to build some entirely new gadgets that would measure chemicals in the air around the few parts-per-million range. Research experts with a knowledge of meteorological phenomena and a skill in the use of highly complex mathematical formulas also had to be found or developed. In one case, for example, it took an API committee two years to find a man competent to do one particularly exacting job.

Studies of this complexity cannot, as you know, be carried to successful completion by the garden variety engineer. In fact, the study of air pollution may lead to the establishment of a new profession called micro-meteorology. There are mighty few micro-meteorologists in the world today and at this

stage of the game I gather they have a pretty good thing for themselves. I am going to stick out my neck and predict that, before many years pass, their extremely practical work will be in even greater demand than it is right now.

So far, I have talked in generalities to give you an inkling of the complexities involved in air pollution research. Now I want to become more specific regarding the individual projects sponsored by the API after it had made a thorough investigation of the capabilities of America's leading research institutions. Since you gentlemen are for the most part practical engineers, I'm quite sure you are most concerned with a run-down on steps that have been taken, or soon may be taken, to alleviate if not cure this annoying and growing blight.

Approaches to Cure Found

So far, I regret to say, research that has cost the API more than \$1.3 million through 1959 has developed no cure. On the other hand, explanations found regarding the basic nature of the problem have opened up a number of approaches to such a cure.

An early result of API-sponsored research at The Franklin Institute was confirmation of a theory that the exposure to intense sunlight of a mixture of hydrocarbons and nitrogen dioxide, such as is present in automobile exhausts, could produce ozone. This substance, which laymen think of as a harmless and rather refreshing aftermath of thunderstorms, can, as you well know, become highly irritating when present in sufficient concentrations. And such concentrations are present in the air of Los Angeles when an inversion clamps down.

The ozone reaction theory originally was developed by Dr. A. J. Haagen-Smit of the California Institute of Technology. Development at The Franklin Institute of a long-path, infrared cell known familiarly as "Silent Sam, the Smog Detective," made possible a closer study of this and other reactions. Shortly thereafter, a simple and portable instrument for determining trace quantities of ozone was studied by the Armour Research Foundation under an API grant.

In the course of experiments with "Silent Sam," a series of strange lines was observed in the infrared spectra of some synthetic exhaust gases which indicated the presence of a new substance. At first, this mysterious material was simply called "Compound X." Later, its structure was tentatively determined as peroxy acyl nitrite and it became of considerable assistance in determining the mechanism of the hydrocarbon-nitrogen dioxide-sunlight-ozone reaction.

Until last year, "Compound X" was considered an interesting intermediate

product of the smog reaction, but probably not a direct contributor to any of smog's irritating characteristics. Then newly-developed equipment made it possible to isolate sufficient quantities of the material to permit its exact nature to be determined. Much to everyone's surprise, it turns out that "Compound X" is a very potent cause of both plant damage and eye irritation.

That is only one sample of the complications that arise continually during the course of the API program. Here is another:

Studies of automobile exhaust gases, before and after they were exposed to sunlight, disclosed that materials in those exhausts which irritate the eyes are not necessarily those that cause plant damage, and vice versa. This research also showed that there *are* several compounds in the air that cause both plant damage *and* eye irritation. Such conflicting discoveries are enough to make any researcher beat his head against the wall.

SO₂ Not Only Culprit

Then, during the early years of the program, projects at the University of Illinois proved that the very slow oxidation of sulfur dioxide to sulfur trioxide in the air made only an insignificant contribution to the smog phenomenon. There had been a widespread belief that this reaction was a primary cause of reduced visibility in Los Angeles and some other cities. After examining all the evidence Dr. Maurice Goldblatt, consultant for the API's Medical Advisory Committee, concluded, however, that the sulfur dioxide content of Los Angeles air could not reasonably be considered, *in itself*, a cause of anxiety.

In 1959, further work pointed the finger of suspicion at sulfur dioxide from an entirely different direction. Now it seems that introduction of minute quantities of this substance into a hydrocarbon-ozone, or hydrocarbon-nitrogen dioxide system exposed to bright sunlight, may cause development of an aerosol that can reduce visibility! These reactions were studied under laboratory conditions, however. Whether aerosols are formed in the atmosphere by any or all of such reactions remains to be investigated.

Over the years, work sponsored by the API has made other contributions to a partial understanding of such exasperating problems. These contributions include:

A technique for tracing the path of material discharged from a single source, such as an incinerator or smokestack, which takes into account the weather conditions influencing such a path.

A study of meteorological phenomena as they affect air sampling.

Contributions to methods for analyzing the many hydrocarbon compounds in automotive exhausts.

A study showing that domestic and industrial furnaces burning gas or oil discharge very minor quantities of hydrocarbons, even under poor operating conditions.

Research into the atmosphere over representative cities which disclosed that the high ozone content typical of Los Angeles smog is *not* characteristic of other localities. An interesting result of this project has been proof that the sulfur dioxide content of Los Angeles air is *much lower* than that of other cities studied. In fact, it is indicated that a high ozone level cannot persist in the presence of a high sulfur dioxide content!

Another investigation, carried out in co-operation with the Air Pollution Foundation, pointed to the conclusion that no single fuel, or fuel property, is entirely responsible for pollution caused by auto exhausts.

On the basis of present knowledge, no responsible scientist would claim that one type of gasoline produces significantly more smog than another. This means, in turn, that legislation designed to regulate the olefin content of gasoline will have little or no effect in reducing smog. Its only result probably will be to increase the cost of gasoline to motorists.

In all fairness, I must add that this question of gasoline composition is far from settled. Extensive work on the problem is being continued by the API and other interested organizations.

Condition of Motor Important

One result already obtained is proof that eye irritation, visibility reduction, and ozone formation from exhausts are affected much more by differences in automobiles than they are by differences in fuel composition. A car with dirty spark plugs, a too-rich fuel mixture and faulty piston rings belches immeasurably more pollution than a well-maintained vehicle, no matter what brands of fuel they both use. One misfiring plug may double the average hydrocarbon concentration of an exhaust. A set of fouled plugs can increase the rate of hydrocarbon emission more than two and a half times during wide open throttle acceleration!

The sometimes-conflicting findings of all of these research projects show that the nature of air pollution and its effects, remain extremely complex, even after years of hard work by some of the nation's leading scientists. A great many things must be more clearly understood before a permanent solution can be obtained. Under such circumstances, the API is continuing its research as a long-range program exploring many facets of the situation, including the effects of air pollution on agriculture, industry, and the public health.

This broad approach is maintained for

two reasons: In the first place, oil companies, being responsible citizens, need every bit of information they can obtain in order to keep their plants from giving offense to communities in which they operate. In the second place, those companies firmly believe that real progress may be made by means of basic research into the mechanisms and chemical reactions involved, as well as into the meteorological conditions that exist over various urban centers. Only by collecting such data, and making it available to people like you for intelligent and realistic use can expensive, wasteful efforts at abatement be avoided.

A case in point is the early effort to apply measures that had been found effective in Pittsburgh and St. Louis upon the Los Angeles situation. Because weather and other conditions were different on the West Coast, this endeavor resulted in failure.

The same thing has happened in other areas that "lifted" abatement legislation without proper study and tried to apply it to their local situations.

One of the most ridiculous of these cases occurred when a town located 100 miles from any navigable stream copied a good St. Louis ordinance that banned smoking stacks on Mississippi River steamboats.

So much for the results, to date, of API's research program. I'd like now to discuss the Institute's recent efforts to communicate its findings to oil company management and employees, to air pollution control officials and to the general public.

From its organization in 1952 until the beginning of last year the Smoke and Fumes Committee devoted itself, as I have said, to basic research. Findings were reported promptly to the scientific world through the journals of professional societies, but no effort was made to communicate with the public during those formative years. It was agreed that researchers and committeemen should work rather than talk, and that talk should be postponed until there was something to talk about.

Public Relations Men Included

Nevertheless, several public relations men were included on the membership of a Smoke and Fumes Publications Committee. They were placed there to familiarize themselves with problems under study so they might be ready to play a larger role at the appropriate time.

When the nature of the air pollution problem had been sufficiently defined by research to justify the release of information to the public, the Institute took steps to meet this changed situation. In the Spring of 1959 the Technical Publications Committee was reorganized as the Information Committee and additional public relations men with oil in-

dustry backgrounds were added to its roster.

The information Committee of which I am chairman understood clearly that it is one thing to unearth pertinent facts and call them to the attention of professionals such as you gentlemen and an entirely different thing to get the general public to appreciate the meaning of those facts. How can people judge the need to purchase afterburners for their cars unless the latest findings about automobile exhausts have been explained to them in layman's language? What good does it do to prove to air pollution officials and legislators that oil refiners have vastly reduced emissions from their stacks and flues if the public doesn't know what has been done?

Public Must Be Informed

This is just another way of saying that if scientists, control officials and representatives of industry are to make full use of research findings to establish adequate controls they must have the backing of an informed, understanding public. Such backing will help to prevent unsound legislation, duplication of effort, waste and "wheel spinning" at all levels.

The Information Committee, therefore, was given responsibility for developing the best possible relations with the public and also with oil company personnel, since the latter's co-operation is essential in implementing the entire abatement program. The committee's basic object was defined as, and I quote, "to recommend remedial activity." Its specific objectives are:

First: To collect, evaluate, and integrate information about six pollution problems facing the industry, the attitudes of the general public on these problems, and the activities of individuals or groups seeking to achieve objectives in this field.

Second: To keep the Smoke and Fumes Committee informed on problems of concern to the public and provide assistance in making decisions concerning the entire program.

Third: To promote better understanding and appreciation of oil industry research efforts in air pollution problems.

Fourth: To develop, through appropriate API channels, a flow of information to oil industry personnel on the subject of air pollution as rated to the industry.

Fifth: To assist in preparing statements on controversial issues in the field of air pollution for distribution to the public through companies that receive inquiries from any source.

The first result of our program in 1960 was publication of this bibliography of all API research papers relating to air pollution.

We also have collected and adapted materials previously used by oil com-

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SIMPLIFIED METHOD IN FINDING OZONE

(Continued from p. 33)

since this gives an integrated approach to the values obtained, and will make comparative studies between areas more realistic, as far as the evaluation of contamination levels are concerned.

The correlation between oxidant levels as obtained by automatic instrumentation, and the ozone levels as obtained by the method outlined in this paper show the applicability of this method in conducting studies on the levels of air pollution in community surveys. It is definitely useful in determining locations for more sophisticated instrumentation. Moreover, where used as standard routine test, it would definitely show whether levels of ozone pollution are increasing or decreasing.

Acknowledgment

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ANNUAL SEMINAR TO BE HELD SOON

The Seventh Annual Radiological Health Seminar at the University of North Carolina, Chapel Hill, will be conducted by the School of Public Health and the North Carolina State Board of Health on January 30-31, 1961. The theme of this Seminar will be "The Concept of Total Dose Assessment." Dr. K. Z. Morgan of the Oak Ridge National Laboratory and Dr. Richard Chamberlain of the University of Pennsylvania and Dr. Jan Lieben of the Pennsylvania State Health Department will be among the instructional staff. Personnel of the Public Health Service, the University, and the State Health Department will do laboratory and seminar instruction. Address inquiries to: Professor Emil T. Chanlett, P. O. Box 899, Chapel Hill, North Carolina.

SOAP-MAKING ODOR CONTROL

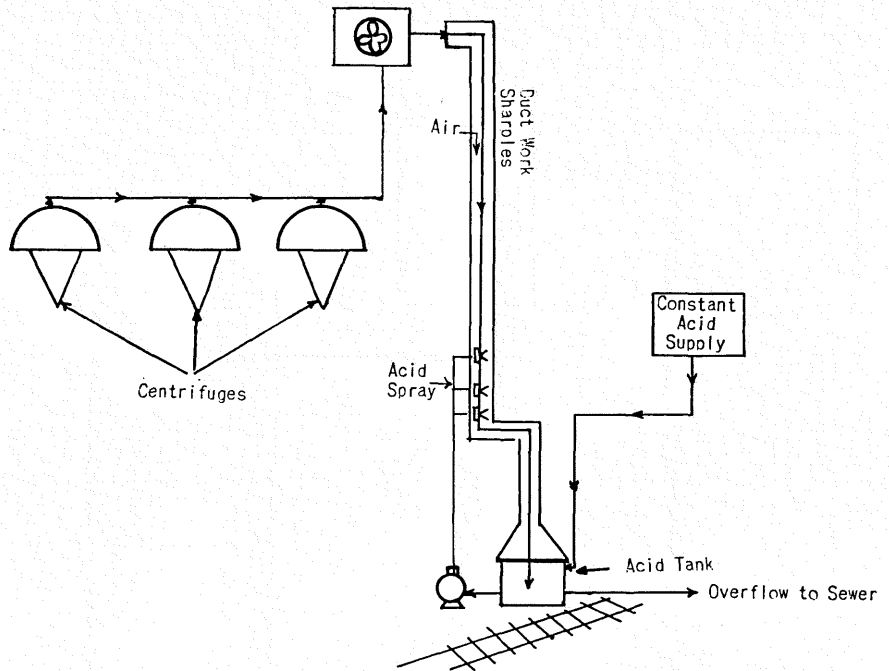


Fig. 8. Control of odors from centrifuge room.

(Continued from page 13)

rine or ozone, combustion and catalytic combustion, odor counteracting, and scrubbing with a strong inorganic acid. Combustion and scrubbing were selected largely because of availability and economic considerations.

Pressures of neighborhood residents were an ever-present consideration in this situation. It could not justifiably be argued that these complaints were not valid, and there was certainly an air pollution ordinance in effect. Nevertheless, to simply have submitted to these pressures and invoked the ordinance seemed unfair in view of the earnest, though unsuccessful (at the time) efforts of the company to control their problem. Since no one could tell the company exactly how to solve the problem, trial and much error were inevitable.

AIR POLLUTION CONTROL PROGRAM

(Continued from page 8)

panies in their own pollution abatement programs. We are giving prompt press coverage to Smoke and Fumes-sponsored research papers. And we are developing authoritative statements which will assist oil men in handling questions or complaints received at local or state levels.

As the Information Program grows, other projects will be developed. Further study is being given to six of these. They include articles for national magazines, leaflets for oil company employees, distribution of a running progress report on air pollution control activities, circulation of pertinent magazine or newspaper articles,

and efforts to interest magazines in publishing interviews with persons who play prominent roles in the anti-pollution battle. At the American Petroleum Institute we believe the objectives and projects I have outlined backstop the research program by leading to better understanding of the problem and of the progress being made toward its solution. In working toward this solution we are fully aware of the important role played by you gentlemen and by your Association. To you and to the Association we give assurance of full co-operation by the United States oil industry in fulfillment of our joint mission.

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