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Vance N. Jenkins

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The Petroleum Industry Sponsors Air Pollution Research

By VANCE N. JENKINS*

Any one who has been in the Los Angeles area during an extended period of smog, has smelled the odors arising at times along the Houston Ship Channel, and has flown over that great pall of coal smoke and dust which at times practically hides the ground from view from altitudes above about 5,000 feet in the area roughly bounded by the air lanes connecting Chicago, Boston, New York, Washington, Roanoke, Louisville and St. Louis, does not need to be told that air pollution in those sections of the United States has become a problem of the utmost importance.

For, to use the popular G. I. expression, "He has had it." He knows by firsthand experience that air pollution is real, that it is here now, and he wonders if it is not here to stay. And, if he has an analytical type mind, he is certain that it is going to get worse before it gets better.

He can see that there is nothing to prevent the situation becoming worse until a lot more basic knowledge on the true nature of it and its causes is acquired and the implications stemming from this knowledge are analyzed correctly and logical programs of air pollution prevention based on experimentally determined facts instead of mere opinions and fallacies are worked out and put into operation.

Now the air pollution problems in certain areas of the United States did not reach their present magnitudes by a process of mushroom-like, overnight growth. To the contrary, they arrived at their present status by a process of slow, gradual increase over a relatively long period of time, during which the population of the nation increased greatly. Coincident with the increase in population, there was, of course, an increase in industrial activity and an increase in the area of land under cultivation with an accompanying increase in the amount of finely divided soil exposed to the dust raising forces of the winds.

Gradual Change

But the average citizen was not aware of the gradual change occurring. Only now, when he realizes that there has been a change and that his children's children may never have the nostalgic pleasure of recalling the beauty of the American landscape as he remembers it when he was a child, does he become very much concerned about it. And when he does, the chances are that he is inclined to place the responsibility for the change solely on industry or its management.

But what is management? The management of an enterprise, a unit of industry, is merely a group of men, called executives, who, as the result of possessing certain extra abilities, have been selected to guide the operations of that enterprise.

Aside from having the extra abilities which fit them to become a part of management, these men are basically no different than the average person who has been reared in contact with the advantages of modern civilization. Among other things, they, even as you and I, like to live in pleasant surroundings which have adequate supplies of clean, clear, water for drinking, sanitary and recreational purposes and lots of good old-fashioned clean, clear, country air for breathing.

The purpose of this paper is to describe the pollution prevention activities of the petroleum industry which have resulted from the recognition, some thirty years ago, by the executives constituting the managements of its various units, that water and air pollution would become a very serious problem in certain portions of the nation unless well-planned actions were taken to prevent it.

Unfortunately, most of the other industries and most civilian units did not heed this early warning. As a result, the situation has become so bad in many areas that both the civilian and industrial populations have already suffered great economic losses as well as great inconveniences. And unless the matter is viewed calmly and logically and appropriate measures devised to alleviate these situations, a great deal more economic loss and inconvenience is liable to be met within these same areas before relief is found.

Major Problem

Although the growing air pollution problem is of national concern, it is not a national problem in the true sense of the word. It is a major problem which is made up of many local problems, many of which, it is true, are quite sizeable problems in themselves.

But each is different from the others because in any particular area the topographical conditions, the climatological conditions, the meteorological conditions, the types of industry and its distribution, and the distribution and habits of the civilian population are unique to that area.

Each of these factors either influences the degree of air pollution resulting from the emission in that area of a given amount of a pollutant or is influential in determining the amount and type of pollution which will originate in that particular area.

Therefore, each area is unique with respect to the factors influencing its air pollution problems and its problems are of a local nature. Hence, the enforcement of a law or laws, irrespective of origin, whether of local, state or national, cannot be expected to solve satisfactorily all air pollution problems. In fact, a law which may be applied

*Executive Secretary, Smoke and Fumes Committee, American Petroleum Institute.

satisfactorily to the air pollution situation in one area may even delay the alleviation of the situation existing in another area.

Panicky People

The worst thing that can happen, in many instances, is the hasty passage of a law or laws for the control of a given air pollution situation. For in many such cases their passage results from a panicky feeling that "there ought to be a law" and laws drawn for such reasons are likely to be poorly drawn and based on either insufficient or erroneous data.

But once a law is on the statute books, there is a tendency for those who were in such a panic to get it there to relax and wait for the miracle it was to bring about to occur. But, as a rule, nothing happens, for the mere existence of even a very poor law that is supposed to solve a problem tends to inhibit further thought on the problem.

And, unfortunately, in such cases, further thought is exactly what is needed. That is why that passing a law is, in many cases, the wrong way to start about solving an air pollution problem. And passing the wrong law can also often be the most expensive and irritating way to approach the problem as far as both the public and industry are concerned.

At the end of the First World War in 1918, the petroleum industry executives serving on the President's War Advisory Committee on Petroleum agreed that their cooperative efforts in behalf of the industry should continue. After considerable thought and discussion, it was decided to form a permanent organization which would be called the American Petroleum Institute. This decision was approved enthusiastically by the industry at large and by 1921 the organization of the association now known universally by the abbreviation "A.P.I." was completed and a General Committee on Pollution appointed.

Because the organization was new and the idea of a cooperative attack on pollution problems was new also, not a great deal was accomplished by this Committee during the first few years of its existence. A number of meetings were held at which the problems connected with the pollution of navigable and other public waters were discussed and several water pollution surveys were initiated.

Magnitude Clearly Defined

As a result of these activities, the scope and magnitude of the problems confronting the industry became more clearly defined to the Committee members and constructive ideas as to how they should be attacked began to emerge. For example, by 1928 a Technical Committee on Prevention of Pollution had been activated and by the following year this Committee had prepared a preliminary draft on an American Petroleum Institute Code of Recommended Good Practice in the Prevention of Pollution.

In 1928 the idea of organizing the American Petroleum Institute into divisions was approved in principle. Under this plan, the various activities of the industry were

grouped under the Divisions of Production, Transportation, Marketing and Refining. This organization plan was completed in 1929, at which time each Division assumed responsibility for developing controls for the pollution which might be expected to occur as the result of the activities of the branch of the industry represented by it.

Under this plan, the specific assignments accepted by the Divisions were as follows:

(a) The Division of Production undertook to prevent stream pollution resulting from oil field operations by studying the problem of oil field waste disposal for the purpose of developing the information and techniques necessary to provide satisfactory treatment of such wastes.

(b) The Division of Transportation agreed to develop information necessary to work out methods for the prevention of the pollution of navigable waters.

(c) The Division of Marketing was given the task of devising procedures to prevent the pollution of public waters by oil escaping from marketing installations.

(d) The Division of Refining accepted the assignment of developing satisfactory methods for the disposal of refinery wastes.

Regulations

Over the years intervening since this organization plan was adopted in 1929, the industry interest in pollution prevention activities of the Division of Production has decreased greatly. This results from the fact that all of the oil-producing states have enacted laws which regulate the disposal of oil field wastes, and compliance with them is necessarily handled by direct contact of individual companies with the state regulatory authorities.

Although over this same period of time the Federal Government has enacted laws regulating the escape of oil to waters under Federal jurisdiction, the Division of Transportation committee which deals with the prevention of such pollution is still very active in assisting the Federal regulatory authorities in preventing pollution of navigable waters.

The Division of Marketing distributed a bulletin in 1930 on the prevention of pollution by the escape of waste oil from filling stations and terminals. Apparently, the current pollution problems of the marketing portion of the industry are either of no great importance or are being disposed of easily on the basis of techniques developed in the past because there is little interest at present in the pollution prevention committee activities of the Division of Marketing.

The articles contained in this issue of Air Repair represent the balance of those given at the Baltimore Annual Meeting. Authors wishing reprints should file their requests with Headquarters which will advise as to cost for the number of reprints desired.

The Division of Refining initiated work on its pollution problems on May 26, 1930, at which time its Committee on Disposal of Refinery Wastes was formed. The minutes of the first meeting of this Committee indicate that it assumed responsibility for the continuation of the program started by the former Technical Committee on Prevention of Pollution by stating that its purpose was "To collect, summarize and recommend for publication to the industry, information which will direct and promote good practice in the disposal of refinery waste, particularly in the design, construction, and operation of waste disposal equipment, to the end that refineries of the petroleum industry in America do not release wastes of any kind which may interfere with the interests of their neighbors or the public in general."

Another Committee

From the time of its organization in 1930, the Committee on Disposal of Refinery Wastes recognized that the air pollution problems confronting the industry would, in time, become of major importance. But, even as late as 1938, few refineries were located in areas where the air pollution they at times caused was viewed as an evil which could be corrected.

The majority of the people living near refineries either worked in them or were dependent upon their operation for a supply of customers with cash from refinery paychecks. It was an accepted fact that refineries at times emitted strange odors and clouds of black smoke and very little, if any, thought was given by the public to the necessity of their continuing to do so.

With the beginning of World War II, however, the situation began to undergo a change. The relocation of war industries brought large numbers of people into refining areas who were not interested in the petroleum industry. And since the refineries were there when they came, it was easy to persuade them that the growing air pollution problem was caused by refineries rather than by the new industries and the people who had moved in to man such plants.

Attitude Changed

This change in attitude first became evident on the West Coast which experienced the greatest increase in war time population. It became evident several years ago that, in addition to the technology of handling waste gases and dusts *within* refinery limits, it was desirable to acquire information pertaining to the composition of the air *outside* refinery limits since it was apparent that the air pollution in certain areas, said to be caused by refineries, might be due to other sources.

As a result, a new American Petroleum Institute committee has been formed to foster development of information relative to the true nature and causes of air pollution of a certain type. The details of the organization of this committee and of its proposed program will be given later, but first let us review the factors leading up to the decision to create such a committee.

As pointed out earlier, the population of the West Coast began to increase at a very great rate during World War II. This increase was particularly large in the Los Angeles area. And, accompanying the increase in population, there was a corresponding increase in the number of automobiles, trucks and buses, of home fireplaces, gas ranges, hot water heaters, of home furnaces and backyard incinerators.

There also was an increase in industrial activity, new industries being created and the ones already in existence, such as steel making, aircraft building, lumber working and petroleum refining, being greatly expanded. As a result, the frequency of the occurrence of an objectionable degree of air pollution also increased.

Conscious of the pre-eminence of Southern California as a vacationing paradise for the remainder of the nation, certain units of the public press began to wage a campaign designed to awaken the citizenry to the danger resulting from the possibility of the area losing its lucrative tourist traffic if the growing air pollution menace were not overcome.

Speakers who had been helpful in mitigating the air pollution problems in other cities were imported and they gave their opinions as to what should be done to alleviate the Los Angeles situation. A number of different committees were formed to investigate the situation and, as a result, it received much publicity.

Refineries Cited

This campaign reached a climax, as far as the petroleum industry was concerned, on December 11, 1946, when one of the leading newspapers devoted half of its front page to a reproduction of an aerial photograph of one of the local refineries and identified it as a unit of the industry responsible for smog.

That afternoon the petroleum industry executives formerly serving on the Refining Committee of District Five of the Petroleum Administration for War were called together. After thorough discussion of the political, economic, scientific, and public relations aspects of the situation, the group organized the Petroleum Industry Committee on Smog, the purpose of which would be to determine what substances composed Los Angeles smog, to what extent the refining industry was responsible for it, and what steps would have to be taken by the industry to reduce its contribution to it. Later it became the "Committee on Smoke and Fumes of the Western Oil and Gas Association." It is still active under this last name and has met regularly each month since its organization.

The task of determining the identity of the pollutants present in Los Angeles smog did not prove to be as simple a matter as it was thought it would be. Therefore, in order to return the industry's scientists who had been loaned to the project to their regular duties, the Committee in March 1947 hired an independent research institution to solve the problem for it. The then recently organized Stan-

ford Research Institute was selected for the job and, in April 1947, it began to assemble personnel, analyse the data already collected by the industry's scientists, and plan a program for the project.

Large Sums Appropriated

Since that time, the seven refining companies originally represented on the Committee on Smoke and Fumes of the Western Oil and Gas Association have paid out well over \$1,250,000 in financing the basic research project and several smaller special related projects at Stanford Research Institute and for the services of technical men loaned to it before the decision was made to hire Stanford Research Institute.

As a matter of record, California State Assembly Bill No. 1, which is the enabling act providing for the formation of County Air Pollution Control Districts in the State of California, was signed by the Governor and became a law on June 10, 1947. The Los Angeles County Air Pollution Control District was formed under that law in October 1947 but the preparation of its budget, the working out of personnel requirements and the drafting of its rules and regulations were not completed until February 1, 1948, at which time it actually began to function on a preliminary scale.

Thus, the smog investigations financed by the Committee on Smoke and Fumes of the Western Oil and Gas Association had been in progress for nearly a year when the Air Pollution Control District began operations. Since that time, it is estimated that the petroleum industry in Los Angeles County has spent some fourteen million dollars for new equipment and the modification of existing equipment for the purpose of reducing air pollution.

It is now evident that a large portion of this money may have been spent unnecessarily, in that its expenditure resulted in no appreciable or noticeable reduction of smog intensity in the Los Angeles area. It also is evident that much more money may be spent unnecessarily by the petroleum industry if certain proposed rules and regulations for the control of the emission to the air of certain substances which may play no part in smog formation are put into effect.

Results Published

The results of the research conducted by Stanford Research Institute were published in three Interim Reports and several Interim Technical Reports which constitute very instructive and very interesting reading.

They present very clear descriptions of the unique topographical and meteorological conditions which are responsible for the relatively small amount of pollutants from the Los Angeles area creating a smog problem of the first magnitude.

They also point out the lack at the beginning of the project of analytical methods sufficiently delicate to determine accurately the minute amount of some pollutants present in the Los Angeles atmosphere and describe the

development of ones suitable for the determination of certain important contaminants.

Experiments are described which were made with a synthetic smog for the purpose of attempting to identify the substance or combination of substances responsible for the eye irritation experienced quite frequently, both in Los Angeles and other cities.

Late in 1950, the Los Angeles County Air Pollution Control District accepted as proven fact a theory on the origin and nature of smog proposed by one of its consultants. This caused a change in the nature of the Stanford Research Institute program which, since that time, has been concerned largely with investigations designed to determine the degree, if any, to which this theory coincides with facts.

New Theory

The theory referred to is the one which postulates that the reduction in visibility, the eye irritation and the crop damage noted during Los Angeles smog periods are due to finely dispersed liquid droplets which are claimed to be formed in the atmosphere by the reaction of ozone with olefinic hydrocarbons.

The ozone, in turn, is claimed to be formed by the reaction of nitrogen dioxide with saturated hydrocarbons. Both types of hydrocarbons are assumed by this theory to enter the air chiefly as the result of the evaporation of cracked gasoline from refinery processes and storage installations. The nitrogen dioxide is said to originate by oxidation of the nitric oxide formed from the nitrogen and oxygen of the air whenever fuel is burned at a high temperature.

The work at Stanford Research Institute has shown that there are a number of apparent errors both in this theory and in its interpretation to account for the various phenomena associated with smog. As yet, no one has been able to name the substance or substances which may be responsible for eye irritation or crop damage and no one has isolated from smog any substance which has been shown to be capable of producing eye irritation or crop damage in the concentrations in which it was found in the air. Actually it appears that air diluted automobile exhaust gases after exposure to sunlight will come closer to giving typical smog-type eye irritation and crop damage than any other pollutant yet tried.

Regardless of this fact, the theory adopted by the Los Angeles County Air Pollution Control District has been widely publicized and similarly accepted as proven fact by a number of other air pollution enforcement agencies throughout the nation.

Its acceptance by such agencies indicates that preparations will be made eventually in other locations, as they are now being made in Los Angeles, to control certain types of hydrocarbon emissions which may prove to play no part in causing air pollution of the type known as smog. If so, such unnecessary control would result in large and unnecessary expenditures by the oil industry.

Therefore, the refining industry as a whole has come to the aid of that portion of it represented in the Los Angeles area and will take over the task of fostering the development of basic information on the nature of air pollution and attempt to determine the responsibility of the industry for causing air pollution which may exist in areas in which refineries are located.

This decision was reached at the Mid-Year Meeting of the Refining Division of the American Petroleum Institute in May 1952 in San Francisco, during which the formation of the Smoke and Fumes Committee of the American Petroleum Institute under the Chairmanship of W. L. Stewart, Jr. of the Union Oil Company of California was authorized. At the Annual Meeting of the American Petroleum Institute in Chicago in November 1952, this Committee was authorized to solicit the industry for a contribution of \$250,000 to be spent during 1953 in financing a number of research projects designed to develop information on certain fundamental aspects of air pollution.

Data Obtained

The program adopted for the first year consists of about a dozen projects, some of which were selected for the purpose of obtaining additional data necessary to clear up uncertainties remaining in connection with the ozone-hydrocarbon theory of smog formation. This is in line with the firm belief of the Committee that accurate knowledge on a subject must be available before accurate decisions can be made.

If the data developed indicate that legislative control of hydrocarbon emissions is desirable, then the A.P.I. sponsored research will have resulted in supplying accurate information instead of theories and hypotheses, upon which such legislation may be based.

If the data indicate that the control of the emission of small amounts of certain type hydrocarbons is not necessary in that they do not enter into reaction with other constituents of the atmosphere to form harmful substances, then the passage of unnecessary legislation may be prevented thereby, at a great saving of time and expense, both to legislative and enforcement agencies and to industry.

For administration of its program, the A.P.I. Smoke and Fumes Committee has set up an Executive Committee of four members, an *ad hoc* Technical Advisory Committee of five members, and a paid, full-time Executive Secretary. One of the aims of the parent Committee is to build up centers of information on the new approach it is sponsoring to air pollution by distributing the research projects constituting its program as widely as is consistent with efficient spending of the funds available.

Therefore, in order to obtain information vital to decisions concerning the location of the various projects, the Executive Secretary has visited some twenty-five of the leading universities and non-profit research institutions throughout the nation.

On the basis of the information developed, which has been reviewed carefully by both the Technical Advisory Committee and the Executive Committee, a number of contracts for projects have been signed already and active work on them is under way. It is sincerely hoped that results obtained from the first year's program will be of such great interest that the industry will wish to continue it for another year or longer until the major problems involved have been solved satisfactorily.

Need Thorough Investigation

I would like to refer again to earlier statements concerning the need for thorough investigation and development of complete and accurate information on a given pollution situation before legislation designed to cover it is enacted and the fact that a law designed to improve air pollution might have a reverse effect if not properly and wisely drawn.

As an example of what has occurred in the past, let us review the history of sulfur dioxide control in Los Angeles County. Although the concentration of this gas has never been nearly as high in the Los Angeles atmosphere as in that over many of the Eastern coal-burning cities, many of the experts imported to advise on the situation were rather emphatic in their statements to the effect that if the sulfur dioxide emissions were reduced or eliminated, the smog and attendant eye irritation would disappear.

As a result, at the first meeting in December 1946 of the Committee on Smoke and Fumes of the Western Oil and Gas Association, one of its members was given the task of determining just how much sulfur dioxide was put into the air each day in the Los Angeles Basin. At the following meeting in January, 1947, he reported that, based upon the average sulfur content of the various fuels and the known amounts of each which were consumed in the Basin, calculations indicated some nine hundred and thirty tons of sulfur dioxide was discharged each day and that approximately four hundred and thirty tons of this amount was contributed by the oil industry, chiefly from the burning of sour fuel gases containing hydrogen sulfide.

Measures Planned

With this knowledge in hand, the industry immediately began planning measures to set its house in order. The various refineries had plants designed and constructed to treat hydrocarbon gases for the removal and recovery of the hydrogen sulfide contained in them.

Some of the refiners arranged to dispose of the recovered hydrogen sulfide by either pumping it through specially constructed pipelines or hauling it in special pressure tank trucks to existing chemical companies which converted it into sulfuric acid. Other refiners contracted for disposal of the recovered gas to a new chemical company organized to produce sulfur from hydrogen sulfide.

As a result of this program, which was initiated voluntarily before the Los Angeles County Air Pollution Control District was formed, the emission to the air of some four hundred tons per day of sulfur dioxide is prevented.

Now the Rules and Regulations of the Los Angeles County Air Pollution Control District state, in effect, that nothing discharged into the air, such as stack gases, shall contain more than 0.2 per cent by volume of sulfur dioxide.

If a stack does emit sulfur dioxide in excess of this concentration, a variance must be obtained in order to continue operation of the plant or process from which the stack gases arise.

When obtained, a variance must be reapplied for at six-month intervals at considerable trouble and expense and plans for continuing efforts to reduce the emission to within legal limits must be shown for the application to have any chance of being granted.

The modified Claus process which is used to convert hydrogen sulfide into sulfur is not economic when more than about ninety-five per cent of the sulfur in the hydrogen sulfide processed is recovered as sulfur. The remaining five per cent is burned and emitted with the stack gases as sulfur dioxide. The sulfur dioxide in these stack gases usually is from about 0.5 to 1.0 per cent by volume and hence is above the legal concentration in Los Angeles County.

There are two modified Claus process plants now in operation in the Los Angeles Basin and application for the construction of a third is pending. Together, the two plants now operating recover approximately one hundred and seventy-five tons per day of sulfur which would be emitted to the air as three hundred and fifty tons per day

of sulfur dioxide if they were not in existence. Yet, because their stack gases contain approximately twenty-five tons per day of sulfur dioxide in concentrations above the legal limit of 0.2 per cent, these plants, to operate, must do so under a variance which may be withheld at any time. It would seem a wise law would encourage the construction of such scavenging plants, the operation of which results in a large overall benefit by making them a special case and permitting their operation under even more economic conditions, such as by discharge from their stacks of up to ten per cent of the sulfur in their feed gases as sulfur dioxide at concentrations of up to 1.5 per cent without the necessity, expense and nuisance of operating under the variance system.

As a matter of fact, the refiners supplying these plants with the hydrogen sulfide they use as feed could burn all of the sulfur these plants recover and emit it to the air as sulfur dioxide from their stacks at less than the legal maximum concentration of 0.2 per cent by volume. And they could save money by doing so. For all they would have to do would be to cease processing their sour gases for the recovery of hydrogen sulfide before burning them as fuel. The fact that they have not done so and have no intention of doing so is good evidence that the petroleum industry is managed by men who want to be good neighbors, by men who will go more than half way in cooperating with enforcement agencies in order to be good neighbors, even when the laws under which they operate are not believed to be wisely drawn.

