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ACCOMPLISHMENTS IN AIR POLLUTION CONTROL

BY THE PETROLEUM INDUSTRY

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The petroleum industry has been concerned about air pollution control ever since the first refinery began operations. Although economic considerations alone dictate that loss of volatile products by evaporation to the atmosphere be held to a very low level, current operating practices in the control of air pollution usually go far beyond the requirements of economics. Refiners make a vigorous effort to be good citizens in the communities in which they operate, and they are fully aware of their responsibilities with respect to the health and comfort of their neighbors. The extent of their efforts can be measured by the fact that since 1956, the industry has spent an estimated $66 million on air pollution control, plus an additional expenditure of about $1 million per year for research.

To an ever-increasing degree, everyone in the industry, from top management down, is interested in preventing pollution. In August 1955 a letter to the Vice President for Refining, American Petroleum Institute, from the Chairman of the Smoke and Fumes Committee and the Chairman of the Committee on Disposal of Refinery Wastes set forth a "Pollution Control Policy." The following is a quotation from this policy statement. "It is suggested that, in view of the recognized importance of adequate pollution control, members of the General Committee undertake the responsibility of seeing that all members of their respective organizations are fully aware of their pollution control policy. It is our belief that recommendations for specific pollution control measures must, for the most part, originate at the refinery level. Top refining department management as represented by the General Committee must, however, establish the policy." Employees throughout the organization are taught to be air pollution conscious, and management is careful to see that employees at all levels understand air pollution control methods and policies. Whenever air pollution control regulations are proposed, industry personnel take an active part as responsible citizens to assist in providing sound and realistic legislation.

The extent of air pollution control required is of course dependent to a considerable degree upon location of the refinery and upon topographical and meteorological conditions of the area. A region of poor ventilation and high population density, as represented by Los Angeles, requires more stringent control than an area where these conditions are absent. A recent survey of industry expenditures for pollution control made by the OIL AND GAS JOURNAL reflects this situation. In others, population is so sparse that only minimum expenditures beyond the economic level are required.

Now, what are the air pollutants that the industry is endeavoring to control?

From the beginning, control of sulfur compounds has been of great interest, and each year as new plants and process units are constructed, sulfur recovery becomes more complete. Throughout the nation the industry recovers about 1,600 tons of sulfur daily which would otherwise escape to the atmosphere. In the Los Angeles area, 600 tons/day of sulfur oxides are converted to sulfur or sulfuric acid and are thus kept out of the atmosphere. In many areas, outside chemical plants are being employed to convert hydrogen sulfide to elemental sulfur or sulfuric acid. Burning of acid sludges with a consequent release of sulfur dioxide to the atmosphere has been discontinued in nearly all populated areas. Sludges are

converted to sulfuric acid for manufacturing purposes or to ammonium sulfate for sale as fertilizer.

Control of smoke and particulate matter is also receiving close attention by the industry. To avoid smoking stacks, many installations include smoke indicators or recorders, oxygen analyzers, and other instruments to enable close control of combustion. Where meteorological conditions indicate, stack heights have been extended to assure complete dissipation of stack effluents. Afterburners have been installed in many cases to eliminate coke fines, hydrocarbons, and carbon monoxide in the stack gases. Catalyst collection devices such as cyclones and precipitators are in use to reduce the emission of dust to the atmosphere.

The researches of Haagen-Smit and others have shown that under certain conditions, hydrocarbons and oxides of nitrogen can participate in the photochemical reactions that lead to the formation of "smog." Therefore in Los Angeles, where ventilation is poor, additional emphasis has been placed on the recovery and control of hydrocarbons. Before control can be effective, the principal sources of hydrocarbon loss must be recognized and evaluated. Individual companies, working cooperatively through industry trade associations and with control agencies, the USPHS, and others, have conducted extensive surveys of refinery hydrocarbon losses. Steady progress has been made in reducing evaporation losses from storage tanks, pumps, wholesale distributing facilities, and water/oil separator operations, to name but a few. For example, the installation of vapor collection systems and floating roofs on gasoline tanks has cut evaporation losses some 70% in the past few years. In instances where hydrocarbons are unavoidably released from a process unit, smokeless flares have been installed to incinerate the gas completely so that only carbon dioxide and water vapor escape to the atmosphere. Again referring to Los Angeles County, since it is the most completely documented area, the total daily loss of hydrocarbons from refining operations is less than the evaporation loss from carburetors and gasoline tanks of automobiles operating on the streets on a hot summer day.

Odor abatement is another of the important phases of air pollution control. Throughout the petroleum refining industry the philosophy is being adopted that refineries don't have to smell bad. Incineration at high temperature to destroy such odor-producing materials as hydrogen sulfide or mercaptans and the use of air oxidation to convert sulfur compounds to water soluble salts are examples of odor control. Spent caustic soda solutions containing phenols and sulfur compounds are potential odor sources in the industry. Careful control of these waste solutions going into sewers, chemical treatment of the wastes, and, in some cases, sale of the waste materials to outside chemical companies for recovery of by-products, has done much to eliminate the odor problem. In general, these are not profitable operations but again reflect the efforts of the industry to be good citizens in the communities in which it operates.

Ten years ago very little was known about the chemistry of the atmosphere and the mechanism of reactions leading to air pollution. Following World War II and the growth in population and industry on the West Coast, the increase in "smog" in Los Angeles County prompted regulations governing the emission of atmospheric pollutants. None of these proved effective in eliminating the nuisance. About 1947 the Western Oil and Gas Association decided

to find out what really caused "smog" in the Los Angeles area. Thus began a long and expensive research program. The Western Oil and Gas Association has done a great deal to advance the knowledge about "smog" formation, and, in addition, has been able to catalog pollutants from operations of the oil industry in the Los Angeles area. It has been found that oil industry operations make only a small contribution to the over-all pollution problem.

The oil industry soon realized that proper decisions with regard to the control of atmospheric pollutants could not be made without accurate, scientific information. In instances where legislation is regarded as necessary, fundamental knowledge based on reliable research rather than on theory or hypothesis or opinion should be available to government agencies to avert restrictive and uneconomic rulings of the type which might later prove to be unnecessary.

Accordingly, in 1951 the entire U.S. petroleum industry determined to supplement the already considerable efforts of its West Coast members in air pollution research. Through the Division of Refining of the American Petroleum Institute, a "Smoke and Fumes Committee" was established to set up a program to determine factually the causes and methods of control of atmospheric pollution resulting from production, transportation, manufacture, and use of petroleum products. Research projects were established at qualified research centers to obtain fundamental knowledge of the mechanisms leading to air pollution. To date, the API's research expenditures in this field have exceeded $1.3 million, and the work is continuing at a substantial level. The combined expenditures of the API, the Western Oil and Gas Association, and numerous individual companies result in an estimated total of more than $1 million per year being spent by the petroleum industry for research in the air pollution field. The following examples illustrate the type of work being done.

At the Franklin Institute research into the nature of chemical reactions in the air leading to atmospheric pollution has produced outstanding results. The design and construction of the long-path infrared spectrometer (popularly known as "Silent Sam, the Smog Detective") has placed a tool in the hands of scientists to permit measurement of materials in the atmosphere at concentrations in the parts per million range. The Franklin Institute studies have substantiated earlier findings that hydrocarbons and oxides of nitrogen in the presence of oxygen react under the influence of sunlight to form ozone. In the course of these investigations, a new organic compound, peroxyacyl nitrite ("Compound X") was identified. It was originally suspected as the material responsible for eye irritation, but subsequent research has shown it to be an intermediate compound in atmospheric reactions.

Oxident-type damage to vegetation is one of the manifestations of "smog." This damage is unique and is believed to be caused by oxidized organic materials. The damaging substance has not yet been identified, but API-sponsored research at the University of California at Riverside is in progress to study the reactions of ozone and hydrocarbons in an attempt to identify the materials responsible.

As mentioned earlier, sulfur compounds have long been recognized as sources of air pollution. Sulfuric acid aerosol has been suggested as one

of the causes of reduced visibility accompanying air pollution. At the University of Illinois, a research project sponsored by the Smoke and Fumes Committee clearly demonstrated that the uncatalyzed gas-phase oxidation of sulfur dioxide in naturally polluted atmospheres in natural sunlight was not sufficiently rapid to be significant in effectively reducing visibility.

The use of petroleum products as fuel is continually increasing in both domestic and industrial heating devices. Many questions have arisen as to the nature and extent of air pollution from such sources. At the Armour Research Foundation, both laboratory and field trials of industrial and domestic burners were conducted to determine the quantity of pollutants emitted. Analysis of the gaseous effluents led to the conclusion that neither domestic nor industrial furnaces burning oil or gas release significant amounts of hydrocarbon contaminants to the atmosphere.

Other research activities sponsored by the Smoke and Fumes Committee have included an air analysis program in several United States cities showing that the oxident level of Los Angeles is abnormally high by comparison; analysis of gaseous compounds in the atmosphere to determine the sources of atmospheric carbon; the development of gas chromatographic methods of analysis for the determination of the composition of exhaust gases; the demonstration of a successful technique to trace air pollution from a single source; and the development of a method of detection of ozone suitable for use in continuous, portable instruments.

Recently automobile exhaust has been singled out as the principal contributor to air pollution of the type found in the Los Angeles area. In June, 1957, the Smoke and Fumes Committee of the API joined forces with the Air Pollution Foundation to study this problem. Both fuel composition and automobile variables have been studied in a system designed to evaluate eye irritation, visibility reduction, and ozone formation as well as the chemical properties of the pollutants obtained from photochemical reactions. Automobile exhausts from fuel mixtures representing extremes in composition of the hydrocarbons of the types found in gasoline were compared with exhausts from a blend of commercial gasolines. The results of these studies have demonstrated conclusively that the exhausts from all fuels tested produce recognizable symptoms of air pollution when irradiated. While some differences in the exhausts produced by different fuels were found, the exhausts from all of the fuels tested produced substantial eye irritation when irradiated, and each produced the same maximum concentration of ozone. It was further demonstrated that eye irritation, visibility reduction, and ozone formation from automobile exhaust are affected as much by differences in automobiles as by differences in fuel composition.

The petroleum industry attempts to control pollution voluntarily rather than await compulsory rules and regulations. Because more information is available about the Los Angeles situation law-makers may tend to look to this area as a source for control regulations. It has been pointed out that the Los Angeles Air Pollution Control District attempts to keep its actions within the limits of current scientific developments. For this they are to be commended. Nevertheless, no community should attempt to pattern a control system after the Los Angeles plan until the need for each regulation has been thoroughly explored. The tendency to adopt entire sets of regulations from another area can lead to programs which unnecessarily impede the progress of the entire community.

Enforcement of air pollution control laws under the permit system -- as practiced in Los Angeles -- requires air pollution control before it is proved that such controls are necessary. On the other hand, an injunctive system based on civil action prevents the needless expenditure of funds for costly controls until it is shown that a pollution problem really exists.

In the past ten years the oil industry has learned a lot about the nature of air pollution and its control. The history of air pollution as related to the industry has revealed scientific facts from which everyone concerned with the problem can benefit. It is clear that air pollution cannot be simply legislated out of existence. Causes, sources, and methods must be known. Control regulations satisfactory to one community should not be adopted by another as the "easy way out." It may be the easy way but also the most expensive and the least satisfactory. The problem must be defined before a solution can be found.

The petroleum industry throughout the nation is continuing to cooperate with local authorities to determine the problem in each local area concerned and to do everything in its power to reduce air pollution caused by the industry. We know we are making progress, because emissions from the processing of petroleum have been drastically reduced.

The air pollution nuisance can only be overcome by the cooperative effort of everyone concerned: industry, government, scientists, and the private citizen. I am certain the petroleum industry will continue to do its share.