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FEATURES

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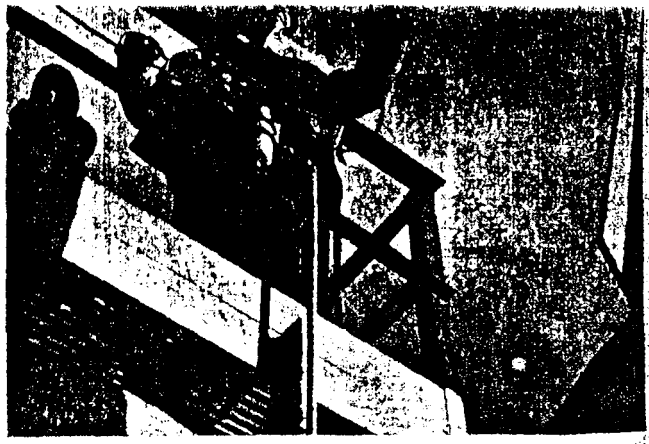


Tool of the industrial hygienist: The midget impinger, an instrument which draws a measured volume of air through a trap containing a liquid collecting medium. Here, the midget impinger is being used to sample atmospheric concentration of toxic dust.

INDUSTRIAL HYGIENE *in the Petroleum Industry*

A. C. Pabst, industrial hygienist, Socony-Vacuum Oil Company, Inc., is called in at the blueprint stage where basic hygiene measures can be incorporated into plants, processing units and other installations, helping to save time, money and problems for management.

A. C. Pabst

THE petroleum industry has made remarkable and enviable progress not only in developing new and better products, but equally in anticipating market demands in terms of both quality and quantity. It has an extraordinary record for providing the customer with what he wants, where and when he wants it. New processing methods have been necessary, of course, to achieve these results.

Many of these processing methods represent highly complex chemical operations that present problems and situations new to the industry. With foresight and planning, the petroleum industry is solving these problems, and, in fact, anticipating situations so that they do not become problems. To accomplish this, comparatively new sciences like health engineering are studied with the same zeal as other types of research. Practically unknown 20 years ago, today's occupational health includes the fields of industrial hygiene and industrial medicine.

Because industrial hygiene is one of the newest phases, many people do not know the meaning of the term, or the functions of the industrial hygienist. Nevertheless, the safeguarding of industrial health already is on a business basis, with labor and management recognizing its importance. Government, too, takes an active interest, and 19 states have health department rules on industrial hygiene. Today, there are only about 800 industrial hygienists in the United States, and a large number of this group are not in industry, but are working for the federal government or state departments.

People hearing the word "hygiene" usually recall they had a hygiene course in high school which dealt with personal habits such as bathing, cleaning the fingernails, teeth, etc., and immediately jump to the conclusion that an industrial hygienist in industry must be interested in keeping employees clean. In my first visit to many of our refineries, it seemed that I was always taken first to the locker rooms and toilets to inspect shower and lavatory facilities. Of course, industrial hygienists are interested in the employee's cleanliness as it is necessary to protect his health, but their primary interest is not in sanitary facilities. They are more interested in keeping an employee's lungs, skin, and other organs free from exposure to hazardous gases, liquids, dusts, and other harmful substances.

The petroleum industry is becoming increasingly involved in the handling of all kinds of chemicals having various degrees of physiological effects on man. These chemicals might be described by quoting from a publication issued by duPont's Haskell Laboratory of Toxicology."

"It Takes All Sorts"

"Chemicals, like people, can be mild, fractious and often exasperating.

"Like people, chemicals are of many types and dispositions. Most are uncomplaining, law-abiding citizens who present no special problems. Some are unstable and unpredictable. Some are out-and-out neurotics, requiring a sharp and observant discipline. Others, harmless by themselves, may be influenced by bad company. Still others are troublemakers in solitary, but docile and helpful in tandem. Some are just plain bad actors."

EXCLUSIVE

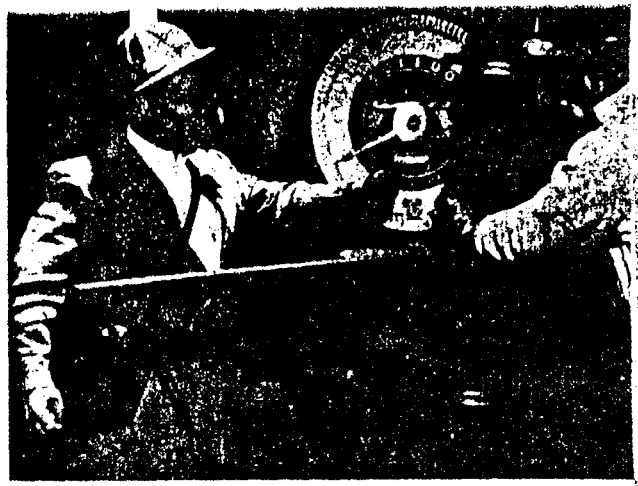
Many of the compounds with which the petroleum industry is concerned are new or are being studied more fully. The industry's concept of industrial hygiene compares favorably, however, with similar activities in chemical and other industries, which have worked many years on these problems.

The advent of catalytic cracking resulted in the production and handling of aromatic hydrocarbons with health problems similar to those long associated with the coal-tar industry. The use of new chemical catalysts, inhibitors, and other chemical compounds creates health problems that the chemical industries have faced for years. To illustrate this trend we need only look at the modern gasolines, fuel oils and motor oils. Years ago motor oils were practically 100 per cent petroleum in nature with little, if any, additives; today they contain up to 15 to 20 per cent of chemicals, additives and inhibitors. This trend doubtless will continue because there is no question that additives contribute much to improve performance characteristics. With every change in formulation, any business makes careful studies regarding the health and safety of personnel and customers. Problems that may arise are solved, many of them by industrial hygiene.

Hygiene is defined as that branch of medical science that relates to preservation of health, and therefore, industrial hygiene may be defined as the science of prevention and control of occupational illness. It resolves itself into the problem of looking for any factors or conditions in work places that could cause or contribute to illness or serious discomfort of employees, and of devising the methods and means of eliminating or controlling such conditions.

The typical industrial hygienist usually started out as a chemist or chemical engineer who became interested in and studied toxicological effects of chemicals on man. Consequently, he has a good background of chemistry and engineering combined with some medical knowledge—a sort of one-third doctor, one-third engineer, and one-third chemist. His objectives are the protection and improvement of the health and safety of workers in the industrial environment from all manner of harmful exposures related to occupation. In the petroleum industry, industrial hygienists usually function as an important part of the medical department and in close collaboration with the safety department for the protection of employees.

Basically, the practice of industrial hygiene in the petroleum industry is the same as in any other industry, and it can be boiled down to four general principles:



The midget impinger is to be used for air sampling in a refinery work area.

1. A knowledge of the toxicology of chemicals and materials.
2. A review of all chemicals or materials used or produced, how handled and the tabulation of toxic or potentially hazardous substances.
3. The measurement of worker exposure to toxic substances.
4. The recommendation and installation of adequate control measures and the evaluation of the effectiveness of such corrective steps where indicated.

Toxicology of Chemicals

In regard to Item 1, the toxicology of chemicals, it is difficult to give an adequate definition of a toxic material because practically anything can be safe or harmful depending upon how it is used or where it is used. For example, air and water are not regarded as harmful, but both are quite deadly under certain conditions—air if injected into the blood stream and water if introduced into the lungs. In the same manner, the use of carbon tetrachloride in a process having proper ventilation would not be hazardous, while the use of carbon tetrachloride for mopping floors would be quite dangerous. In other words, a toxic material may be hazardous or non-hazardous, depending on the conditions of its use.

In regard to toxicology, there are three ways in which a harmful substance can cause adverse effects upon man:

1. It can be ingested or swallowed.
2. It can come into direct contact with the skin or parts of the body.
3. It can be inhaled as a gas, vapor, mist, or dust.

Ingestion

Fortunately, petroleum materials are not commonly or intentionally taken internally and therefore, trouble from this is rather rare in a refinery, although it occasionally does occur unknowingly. I recall watching a worker who had been complaining of stomach trouble, whose duties involved the compounding of litharge or lead oxide in a doctor solution—this man proceeded to empty the bags of litharge into an outdoor mixing tank and, because of the dust and mists generated, he correctly wore a respirator. Of course, his hands were covered with lead oxide, and to my amazement, the first thing he did when he came down from the catwalk was to take from his lunch box an orange which he started to peel and eat, probably one of the most effective ways to get lead poisoning.

When petroleum products get to the consumers, ingestion is more frequent, but nearly always its occurence is a result of carelessness or mishandling. Small children whose parents carelessly leave products within easy reach may have unhappy experiences. We have had hurry calls from doctors involving children drinking kerosine or such products as penetrating oil and fly sprays. Sometimes adults are even worse. There are cases of anti-freeze poisoning, drinking of brake fluid and one, I recall, of a radiator flush that contains muriatic acid and chlorinated hydrocarbons. This occurred despite the fact that the product was fully labeled, including poison warning with skull and cross bones.

It should be emphasized that hardly a substance exists that is not capable of producing adverse effects on the human body if taken in sufficient quantity or

TABLE 1. Average effect of alcohol level in blood.*

Ounces of whiskey consumed in 1 hr or less	% alcohol in blood	Behavior
½	0.01	Normal
1	0.02	Feeling of warmth, pleasant social behavior.
2–3	0.05	Judgment blunted; Boastful, impulsive, Officially still sober.
5–6	0.1	Fumbling, staggering gait, clumsiness, slurred speech.
8	0.15	Officially drunk. Responses and motor coordination strongly affected.
10	0.2	Helpless, nausea
16	0.3	Stupor
24	0.4– 0.5	Coma
30	0.6– 0.7	Paralysis of the respiratory center—Death.

*Pfizer Spectrum, JAMA, March 27, 1954.

Problem for the industrial hygienist: Instructing employees in the proper handling of toxic materials. This posed shot represents an actual instance where a worker, handling lead oxide, neglected to wash his hands before eating. If his careless habit had not been corrected, he would have had a real health problem.

It should be a part of any occupational health program to educate employees in the correct handling of materials and to warn of the hazards of excessive exposure. Here, a kettle is being charged with a chemical which generates toxic dust. Note use of respirator, gloves, ventilating equipment, and coverall.

under wrong circumstances. Even common table salt is toxic if taken in sufficient amounts. It is reported that many years ago, the Chinese used table salt as a means of committing suicide. Every chemical, therefore, has a nontoxic dose and at toxic dose. This can be well illustrated by Table 1 on a widely used commodity.

Skin and Body Contact

In the petroleum industry, skin contact is not generally experienced to the extent that it is, for example, in the metalworking industries where a daily eight-hour contact with cutting oils often takes place. Cases of oil dermatitis are uncommon among our employees but they are reported not infrequently among industrial users of petroleum products.

It is definitely established that skin is not an impermeable barrier to chemical substances. In fact, it is increasingly important as a route of absorption for many materials. Regarding external or local skin effects, chemicals may be classified either as primary irritants or sensitizing agents.

A primary irritant is a chemical that may cause dermatitis in individuals, frequently after only one contact. It may have a strong chemical action, like acid, alkalis, amines, etc., or it may have a weak chemical action and require prolonged contact to cause dermatitis. Most petroleum hydrocarbons are primary irritants but are usually weak irritants since prolonged or extensive contact is generally required to cause skin irritation. The petroleum industry now is handling large quantities of chemical additives and inhibitors, many of which are strong primary irritants and are active chemical compounds.

It should be a part of any occupational health program to educate employees in the correct handling of such materials and to warn of the hazards of exposure. Recommendations and instructions also are given for protective equipment like respirators, goggles, gloves, and aprons.

This applies to concentrated or undiluted inhibitors. Finished petroleum products should and usually do contain such a small quantity of additives and in such dilution that there is scarcely more harm in the finished product than there would be from straight mineral oil itself.

Bizarre and erroneous conclusions sometimes are drawn in industrial dermatitis cases as to their cause, even by those who should know better. I recall a case of a young man who worked in a gasoline station and developed a severe dermatitis. He went to a physician who made patch tests on him and found he had a sensitivity to special gasoline but practically no reaction to regular gasoline. Apparently, the physician had heard special gasoline contains a lot of lead because the case was diagnosed as resulting from an excess of lead tetraethyl in the special gasoline. We thought this strange because lead tetraethyl is not a primary skin irritant and never has been known to cause dermatitis, although it is known to be a poison and can be absorbed through the skin.

A review of records of gasoline shipments into the particular area showed the regular gasoline actually contained the same or sometimes more lead than the special gasoline, clearly indicating that lead tetraethyl was not to blame, but that some other material was responsible, possibly the coloring agent.

Inhalation

Of the three avenues by which chemicals can be taken into the body, inhalation probably has received the most study and investigation because it is the avenue of greatest importance in industrial operations. From a vast amount of research has come publication of very useful data on safe human exposure levels known as Threshold Limit Values or Maximum Allowable Concentrations. This is a list of several hundred commonly encountered chemicals, solvents, dusts, etc., the toxicology of which has been carefully studied by medical research and industrial experience.

The list is compiled annually by the American Conference of Governmental

Industrial Hygienists and is published by the American Medical Association in AMA Archives of Industrial Hygiene and Occupational Medicine. Introductory paragraphs define the values as follows:

"Values are given in the following tabulation for the maximum average atmospheric concentration of contaminants to which workers may be exposed for an eight-hour working day without injury to health.

These values are based on the best available information from industrial experience, from experimental studies, and, when possible, from a combination of the two. They are not fixed values but are reviewed annually by the Committee on Threshold Limits for changes, revisions, or additions as further information becomes available. Threshold Limits should be used as guides in the control of health hazards and should not be regarded as fine lines between safe and dangerous concentrations. They represent conditions only

They represent conditions only within which it is felt that workers may be repeatedly exposed, day after day, without their health being adversely affected. It is felt, at the present time, that workers should not be exposed to a working environment containing any of these substances in excess of the value indicated.

These values are not intended for use, or for modification for use, in the evaluation or control of community air pollution or air pollution nuisances."

A few of the materials encountered in the petroleum industry and their Threshold Limits are listed below:

Gases and Vapors

Substance	Parts per million
Benesene (benzol)	35
Carbon dioxide	5000
Carbon monoxide	100
Carbon tetrachloride	25
Gasoline	500
Hydrogen sulfide	20
Naphtha (petroleum)	500
Octane	500
Sulfur dioxide	10

Toxic dusts, fumes, and mists

Substance	Milligrams per cubic meter
Iron oxide fume	15
Lead	0.15
Sulfuric acid	1

Mineral dusts

Substance	Millions of particles per cubic foot
Asbestos	5
Dust (nuisance, no free silica)	50
silica	
high (above 50% free SiO_2)	5
medium 5 to 50% free SiO_2)	20
low (below 5 % free SiO_2)	50

Nineteen states observe Threshold Limit Values in their laws or regulations, and more are sure to follow. Industrial hygienists, as part of their duties, advise management of the existence of these requirements in order that precautionary measures may be taken to avoid excessive exposure of personnel.

Industrial hygienists undertake measurement of air contaminants for compliance with states' codes. Even a common material like gasoline has a maximum safe level which is 500 parts per million.

The following are just a few of the hazardous materials that are encountered in petroleum refinery operations:

Materials encountered in petroleum refinery operations

Respiratory irritants	Toxic materials	Skin irritants
Acrolein	Aniline, liquid	Acids—all kinds
Acetaldehyde	Anilne, dyes	Amines
Aluminum chloride	Benzol (Benzene)	Benzol (Benzene)
Ammonia	Cadmium	Caustics
Asbestos	Carbon monoxide	Chromium salts
Ditertiary butyl para cresol	Chlorinated hydrocarbons	Coal-tar compounds
Dusts, physiologically inert, general	Chrome compounds	Cobalt, metal and compounds
Dusts, attapulgus clay	Cobalt, metal	Dyes
Dusts, bauxite	Hydrogen sulfide	Inhibitors
Dusts, catalyst	Inhibitors	Nickel salts
Formaldehyde	Lead, metal & fumes	Oils, general
Fluorides	Lead, oxide, litharge	Oils, high boiling aromatic
Furfural	Lead, tetraethyl	Oils, insoluable cutting
Inhibitors	Lead, soaps	Phenol
Lime	Manganese	Pitch
Nitrogen oxides	Mercury	Solvents
Ozone	Methanol	Ultra violet radiatioo
Pine oil	Radioactive materials, general	Wax, untreated
Silica	Toluol (Toluene)	
Smoke	Xylol (Xylene)	
Sulfur dioxide	Zinc	
Welding fumes		

Product Labeling

One very important function of the industrial hygienist in the petroleum industry concerns precautionary labeling of products. This is receiving more emphasis as state after state passes labeling regulations. One of the most recent is the State of New York, where on February 26, 1954, the Council on Public Health passed labeling regulations which became effective August 26, 1954, as Chapter IX-A of the New York State Sanitary Code. These labeling regulations have the force and effect of law and require precautionary labeling on any product that entails a hazard in a reasonably anticipated use.

A hazard is defined as "the risk of injury or illness which may be encountered during or as a result of any reasonably anticipated type of handling or use of a substance, or during its specified use, if any, by reason of toxicity of the substance through ingestion, inhalation or absorption through the skin, or due to its corrosiveness or irritating properties, or because of its flammability or explosiveness."

Somewhat similar labeling regulations already exist in California, Illinois, New Jersey, Oregon, and the Territory of Hawaii and are in the making in many other states, so more can be expected. Most state regulations are guided by recommendations of the Manufacturing Chemists' Association, Inc., and with some exceptions, conformity in one state results in conformity in other states.

It is recognized that, as a rule, labeling of many products is advisable and results in safer handling of the material by customers. However, this requires extensive work, knowledge of product, and toxicological information to determine what products must be labeled and how they should be labeled.

Prior to 1932, only a handful of persons were engaged in industrial hygiene procedures. By the end of the next decade, there were industrial hygiene divisions in nearly every industrial state, and in many insurance companies. Industries themselves, however, have made the greatest expansion in industrial hygiene units over the past 22-year period. Today, in most large industries, industrial hygiene is being conducted under the guidance of increasingly well-trained, professional personnel.

No longer is industrial hygiene seen by industry as an "aimless effort of intellectuals collecting bottles filled with nothing so that they can prepare long and useless discourses that few read or understand or would know what action to take". Instead, the safeguarding of health is assuming a new significance. It not only saves time, money, and problems for management, but it actually improves employee morale and efficiency by eliminating apprehension in occupational environments.

Instead of telling what mistakes have been made and how to correct them with costly changes, industrial hygienists now are called in at the blueprint stage where their ideas can be incorporated into factories, machines and other installations to accomplish the most good easily and inexpensively.

Industrial hygiene at its best in the petroleum industry requires the cooperation and skills of industrial physicians, industrial nurses, toxicologists, chemists, safety men, and industrial hygienists working together as a team. American industry, particularly the oil industry, is aware of the benefits of more and better production derived from environmental control and health-promotional activities. It needs only to be guided in the application. * * *