



The industrial hygiene laboratory has become a center of research for better working conditions through study of materials used and control of manufacturing processes. (Courtesy General Electric Co.)

The Expanding Field of Industrial Hygiene

By A. C. PABST

Twenty years ago industrial hygiene was a new science. Today the hygienist and the safety engineer are on the same team working for a safer environment

INDUSTRIAL HYGIENE is a field that is closely interwoven with industrial safety. In fact, it can be regarded as a medical engineering phase of safety.

Unfortunately, many people know little about industrial hygiene and the functions of the industrial hygienist. Industrial hygiene is a comparatively new science—practically unknown 20 years ago. Today there are only 800 industrial hygienists in the United States, and a large num-

ber of them are not in industry but working for the federal government or state departments.

Usually, the word "hygiene" recalls hygiene courses in school which dealt with personal habits, such as bathing, brushing teeth, cleaning finger nails, etc. People jump to the conclusion that a hygienist in industry must be interested in keeping employees clean. In my initial visit to many of our refineries, it seemed that the first stop in the tour was to visit the locker rooms and to inspect shower and lavatory facilities.

Industrial hygienists are interested in personal cleanliness so far as it is necessary to protect the employee's health. We are

more interested in keeping his lungs free from poisonous dusts and gases, his bones free from lead, his liver free from chlorinated solvents, etc.

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

The industrial hygienist has

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done much toward bringing medicine and safety engineering into close cooperation partly because his interest overlaps these two fields.

The typical industrial hygienist started out as a chemist or chemical engineer who became interested 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 from all manner of harmful exposures related to occupation.

From this you will note that industrial hygienists and safety engineers have pretty much the same objectives and are members of the same team. Actually, the functions of each are sometimes so inter-related it is not possible to draw clear lines of separation. Nor is it necessary to do so, for if a man's health is endangered by working conditions it is an important part of his safety picture. In many industries, safety and industrial hygiene are combined in the same department.

In the petroleum industry, how-

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.

—From a publication by Du Pont's Haskell Laboratory of Toxicology

* * * * *

ever, industrial hygienists are usually attached to the medical department and work as closely as possible with the safety department. There is good reason why the petroleum industrial hygienists must lean heavily upon the safety department. In the petroleum industry the concept of industrial hygiene is relatively new and is considerably behind similar activities in the chemical and other industries, consequently, the number of petroleum industrial hygienists is exceedingly small.

On the other hand, safety departments are well established, well acquainted and close to the every day problems of the petro-

leum industry, and have considerably more coverage and manpower. To illustrate, the American Petroleum Institute's roster of safety and fire protection personnel lists some 1200 names, probably not all, in this occupation.

Contrasted to this, to the best of my knowledge, there are at present only 17 industrial hygienists working for petroleum companies—an industry ratio of approximately 70 safety men to one industrial hygienist. Most of the major oil companies now have at least one industrial hygienist and from 50 to 100 safety men, so you can see it is very necessary for us to work with and through our safety people.

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:

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

Toxicology of Chemicals

In regard to Item 1, the Toxicology of Chemicals, it is usually difficult to adequately define a hazardous material because practically anything can be safe or harmful depending upon how 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 properly designed ventilation would not be hazardous, while the use of carbon tetrachloride for mopping floors would be quite dangerous. Most safety people are aware that carbon tetrachloride is a hazardous chemical because there has been con-

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TABLE I—EFFECT OF ALCOHOL LEVEL IN BLOOD*

Ounces of Whiskey Consumed in 1 Hr. or less	% Alcohol in Blood	Behavior
3/4	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

A Safe Job at Last (Want to Bet?)

Nicholas Alkemade, of Loughborough, England, has a new job and, for the first time in his life, he feels secure says a *Chicago Tribune* story.

Alkemade's first job was rear gunner in a bomber. On a mission over Germany in 1944, his plane was hit and caught fire. The pilot ordered the crew to bail out. But Alkemade's parachute was on fire. So was his clothing. Faced by certain death if he remained in the plane, Alkemade jumped—without a chute.

As he tumbled head over heels, he lost consciousness. Three hours later he came to—in a big snow-drift. The 3½ mile fall, plus the snow, had put out the flames in his clothing. The snow had broken his landing.

He started to walk, but discovered a knee was injured. It collapsed on him. He spent the rest of the war in a prison camp.

After the war, Alkemade got a job in a factory. A nine foot piece of steel fell on him. He was knocked out but lived.

He changed his job and started pumping ammonia from a tank, where nothing could fall on him. But his electric pump shorted. The shock knocked him out although his rubber soled shoes saved his life. As he slumped in the tank, his gas mask slipped off. An alert colleague saved him.

He changed his job again. His new task involved transfer of sulphuric acid. The hose broke and acid sprayed over him, but prompt spraying with a neutralizing chemical again saved him.

Alkemade, now 32, and amazed to be alive, has a new job again—selling accident insurance.

Industrial Hygiene

—From page 21

siderable publicity regarding its toxicological effects, and in some cases, restrictive labeling requirements have been passed, for example, in New York City. Many other chemicals used in the petroleum industry have inherent toxic qualities of the same magnitude, yet are not so well known.

In regard to toxicology, there

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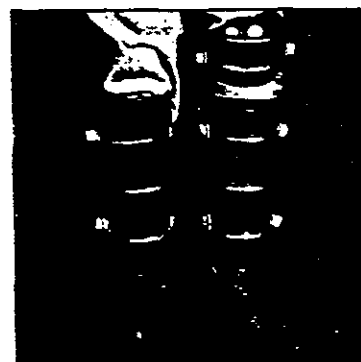
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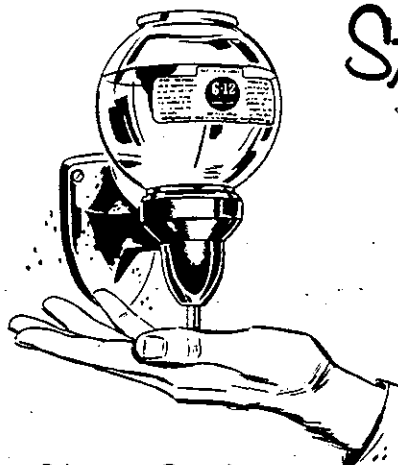


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are three ways in which a substance can cause adverse effects upon man:

1. It can be ingested or swallowed
2. It can be harmful by 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 does occasionally 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 off the catwalk was to take an orange out of his lunch box which he started to peel and eat—probably one of the most effective ways to get lead poisoning.

Unfortunately, when petroleum products get into the hands of customers, ingestion is more frequent, usually by small children whose parents carelessly leave products within easy reach. You know that every year there are fatalities reported from children drinking kerosene. We have had hurry calls from doctors involving children drinking penetrating oil and fly sprays. Some times adults are even worse, as there are many cases of anti-freeze poisoning, drinking of brake fluid, and one I recall of our radiator flush which contains muriatic acid and chlorinated hydrocarbon. This product is fully labeled, including skull and cross bones.

It should be emphasized that hardly a substance exists that is not capable of producing effects on the human body if taken in sufficient amounts or under the wrong circumstances. Even common table salt, if used in sufficient quantities, is toxic. It is reported

that many years ago the Chinese used table salt as a means of committing suicide. Every chemical substance, therefore, has a non-toxic dose and a toxic dose for man. This can be illustrated by the following data on a widely used commodity, shown in Table I.

Skin and Body Contact

Approximately 60 per cent of complaints received by our department are concerned with dermatitis and skin irritations resulting from contact with petroleum materials. By far, the majority of these complaints are from customers so this subject is very important in the marketing of petroleum products.

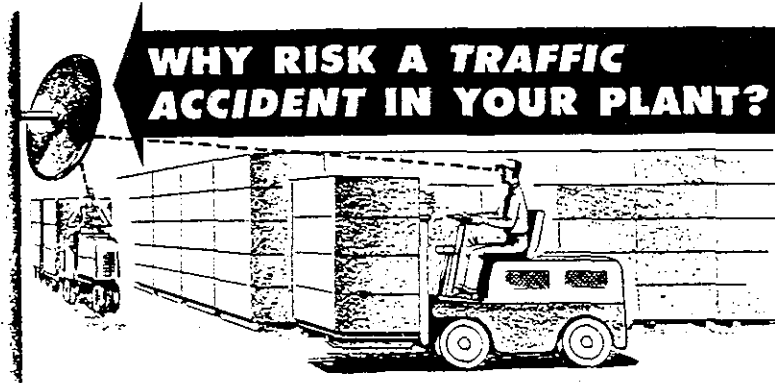
Cases among our employees or in our refineries are few when compared with those among industrial users of petroleum products, and it is believed that the reason for this is due mainly to the degree or extent of contact. In the petroleum industry skin contact is not generally experienced to the extent that it is, for example, in the metal working industries where a daily eight hour skin contact with cutting oils often takes place.

It is definitely established that skin is not an impermeable barrier to chemical substances, and it is increasingly important as a route of absorption for many materials. Action of chemicals on skin may be local, resulting in dermatitis. Examples we are familiar with are kerosene, cutting oils, etc., or a chemical may be absorbed through the skin and cause damage to blood or internal parts of the body. Lead tetraethyl, as an illustration, does not affect the skin or cause dermatitis but can penetrate the skin and cause internal poisoning.

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. They may have a strong chemical action, such as acids, alkalis, amines, etc., or they may have a weak chemical action but require prolonged contact to cause dermatitis. Most petroleum hydrocarbons are primary irritants but

National Safety News, April, 1955

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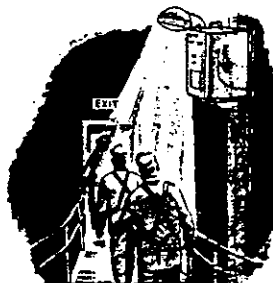
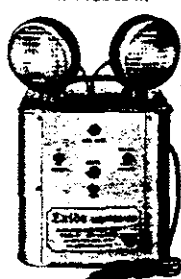
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are classed in the latter category in that prolonged contact is usually required to cause irritation.

Sensitizing agents, on the other hand, are chemicals that are innocuous to most skin but capable of producing dermatitis in a few susceptible individuals following repeated contacts over a long period. Sensitization may require weeks, months or even years of contact with the material before dermatitis develops.

As mentioned above, the petroleum industry is now handling large quantities of chemical additives and inhibitors, many of which are strong primary irritants and very active chemical compounds. By nature, inhibitors usually have to be very potent chemicals because while they are used in very low concentrations, they exert a powerful influence on the characteristics or performance of the product, and many of the inhibitors are just as potent towards man.

One very active class of inhibitors are the amines and substituted amines, and we are particularly concerned about them because they are very damaging to the eyes, and a splash can readily result in blindness. The amines are usually strong smelling caustic liquids, insoluble in water, hence difficult to remove by washing. They can cause severe eye burns and necrosis of eye tissue. In addition, most amines are readily absorbed through the skin, and even low quantities may cause internal damage, and death.

Employees should, of course, be fully alerted as to the hazards of such materials and should be educated to the use of protective goggles, gloves and aprons.

The foregoing applies to concentrated or undiluted inhibitors. Finished petroleum products should and usually do contain such a small quantity, and the inhibitor is so diluted, as to result in practically no more harm in the finished product than there would be from the straight mineral oil itself.

Industrial dermatitis cases sometimes result in erroneous conclusions as to their cause, even by those who should know better. I recall the case of a young man

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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 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 while we all know that lead tetraethyl is a violent poison and can be absorbed through the skin, it is not a primary skin irritant and has never been known to cause dermatitis.

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 proving that lead tetraethyl was not to blame, but that some other material was responsible.

Inhalation

Of the three avenues by which chemicals can be taken into the body, inhalation probably has received by far the most study and investigation because it is the most important consideration in industrial health. The vast amount of research on the inhalation of materials has resulted in the publication of very useful data on safe human exposure levels known as threshold limit values, or maximum allowable concentrations. The list is compiled annually by the American Conference of Governmental Industrial Hygienists and is published by the American Medical Association. It tabulates the maximum amount of the various materials workers can safely be exposed to for an eight-hour working day without injury to health.

A few of the materials encountered in the petroleum industry are listed in Table II.

TABLE II

Gases and Vapors

Substance	PPM
Benzene (benzol)	35
Carbon dioxide	5000
Carbon monoxide	100
Carbon tetrachloride	25

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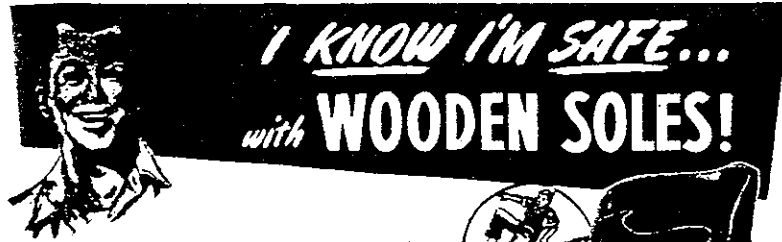
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Safety Equipment for all Industries

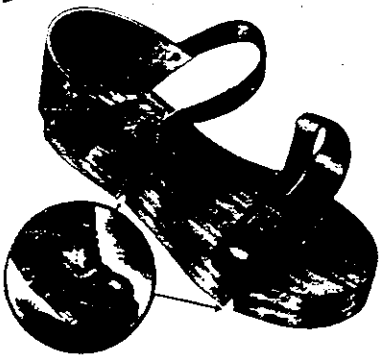
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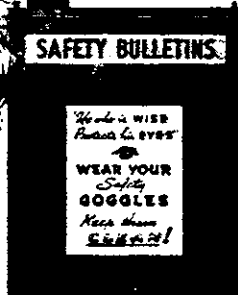
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Iron oxide fume	15	
Lead	0.15	
Sulfuric acid	1	

Mineral Dusts

Substance	MPPCF
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

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 within which it is felt that workers may be repeatedly exposed, day after day, without their health being adversely affected.

I cannot overemphasize the importance of the threshold limit values. I believe that every safety man should be familiar with them and have copies of the complete table, because they have been incorporated in state codes and have the force of law in many states, and therefore, must be complied with. So far some 19 states have written threshold limit values into their laws and often management is not aware of such requirements but would be in a vulnerable position if trouble resulted from excessive exposure to any of the materials. Usually it is up to the safety people and the industrial hygienists to alert management to the existence of these codes and to institute measures for the measurement of air contaminants so as to insure compliance.

Even gasoline has a maximum safe level which is 500 parts per

million. The result of exposure to concentrations greater than 500 ppm is shown by the following:

TABLE III—GASOLINE EXPOSURE

Symptoms: Headache, irritation of eyes and throat, dizziness, nausea, loss of consciousness, death.

	Parts Per Million	%
Maximum allowable concentration for prolonged exposure	500	0.05
Slight symptoms after several hours	1000	0.1
Maximum concentration tolerable for 1 hr.	5000	0.5
Dangerous for short exposure	15000	1.5
Fatal for short exposure	25000	2.5
Lower explosive limit	14000	1.4

Product Labeling

One very important function of the industrial hygienist is in regard to precautionary labeling of product. This is receiving more and more emphasis as state after state passes labeling regulations. The most recent is the State of New York where the Council on Public Health passed labeling regulations which became effective August 24, 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 which 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 the 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.

Similar labeling regulations already exist in California, Illinois, Oregon, and the Territory of Hawaii, and are in the making in New Jersey, New Hampshire, Ohio and Rhode Island. More can be expected. Fortunately, most state regulations are guided by recommendations of the Manufacturing Chemists' Association, Inc., and with some few exceptions, conformity in one state results in conformity in other states.

It is recognized that, as a rule, labeling regulations of many products are advisable and result in safer handling of the material

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This bulletin illustrates a simple and inexpensive way of constructing your own guards for moving parts, such as: flywheels, gears, and belts, and for individual punch press dies. Only ordinary tools, such as a hack saw, hand snip, hammer and screw driver are needed. When properly constructed, guards made of sturdy H & K parts will comply with State and insurance requirements and will conform with American Standard Safety Codes.

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INDUSTRIAL
Safety Apparel**

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Trade Mark

INDUSTRIAL GLOVES COMPANY

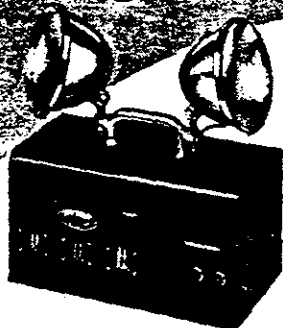
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1704 Garfield Street, Danville, Illinois
(In Canada: Safety Supply Co., Toronto)



Big Beam

**AUTOMATIC
EMERGENCY
LIGHTS**



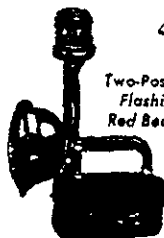
GUARD AGAINST The Hazards of Sudden Blackouts

Big Beam Model 2ATW with storage battery and built-in charger that keeps battery fully charged at all times. Variety of models to choose from.

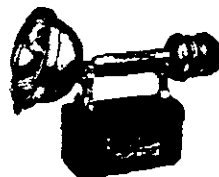
Sudden blackouts breed confusion, panic, property damage, bodily injury — even loss of life. You can have completely dependable protection against sudden blackouts by installing

Big Beam automatic emergency lights. (Plug into any convenient lighting outlet.) Then whenever regular lights fail, your Big Beam will provide hours of bright, safe illumination.

Big Beam PORTABLE ELECTRIC HAND LAMPS



Model No. 164 (Sealed Beam)
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BEACON LAMP



Model No. 408F
Flare and Lantern



Model No. 211
1500-Foot Beam

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by customers, but it requires extensive work, knowledge of product and toxicological information to determine what products must be labeled and how they should be labeled. In our company's operations, we use somewhat over 2000 basic chemicals or raw materials and manufacture some 3500 finished products which must be reviewed individually.

To illustrate, the following are just a few of the hazardous materials that are encountered in petroleum refinery operations or that might be compounded into finished products:

Respiratory Irritants
Acrolein
Acetaldehyde
Aluminum Chloride
Ammonia
Asbestos
Ditertiary butyl para cresol
Dusts, physiologically inert, general
Dusts, attapulugus clay
Dusts, bauxite
Dusts, catalyst
Formaldehyde
Fluorides
Furfural
Inhibitors
Lime
Nitrogen oxides
Ozone
Pine Oil
Silica
Smoke
Sulfur dioxide
Welding fumes
Toxic Materials
Aniline, liquid
Aniline, dye
Benzol (benzene)
Cadmium
Carbon Monoxide
Chlorinated hydrocarbons
Chrome compounds
Cobalt, metal
Hydrogen sulfide
Inhibitors
Lead, metal & fumes
Lead, oxide, litharge
Lead, soaps
Lead, tetraethyl
Manganese
Mercury
Methanol
Radioactive materials, general
Toluol (Toluene)
Xylol (Xylene)
Zinc
Skin Irritants
Acids—all kinds
Amines
Benzol (benzene)
Caustics
Chromium Salts
Coal-tar Compounds
Cobalt, metal and compounds
Dyes
Inhibitors

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Nickel salts
Oils, general
Oils, high boiling from
Cat. & steam cracking
Oils, insoluble cutting
Phenol
Pitch
Solvents
Ultra-violet radiation
Wax, untreated

The petroleum industry has made remarkable progress in the development of new and better products and in improving processing operations. Accompanying this progress have been new problems of toxicology and health engineering which must be studied with the same zeal as other types of research. The advent of catalytic cracking resulted in the production and handling of aromatic hydrocarbons, and of importance to us, health problems long associated with the coal-tar industry. The use of new chemical catalysts, inhibitors, and other chemical compounds involve 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 with little, if any, additives; today they contain up to 15 to 20 per cent of chemicals, additives and inhibitors, and this trend will continue because there is no question that additives contribute much to improve performance characteristics.

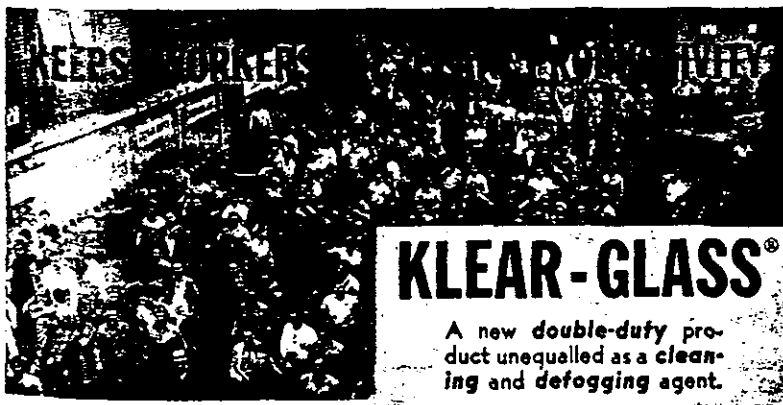
Every step in this direction, however, does pose new problems of health and safety among our plant personnel and our customers.

Fork Trucks

—From page 35

er catalytic muffler—on mining and construction equipment, may add impetus to two growing trends in mining—the shift toward trackless mining and the increasing use of diesel equipment underground.

The Coplay Cement Company, Coplay, Pa., has been using a

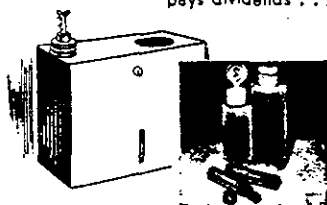


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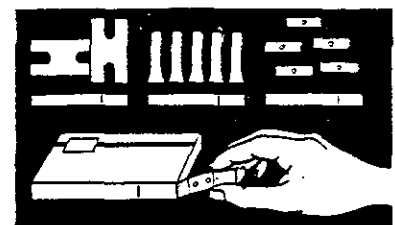
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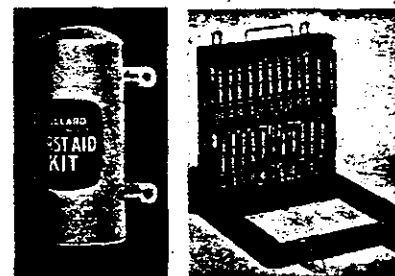
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