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INDUSTRIAL HYGIENE IN THE PETROLEUM INDUSTRY †

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ABSTRACT

The objectives of industrial hygiene are the prevention of disease and loss of efficiency through the control of occupational factors which may affect normal people. In the past, industrial-hygiene practices were directed mainly toward the control of existing conditions. Today engineering control features are applied to potential health hazards at the design or blueprint stage, and a number of procedures have been developed for evaluating problems which are not apparent or cannot be controlled at the design or development stages. Most of the occupational and health hazards found in the petroleum industry are not peculiar to it, and the experience gained in other industries can be applied directly in evaluating and solving its problems. Representative examples of probable chemical hazards, their sources, and extent in major departments of an oil company are listed.

Introduction

Modern public-health techniques have allowed the present world to build congested industrial, business, and residential centers. The secret of this development lies in our control of communicable diseases. Benefits from control of the environment are obvious to everyone living in a modern community, where our food and water supply, waste disposal, insect-vector control, and general sanitation are guided by public-health principles.

Control of communicable diseases in modern industrial communities has given rise to a new standard of living in our homes. It has been said that there is no better yardstick to gage the culture of a community than that of basic sanitation. Today we have large groups of people working closely together in modern plants where efficiency and production are greatly accelerated because we have these controls. Communicable diseases have been brought under control by a combination of medical and engineering practices. Generally, isolation, vaccination, protection of food and water supplies, and limitation of contacts and transmittal by insect vectors have been the winning approaches.

Occupational diseases are also controlled by the application of present-day scientific knowledge. The practice of this science is called industrial hygiene and industrial medicine. This field has many facets and, therefore, requires the application of several branches of basic sciences, as does the control of infectious diseases. Industrial hygiene has multiple dividends to offer industry, the same as environmental sanitation has multiple rewards.

Specifically, we also have sanitation for aesthetic reasons. The pleasure we derive from boating and fishing on our rivers, and from our beaches and parks, is an example of the worth of suitable conditions in recreational areas. Also, for aesthetic reasons, we build our washrooms and toilets in modern refineries as attractive structures, using tile and other suitable materials for easy cleaning and pleasing appearance.

The petroleum industry has gone to much expense to increase the comfort of employees, thereby promoting mental and physical efficiency. Industrial management has recognized for years that, during the summer season, man's efficiency may fall and there is more need for vacation periods, and that recuperation from heavy physical and mental activities takes longer. Further indication of the cost of discomfort can be noted by examination of the degrees of civilization throughout the world, because it is found that civilization has developed to the greatest degree in the temperate zones. This development is undoubtedly associated with the ability to work efficiently, both mentally and physically. Last, but not least, we are interested in the control of occupational diseases. It is the control of these latter diseases which we shall discuss for the next several minutes.

Occupational diseases are not a new entity in the field of medicine and the ills of mankind. Greek scholars in 460 B.C. wrote about them, and early scientists in the field of medicine recognized the ills of occupation when seen in their patients. The materials responsible for these ills have been identified and measured in quantitative terms by toxicologists. A few medications have been prescribed for some of these diseases, which today are numbered by the hundreds. The cure is generally limited to prolonged removal from contact with the offending agent. The only sure control of occupational disease is prevention. This is the science of industrial hygiene or occupational health engineering.

Modern industrial hygiene had its beginning in the first decade of the 20th century in the U.S. Bureau of Mines working in cooperation with the U.S. Public Health Service. It soon moved out of the experimental stage and became a practical tool for operating management in industry to maintain the important assets—manpower and human efficiency.

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Objectives and Scope of Industrial Hygiene

The objectives of industrial hygiene are to prevent disease and loss of human efficiency through the control of the occupational factors which may affect normal people. The scope of this science is to detect materials and physical agents within an environment which have health significance, to evaluate them in quantitative terms in relation to their effect on man, and to prescribe or design practical controls. To accomplish this it is necessary to understand man's limitations, his occupational relation to his tools, his physical contact with materials in his work, and physical factors of the chemical and material atmospheric contaminants of his working environment. There is no material too toxic to be used safely and, conversely, there is no material so innocuous that it can be ignored.

Industrial-Hygiene Team

An industrial-hygiene team, to be fully reliant, is generally made up of the physician, the industrial-hygiene engineer, and the chemist. They must work closely with allied groups. Other speakers on this program have ably touched upon the important part of the physician. The industrial-hygiene engineer is concerned primarily with field studies, collection of atmospheric samples, making of physical measurements, and evaluation of results in terms of effect on health and in the preparation of proposed control measures. The chemist is concerned with analytical work involved in handling samples, as well as assisting in the collection of them. Frequently he serves by supplying information relative to the toxicity of products or materials and the interpretation of the field results.

Industrial-Hygiene Practices

Past industrial-hygiene practices have been directed mainly toward the control of the existing working environment where processes, units, and operations were well established. It has been necessary to play "catch-up," and this has often made it difficult and costly to provide effective control facilities. Today industrial hygiene has advanced to the point where it is realized that problems of environmental health will continue to increase as the "catch-up" approach alone is used. The best time to apply engineering control features to potential health hazards and factors in the working environment is at the design and blueprint stage.

A good illustration occurred in a new gas plant. In the laboratory it was necessary to use mercury in the distillation units. Spilled mercury found its way behind a laboratory bench and into minute cracks in the floor surface. From these places, its vapor rose to contaminate the atmosphere during the heating season while windows and doors were closed. It was necessary to replace the flooring with impervious material, and to relocate the furniture to allow cleaning behind each piece, to correct this moderately serious health hazard.

Admittedly, it will always be necessary for industrial-hygiene personnel to spend a good portion of their time studying existing environmental conditions and to evaluate them in terms of quantitative facts. The fact cannot be overemphasized that there are many obvious advantages to the application of industrial-hygiene principles at the design stage. For example, control features are more acceptable and economical, and control features built into the process are more efficient, than those added at a later date. Furthermore, when the control measures are part of the original unit, no health hazard is permitted to exist even for a short period or until it could cause harm.

One finds that design engineers usually welcome constructive comments on anticipated health problems and control methods. It may be necessary for the industrial hygienist to establish channels for receiving plans for review, and it is necessary to stress the reasons for wanting them. It should always be made clear that the hygienist is in no way in competition with the design and development engineers but wishes to serve as a consultant staff member in a specialized phase. Usually the information which he may supply to the engineering group is: 1, how toxic the materials in question are; 2, whether it is a problem of inhalation or skin contact; 3, what the possible points of exposure are; 4, how serious the exposure would be; and, 5, what would be the best and most economical control methods.

Unfortunately, all problems cannot be controlled at the design stage. Obviously, some problems will not be apparent; but, if proper consideration is given to materials and processes to be used, potential health hazards can be predicted. For evaluation of new potential problems, as well as old ones, the following steps serve to point out the procedures commonly followed by the industrial hygienist:

1. Develop toxicity data on all materials used.
2. Determine quantitatively the atmospheric concentration of toxic materials.
3. Then, evaluate the health hazard based on recognized limits or standards, commonly called maximum allowable concentrations.
4. Place exposed workers under proper surveillance.
5. Develop, if needed, engineering methods of control.

The evaluation of the environmental health of a plant may be accomplished in the following order:

1. Make a preliminary survey, which is an inventory of the health factors, and a list of all materials used.
2. Whenever toxicological information so indicates, make atmospheric tests.
3. Determine atmospheric contaminants and physical factors of the environment in quantitative values.
4. Analyze biological samples (body fluids) where indicated.
5. Make statistical studies of sickness records.
6. Occasionally, develop toxicological data and apply them to the other factors in the survey.
7. Carefully study possible correlation between environmental and medical data.
8. Develop control procedures whenever indicated.

This same technique may be applied to handle most industrial environmental health problems. The data, whether negative or positive relative to health, provide a definite basis for management decisions on the need for control.

The experience of a unit with a regular painter points out the need for definite data. Surveys of materials used and methods of application showed no exposure to lead. However, the urinary lead indicated hazardous absorption. Inspection of the worker's off-duty activities disclosed that his exposure came from his home paint shop, where he painted farm machinery with red lead for his neighbors. He stopped that exposure and was soon normal in lead excretion.

Extent of Industrial-Hygiene Problems

It is of interest that most problems found in the petroleum industry are not peculiar to it. Materials and occupational health hazards recognized in machine shops and maintenance work, and in chemical, metal, electronic, and other industries throughout the nation, cause the same problems. This is good news, inasmuch as the application of industrial hygiene is relatively new in the petroleum industry, and experience gained in other industries can be directly applied in the evaluation and solution of its problems. A few representative examples of industrial-hygiene services to major departments of an oil company are listed in Table 1.

Benefits of Industrial Hygiene

Union and labor interest in fields of health and fringe benefits necessitate good liaison with official agencies. These agencies are state departments of health and labor, compensation boards, and other regulatory groups. One must be prepared to compare data for work areas in plants with their data.

We often find it possible to be of service to the sales department in preparing precautionary labels as to safe use of petroleum products. Other fields of service may be to customers concerning the safe use of petroleum products in their plants.

This field is not static. It is dynamic; and, therefore, it is necessary to keep in contact with others in this field by participation in professional activities. Industrial-hygiene activities extend the medical services out of the clinic into the industrial plant. They provide a mutual contact between the engineering and maintenance group in the field and the physician.

Conclusion

To summarize some of the benefits which arise from an active and constructive industrial-hygiene program: It provides facts regarding working environment; it prevents, or reduces to a minimum, occupational diseases; it reduces compensation costs; it demonstrates company interest in health and welfare; it permits control of hazards before injury is done to employees; it assists medical departments in protecting employee health; it serves as a clinical diagnostic aid; it reduces lost time caused by illness; it reduces employee illness costs; and it provides most effective and economical control of hazards.

Industrial hygiene is a natural evolution in the enlightened, resourceful industrial world. It is another practical tool of science used to increase the efficiency, lower the cost, and maintain higher standards of living in our free-enterprise system. Today management recognizes that no longer is manpower cheap. Slight losses in efficiency are important.

Summary

In the broad sense, any program of environmental health or industrial hygiene is one of preventive medicine. For many occupational diseases there is no satisfactory medication; the only method of control lies in prevention. There are certain medical and engineering principles which can be applied to the working environment to enable an industry to locate and eliminate working conditions which are likely to cause illness, lower production, and the like. Modern industry, especially the petroleum industry, accepts the responsibility for the health of the worker while he is on the job, and it is willing to institute the necessary steps for adequate health maintenance. It needs to be guided in the approach to this goal.

TABLE 1

Examples of Industrial-Hygiene Services to Major Departments of an Oil Company

Department	Material	Unit or Process	Degree of Hazard
Refining	Lead	Painting	Severe
		Doctoring	Moderate
		Welding and burning	Severe
		Gasoline finishing (tetraethyllead)	Severe
	Mercury	Laboratory	Moderate
		Meter and instrument shop	Moderate
		Pilot plant	Severe
	Benzene	Hydroformer	Slight
		Laboratory	Moderate
		Dewaxing	Severe
	Dust (silica)	Lubricating oil	Moderate
		Reclamation	Moderate
	Dust clay	Contact treater	Moderate
	Carbon tetrachloride	Electrical	Severe
Production	Mercury	Meter	Moderate
		Geological	Severe
		Gas testing	Moderate
	Lead	Painting	Moderate
	Insecticides	Camp site	Moderate
	Benzene	Paraffin removal	Moderate
	Carbon tetrachloride	Core analyses	Severe
	Herbicides	Field maintenance	Moderate
	Noise	Drilling	Moderate
	Solvents (petroleum)	Drilling	Moderate
Pipeline	Hydrogen sulfide	Pump station	Moderate
		Gaging	Severe
	Carbon monoxide	Pump station	Moderate
	Solvent vapors	Pump station	Moderate
	Degreasing solvents	Maintenance	Moderate
	Bitumastic coating	Pipe doping and painting	Moderate
Exploration	Carbon tetrachloride	Core analyses	Severe
	Mercury	Core analyses	Severe
	Benzene	Cable shop	Severe
	Fluorinated plastics	Electrical	Moderate
Law	Crude oil	Claim	Slight
	Industrial waste	Claim	Slight
	Air pollution	Claim	Moderate
Research and development	Mercury	Reservoir laboratory	Severe
	Carbon disulfide	Laboratory	Severe
	Nickel carbonyl	Catalyst	Severe
	Radiation agents	Reagents	Moderate
Sales	Cutting oils	Customer shops	Moderate
	Solvents	Customer shops	Moderate
	Lead oxide	Paint plant	Severe