

Elements of Industrial Toxicology

usually transitory and do not have any permanent ill effects. Asphyxiation may be brought about by the reduction of the partial pressure of oxygen in the inspired air.

Carbon monoxide is an example of a chemical asphyxiant. Its action is to combine with the hemoglobin to form carboxyhemoglobin which cannot be utilized in carrying oxygen to its tissues.

As mentioned previously, the liver, kidneys, bones and other organs of the body may become affected by exposure to harmful materials. Organic phosphates inhibit the enzyme, cholinesterase which is present in red blood cells.

In addition to consideration of exposure to a single material, combined toxic effects due to the simultaneous action of different materials may occur. For example, a synergistic effect, greater than that from the same concentration of inhaled gas alone, will be produced by exposure to a mixture of sulfur dioxide and sodium chloride crystals. Sodium chloride crystals inhaled alone are relatively inert.

Antagonistic, or potentiation effects are produced by inhaling fumes of iron, and gaseous nitrogen oxides, the reduction of effect in this case is explained on the basis of a firmly combined layer of nitrogen oxides on the iron oxide particles.

In the absence of other information it may be assumed that the effects of exposure to chemical agents should be considered as additive. When purely local effects on different organs of the body are produced by the various components of the mixture, it may be assumed that the chief effects, upon exposure would be independent.

Harmful chemical agents may attack living organisms in two different ways—locally and systemically. Caustic alkalis and strong acids are capable of producing severe damage and local tissue destruction. Many of the materials exert a milder local action which usually consists of skin irritation or dermatitis, which is of a transitory nature. Systemic poisons are carried by the blood stream to the tissues or organs where they exert their effects.

Studies of cellular metabolism have established important mechanisms on the action of toxic agents involving interference with enzyme systems. Ultimately, all toxic agents produce either directly or indirectly an altera-

tion in cellular metabolism, leading to changes in permeability, irritability, alteration of normal function, or some other physiological change.

Intensity of action

The severity of action of the toxic agent is a function of the concentration of the substance in the damaged organ. This depends upon the rates of absorption, detoxification, and excretion. Absorption is primarily dependent upon the solubility of the harmful material. Detoxification is a result of the body's attempt to eliminate the toxic substance or to form a non-toxic product. Excretion refers to the elimination of a toxic agent and its toxic metabolites from the body.

Apparently, then the intensity of action of a harmful material is dependent upon the nature of the material, the type and rate of exposure, and the fate of material in the body. A single large dose of a toxic substance may be expected to produce a greater response than the same total dose administered over a long period of time, because a large dose may be able to produce its detrimental action before appreciable detoxification occurs. The same amount given as a series of small repeated doses can be handled by detoxification and excretion mechanisms. A toxic substance that is detoxified or excreted at a rate which is slower than the rate of intake of the substance is called a cumulative poison (Lead is an example of this type of poison).

As a rule, young people are more susceptible to toxic substances than are their elders. Either natural or acquired hypersensitivity may increase the response to toxic agents. This abnormal sensitivity is called an idiosyncrasy to the toxic agent.

Physiological tests are available to detect early stages of poisoning before clinical symptoms ordinarily appear. Chest X rays often detect silicosis before it becomes disabling. A reduction in the cholinesterase activity of the blood is a reliable indication of organic phosphate poisoning. Periodic medical examination in conjunction with analysis of atmospheric contaminants may be necessary to completely define the worker's exposure in relationship to his environment.

Experimental toxicology

Smyth (see "References") stated that four