

Elements of Industrial Toxicology

- *Absorption through the skin* can occur upon exposure to some toxic agents. Some liquids and vapors are known to pass through the skin to such a degree that respiratory protection is not adequate against high concentrations. For example, hydrogen cyanide (HCN) is known to pass through the unbroken skin. Consideration should be given to the type of work clothes being worn, if they become saturated with solvents, they will act as a reservoir to bathe the body continually with the harmful material.

- The *absorption of harmful materials by the lungs* is dependent upon the solubility in body fluids, the permeability of the lungs, the volume of inhalation, the volume of blood in the lungs, and the concentration gradient of vapors between the inhaled air and the blood.

The respiratory system is composed of two main areas: (a) the upper respiratory tract airways—the nose, throat, trachea, and bronchial tubes leading to the various lobes of the lungs, (b) the alveoli where the actual transfer of gases across the cell wall takes place.

In general only very fine particles and gases will reach the alveolar sacs. The larger the particle, the sooner it will be deposited through impaction, gravity, etc., on the lining of the airway tubes leading to the sacs. Only particles smaller than about one-half micron are likely to enter the alveolar sac.

The nasopharyngeal passages serve as a heat exchanger and humidifier, warming and moisturizing the inhaled air so that it will not constitute a shock to the delicate lung tissue.

The trachea and bronchial tubes have a sticky lining that traps larger particulate contaminants before they can reach the lungs.

The body is poisoned by substances absorbed by the lung in the same way and to the same general extent as it would be if a like amount entered the body by any other channel of absorption, such as through the skin or the intestinal wall.

The harmful effects of deleterious materials are determined by the amount accumulated in the body—by the total dosage. The number of milligrams of harmful material per kilogram of body weight determines the toxic effect produced. This is often overlooked

when expressing individual exposures only in terms of concentration (parts per million) in the air breathed and the length of time of exposure. The amount inhaled is not necessarily the amount absorbed.

The pulmonary ventilation rate of an average worker may be taken as 20 liters per minute (L/min) or approximately 10,000 L in an eight-hour working day. If the air contains one milligram per liter (mg/L) of some harmful material, the maximum amount that can be absorbed in one day is 10 gm. Likewise, the same total dose would result from an exposure of one hour to a concentration in air of 833 mg/L.

The employee's exposure to gases and vapors is usually limited to his working hours. The time spent away from work is usually more than adequate to permit complete elimination of the volatile material in the body before the beginning of the next daily exposure. Except for highly soluble and nonreactive substances, such as methyl alcohol, or with reactive gases whose decomposition products are eliminated slowly, there would be no accumulation of gases and vapors from daily exposure.

Henderson and Haggard's book on noxious gases (see "References") treats the subject of respiration and absorption of gases and vapors in great detail, and the reader is urged to consult this reference for specific details.

Harmful materials or their detoxification products are eliminated from the body through the respiratory tract, the intestinal tract, the urinary tract, and, in some cases, the sweat glands.

Most volatile organic compounds are eliminated in a matter of hours or, at most, days.

Many of the poisonous elements, however, can be stored for long periods of time in various parts of the body. Chronic toxicity damage is unlikely to have an even distribution throughout the body. In many cases the organ affected is the liver or kidney, and in a number of substances, both in the liver and bone. In toxicity studies with radioactive isotopes, the organ which suffers the most severe damage and appears to contribute most to the toxic effect on the body as a whole is called the critical organ. The particular organ that shows the largest amount of damage is the one that is chosen for estimating the effect.