Course Learning Outcomes for Unit VIII

Upon completion of this unit, students should be able to:

5. Identify occupational health hazards that may exist in the workplace, including ergonomic, chemical, biological, radiological, and physical hazards.
   5.1 Describe the industrial hygiene aspects of beryllium and nanotechnology.

6. Perform basic industrial hygiene calculations.
   6.1 Perform a basic time-weighted average calculation.

Reading Assignment


The following ebooks can be found in the CSU Online Library in the ProQuest ebrary database. Please read pages 10-14 from the ebook below:


Please read pages 179-183 from the ebook below:


Unit Lesson

In this final unit, two relatively new issues related to industrial hygiene will be discussed: beryllium and nanotechnology. Both of those will be discussed from the perspective of the fundamental tenets of industrial hygiene: anticipation, recognition, evaluation, and control. In addition, a very simple but common industrial hygiene calculation will be walked through, the time-weighted average or TWA.

Beryllium

After reading the information from the U.S. Department of Energy, you should have a good overview of beryllium and its hazards. Beryllium is a metal that has some amazing properties such as being very light yet very strong. Beryllium usage in the United States increased during the 1940s and 1950s in conjunction with activities related to World War II. The Department of Energy used beryllium in a variety of applications during that timeframe, and the material was handled according to established practices of the time. Unfortunately, health effects resulting from exposures started to appear and forced a much more in-depth appreciation of the metal's toxicity. In the case of beryllium, it is easy to see the critically important role played by the industrial hygienist.
Nanotechnology

Reading the information from the Centers for Disease Control, gives you a thorough introduction to the topic of nanotechnology. Nanoscale materials have been in use for many years. The prefix "nano" means that these materials are very, very small. It is interesting to note that the characteristics and properties of a material change as the particle size gets smaller and smaller. What explains this phenomenon? Well, there are many theories that have been discussed, but a prominent theory has to do with surface area. Here is an example:

Aluminum is a solid material, it is normally thought of in a bulk form such as sheets of aluminum. However, if the material is gradually divided up into smaller and smaller pieces, the available surface area increases. Now, think of a chemical process such as oxidation and how many opportunities there are now for that chemical reaction to occur due to the increase in surface area. Pretty wild, huh? At first glance, it may not seem intuitive that surface area increases as the size of particle gets smaller. However, if you think of a solid sphere being composed of millions and millions of tinier spheres, you soon realize that this phenomenon is true. Once that reality is appreciated, you can think of the same principle as it applies to interactions with the body. If some sort of physiological reaction with the bulk material results in a toxic effect to the body, imagine what happens when the surface area increase. The physiological reactions and resulting toxic effect increase as well! Wow! Now it should be easy to see why this family of compounds is of such tremendous interest to researchers—just like beryllium. You should now be able to see the critical role that can be played by the industrial hygienist.

A Basic Industrial Hygiene Calculation: Time-Weighted Average

It is worthwhile to get a little better understanding of the basic concept of exposure limits. Exposure limits are most commonly established for airborne contaminants. Recall that an exposure limit is the average allowable concentration of a contaminant that a worker can be exposed to over a prescribed period of time, usually an eight-hour period. Further recall that exposure limits are derived from studies (usually in animals) that help establish a threshold dose, below which the majority of healthy workers would not be expected to have any adverse health effects. Now, if you think about an average concentration, that means that the concentration can vary throughout the shift between times of higher concentrations and times of lower concentration. However, the time-weighted average (TWA) concentration must be below the exposure limit in order to be in compliance.

Below is a common industrial hygiene formula that can be used to calculate the TWA of an airborne exposure to a chemical contaminant:

\[
TWA = \frac{CaTa + CbTb + \ldots + CnTn}{8}
\]

The meaning of the abbreviations are as follows:

- \(TWA\) = Time-Weighted Average
- \(Ca\) = Concentration of contaminant during the sampling period “a”
- \(Ta\) = Time of sampling period “a”
- \(Cb\) = Concentration of contaminant during the sampling period “b”
- \(Tb\) = Time of sampling period “b”
- \(Cn\) = Concentration of contaminant during the sampling period “n”, where “n” is the last of a series of contaminants
- \(Tn\) = Time of sampling period “n”

Note: All concentrations are in parts contaminant per million parts of air or milligrams of contaminant per cubic meter of air.

Below is an example:

An industrial hygienist is conducting personal sampling on a worker who is overseeing a production process involving use of acetone. (Note: The Occupational Safety and Health Administration has established a permissible exposure limit of 1000 parts per million (ppm) of acetone). The following exposures are measured:

700 ppm for 3 hours
1300 ppm for 2 hours
700 ppm for 3 hours

Now, Plug the numbers into the formula:

\[
TWA = \frac{700(3) + 1300(2) + 700(3)}{8}
\]

\[
TWA = \frac{2100 + 2600 + 2100}{8}
\]

\[
TWA = \frac{6800}{8}
\]

\[
TWA = 850 \text{ ppm}
\]

Comparing the calculated value of 850 ppm to the OSHA PEL of 1000 ppm demonstrates that the measures are below the PEL and therefore, in compliance. Based on the earlier definition, you would not expect the worker to experience any adverse health effects as a result of an exposure at this concentration.

Truth be told, this is a very simplistic example and only one of many types of calculations that are learned during a more robust study of industrial hygiene. Also, this is the type of question that might be encountered by a candidate sitting for the Certified Industrial Hygienist (CIH) exam. The CIH exam has a reputation of being very difficult (passing rate can be as low as 40%), so the candidate would need to be very well versed in this and many other types of industrial hygiene calculations.