Learning Objectives

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

1. Describe types and sources of indoor air pollution.
2. Identify chemicals found in indoor air and describe their characteristics.
3. Explain and discuss health effects of indoor air pollution.

Written Lecture

Unit IV covers indoor air pollution (IAP) and indoor air quality (IAQ). Chapters 4 and 5 are covered in this unit. Figure 4.1 below, illustrates what happens when pollutants are inside a building (chart can be found on page 112 of the textbook).

Indoor air pollution can be worse than outdoor air pollution. Indoor environments may be unvented and have air that may or may not recirculate. Air that recirculates helps to reduce IAP. However, the benefits of recirculated air depend on the recirculation rate, the amount of ventilation, and whether or not the recirculated air is filtered.

Indoor air pollutants come from many sources including building materials, carpets, furniture, cooking, laser printers, tobacco smoke, pets, human respiration, cars in built-in garages, and items brought in from outdoors. If the indoor environment is not ventilated, then the concentrations of indoor air pollutants will increase and possibly cause harm to individuals who breathe them into their lungs.
Ventilation is important. Ventilation is the process of bringing outside air into the indoor environment and removing indoor air to the outside, a process that is a primary factor in maintaining acceptable indoor air quality (IAQ). Page 119 of our textbook lists ventilation requirements, providing information concerning location, occupancy, and the required rate of circulation for maintaining acceptable IAQ. For example, an auditorium in a theatre holding 150 people per 1000 cubic feet ($\text{ft}^3$) needs to be ventilated with 15 cubic feet per minute (cfm) of outdoor air.

Filtration of indoor air is also important. Filtration can remove a significant amount of particulate matter. Filters must be changed regularly to maintain effectiveness. An extremely dirty, clogged filter can cause a significant drop in air flow rate through the air handling system. Thus, recirculation is greatly reduced. Further, over time, pollutants that were initially caught on the upstream face of the filter can work their way through the filter and come out the other side, thus returning to the indoor environment.

An extreme and very rare result of poor indoor ventilation has historically been known as sick building syndrome (SBS), although that term is not routinely used by indoor air quality professionals today. If people are generally healthy when they enter an indoor environment (e.g., office or home), but begin experiencing headaches, coughs, dizziness, or fatigue after being in the indoor space, the cause may be SBS. Causes of SBS can be difficult to ascertain, because the symptoms may be due to sources other than the building itself. But if enough people have similar symptoms—and are otherwise healthy—SBS may be the cause. When an illness is identified that can be directly attributed to airborne contaminants in a building, this is known as "building related illness" (BRI).

After Hurricane Katrina hit New Orleans, Louisiana in 2005, temporary trailers were set up to house homeless people who were displaced by the storm. The trailers were designed and intended to house people for only a few months. However, as the number of insurance claims kept piling up and there were not enough workers for all the repairs needed, obtaining relief took longer than anticipated. The stays in the temporary housing also became much longer than anticipated, with some people living in the trailers for years. There were many cases of people getting sick and attributing their disease to living in the trailers. The cause was determined to be primarily the chemical formaldehyde.
Formaldehyde is used in building materials, including particle board and plywood. Used to aid bonding (glue) and as a preservative, formaldehyde can cause lung, eye, and nose irritation, although low concentrations are thought to be safe. However, prolonged exposure to the chemical in poorly ventilated environments can result in health problems. Additional ventilation would have helped the trailer occupants. Running an air conditioner during hot, humid weather would also have helped, as doing this keeps moisture low and reduces particulate matter in the air, as well as reducing indoor concentrations of formaldehyde and other chemicals that are in particulate matter. However, outdoor ventilation is needed in addition in order to cycle in cleaner air.

You will learn more about SBS in Chapter 4. The chapter discusses sources of many chemicals found in IAP. Many of the chemicals are listed in the NAAQS, as you learned in Unit III. The NAAQS regulates ambient air quality, which is outdoors; indoor air quality is not as well-regulated, if it is regulated at all.

Chapter 4 explains indoor sources of carbon monoxide, carbon dioxide, ozone, sulfur dioxide, formaldehyde, asbestos, chlorofluorocarbons, volatile organic chemicals, particulate matter, radon, and others. Symptoms of poor IAQ are discussed, and health effects and standards for IAQ are presented.

Table 4.7 presents "standards for acceptable indoor air quality." These were developed by the government of Hong Kong and make a distinction between "Excellent Class" and "Good Class." The classes refer to the level of air quality for building design, based on eight-hour averages. The Excellent Class of standards is for buildings that are required to have better air quality than those meeting the standards established for the Good Class. Per the footnote under the table, this may be a socioeconomic standard based on wealth. The U.S. would not likely make such a distinction unless a facility was designed for people with diseases who need better air quality, such as a hospital.

Chapter 5 builds on Chapter 4, and focuses on women's health in India. A large portion of the Indian population uses biomass energy for cooking. Biomass is a renewable energy source that includes materials that originate from current or once living organisms, such as wood, animal feces, and agricultural crop leftovers. By burning biomass instead of cleaner fuels, Indian women are exposed to higher concentrations of air pollutants.
Studies are presented in the textbook that compare health effects in women who regularly cook with biomass energy to those of women who cook with liquid petroleum gas (LPG), a fuel that is commonly used in the U.S. for gas grills. Biomass emits significantly more pollution than LPG, and therefore, can result in increased health problems. The chapter shows significant increases in such health problems as respiratory illness, chronic obstructive pulmonary disease (COPD), low birth weight babies, and still births due to exposure to biomass smoke when compared to LPG emissions.

Unit IV provides the student with an understanding of indoor air pollution, its sources, its pollutants, and its health effects. Although much of the data presented originates in other countries, the health risks exist wherever such pollution occurs—and it can occur anywhere.

References


Supplemental Reading

The CSU Online Library contains many excellent references that will help you learn positive and negative aspects of biomass, a renewable energy source that originates from living and once-living organisms. The following examples were found in the GreenFILE database.
This unit explores how cooking with biomass fuels can lead to health problems. Examine how high airborne particulate levels from burning biomass fuels in the home affect health in “Airborne Endotoxin Concentrations in Homes Burning Biomass Fuel,” by Sean Semple, et al.

Learn more about other aspects of biomass energy, including a potential positive future use for it, in “Fuel for the Future?” by Bruce Clark, Marc Rogoff, and Gregory McCarron. It can be found in the GreenFILE database.

Another positive spin on the biomass story can be found in “District Energy from Woody Biomass,” an article by Diane Greer. It discusses using woody biomass instead of fossil fuels to run heating systems in Colorado, with the benefit of reducing greenhouse gas emissions, keeping jobs, and saving costs.