Chapter 25

INDOOR AIR POLLUTION

Case Study – Sick Building Syndrome

●The problem of sick building syndrome is introduced by discussing the case study of the Massachusetts Registry of Motor Vehicles. Constructed in April 1994, the first problems were reported in June of the same year. These included unpleasant odors, respiratory problems, eye irritations, rashes and other symptoms. The cooling system condensed water vapor onto ceiling tiles, which were composed of a starch that fermented when wet. Fire proofing around the ductwork was also wet and falling apart, releasing fibers into the air. The building was closed after 15 months of occupancy.

25.1 SOURCES OF INDOOR AIR POLLUTION

● Sources include tobacco smoke, *Legionella pneumophila* (a bacterium), mold spores, radon gas from soil under the building, pesticides used in the building, asbestos from insulation and tile, formaldehyde gas from decomposing particle board, and dust mites (see Table 25.1). Unfortunately, two of the best ways to conserve energy in buildings, namely to increase insulation and eliminate air leaks, exacerbates the problem of indoor air pollution.

25.2 HEATING, VENTILATION AND AC SYSTEMS

● Should be properly designed to provide comfort and humidity control. Air filters should be replaced regularly.

25.3 PATHWAYS, PROCESSES AND DRIVING FORCES

● Should be properly designed to provide comfort and humidity control. Air filters should be replaced regularly.

25.4 BUIDING OCCUPANTS

● The sensitivity of people to indoor pollutants varies depending on genetic factors, lifestyle, and age. Symptoms also vary as a function of the particular pollutant. Some can be fatal under special circumstances (e.g. CO poisoning). The problems in sick buildings may be traceable to specific sources, or they may be unknown (sick building syndrome). Sick building syndrome can be brought on by stress from various sources, even employment-related stress.

25.5 ENVIRONMENTAL TOBACCO SMOKE

● The issue is second had smoke. The combustion products include NOx, CO, hydrogen cyanide, and about 40 carcinogenic chemicals. In the U.S. 3,000 cancer deaths and 40,000 more from heart disease are thought to be related to second hand smoke. There are still 40 million smokers in the U.S.

A CLOSER LOOK 25.1: Is Radon Gas Dangerous?

● The EPA estimates that 14,000 lung cancer deaths annually in the U.S. are rerlated to radon gas exposure. This compares with a total annual mortality rate from lung cancer of about 140,000. However, there are few studies and risk estimates are controversial. The greatest risk is thought to be from the particles of a radon daughter product such as polonium-218 that adhere to dust and becomes trapped in the lung. The EPA equates the risk associated with exposure of a nonsmoker to 4 pCi/liter with that of drowning. The EPA's established action level for indoor concentrations (average in the outdoor environment is 0.4 pCi/liter, average indoor is 1 pCi/liter).

25.6 RADON GAS

● Radon is a naturally occurring radioactive gas that is colorless, odorless and tasteless. It is produced from the decay of ^{238}U. Once thought to be healthy, radon is now known to be a risk factor for lung cancer, and indoor radon gas poses risks that are 100s of times greater than those from outdoor pollutants in the air.

● The production of radon gas varies with the local geology and, thus, varies spatially. There are large areas of PA, NJ and NY that are notorious for high radon levels. High concentrations have been identified in other states as well.

● Radon enters homes by migrating up from the soil into basements and lower floors, from groundwater that sometimes is pumped into homes, and from radon-contaminated building materials such as building blocks. There are simple test kits available through commercial testing laboratories. When it is identified as a problem, it can be controlled by sealing the entry points and improving the ventilation.

25.7 CONTROL OF INDOOR POLLUTION

● There are financial incentives for controlling indoor air pollution in the workplace, because of time lost from work and associated health care costs. Legislation requiring a minimum level of indoor air quality and building codes that require ventilation would be desirable. Such codes exist in Europe. Education is also important. The public can protect themselves against many hazards simply by exercising good judgment, common sense, and some behavior modification (e.g. not smoking indoors).

CRITICAL THINKING

● Are airplanes adequately ventilated? Jets fly at altitudes where the temperature and oxygen are too low for survival. Ventilation is accomplished by the heating and compression of outside air by the engines, which requires fuel. Higher levels of ventilation require more fuel, which of course raises the operating cost. Ventilation rates

vary from 150 cfm/person in the cockpit to 50 cfm/person in first class to 7 cfm/person in coach. The CO_2 levels in the cabin are as high as 2000 ppm on 25% of flights studies. Recall that well-mixed air at ground level is about 390 ppm. OSHA set a standard of 5000 ppm for industrial buildings. The CO_2 concentration in the cabin is not really a problem, but the recirculation of air in a confined space with hundreds of people might be. Why? Little research has been done. How would you design an experiment to test for the health effects of flying?

● At the action level (see A Closer Look), the risks from radon exposure seem fairly small when equated to the risk of drowning. Put another way, the EPA estimates that about 29 people out of 1000 could get lung cancer. Is that risk too low to justify the cost of remediation or corrective action?

Web Resources

http://www.epa.gov/iaq/radon/riskcht.html This site gives a nice risk comparison chart for radon exposure and links to 'how to get a qualified radon service professional' and others.

http://www.epa.gov/iaq/radon/pubs/citguide.html The citizen's guide to radon.

http://www.epa.gov/iaq/ This is EPA's comprehensive web site