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Home Air Quality

WASHINGTON STATE ENERGY OFFICE

Washington Energy Extension Service

Wise Use of Resources Through Education

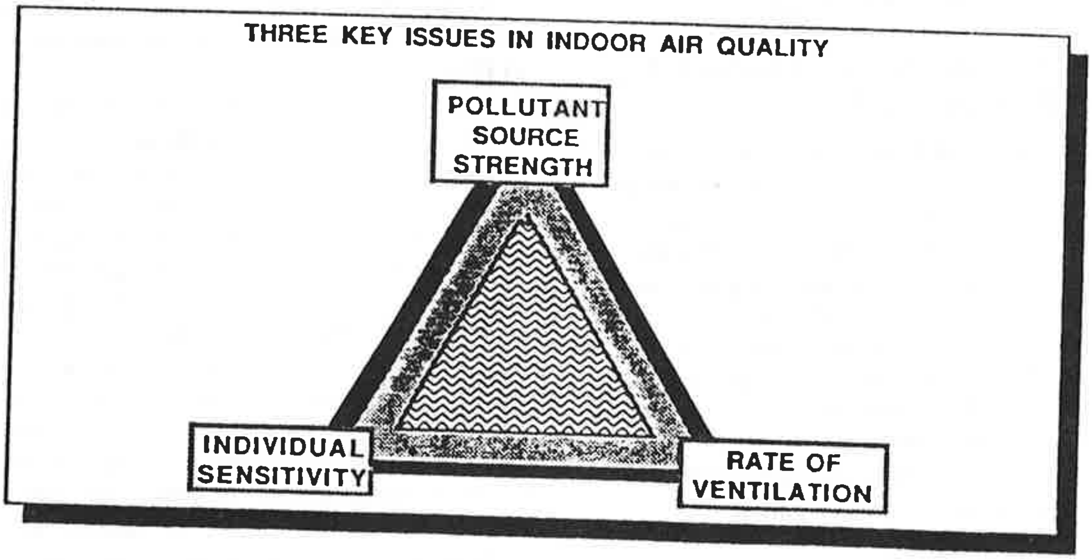
Indoor Air Quality

The air inside a home contains many substances that could potentially be either harmful to human health or damaging to the quality of the building itself. If the concentration of one or more of these substances were to become large enough, the home would have poor indoor air quality.

On average, we spend about 80 percent of our time indoors, taking well over 10,000 breaths per day to provide the necessary oxygen for human metabolism. Given the amount of time spent indoors, safe indoor air quality should be a high priority.

Increased awareness about the merits of residential insulation and weatherization has motivated many to invest in measures that reduce the air leakage rate of houses. Both the energy savings and increased comfort of "house tightening" are well documented. These conservation measures have been blamed, however, in media accounts for adverse health effects suffered by occupants. Many people are now concerned about the effect of weatherization on their home's air quality.

This pamphlet will help you place those concerns in perspective by discussing the relationship between the indoor air environment, major sources of air contaminants, and strategies for reducing contaminant levels. The listed references can provide greater detail.



Three Key Issues

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What Is An Unsafe Air Quality Level?

Air is never absolutely pure, so the question boils down to what is considered a "normal" or acceptable concentration of a pollutant. This is a crucial, but very difficult question to precisely answer.

- Concern about indoor air quality goes back several centuries, as evidenced by ventilation standards; but the issue of residential indoor air quality has received little scientific study until very recently.
- Though government standards have been set in the United States and many other countries for both outdoor and workplace exposure levels to some toxic pollutants, there are no regulatory standards for pollutant levels in U.S. residences.
- The number of potential pollutants is enormous.
- Each individual has different sensitivities to certain pollutants. What is an allergen or irritant for some will leave others seemingly unaffected.

However, many agencies and organizations have offered guidelines for exposure levels to a great number of pollutants; and there is a growing body of literature available to the person who wishes to learn about major indoor air pollutants and their effects on human health. It is possible to make an informed decision about actions you might wish to take to reduce your exposure to pollutants in the home.

Can The Concentrations Of Indoor Air Pollutants Be Measured?

A few pollutants can be measured inexpensively by the homeowner who purchases a small detector and exposes it in the home. Some examples are radon, formaldehyde, carbon monoxide, and nitrogen dioxide. Proper measurement, however, requires a good understanding of the factors which can influence the daily as well as seasonal fluctuations in the concentration of a given pollutant. The detectors must be properly located within the home and the measurement must be conducted under the proper conditions.

Monitoring for most other pollutants requires use of expensive equipment operated by trained technicians.

How Can Pollutants Be Controlled?

There are basically two ways to control indoor air pollutants. They can be kept out in the first place or they can be removed once they are in the indoor air. These two approaches are often used together, and it is important to understand the relative importance of each.

The single most important factor in indoor air quality is the intensity of the pollutant source. The greater the "source strength," the greater the potential for unhealthy air in the home. The source strength depends on both the quantity of a pollutant present and the rate at which it is emitted into the indoor air. For example, urea-formaldehyde foam insulation may contain a large amount of formaldehyde; but if the material was properly mixed when it was applied, very little formaldehyde will be released. In this case the low rate of emission will result in a weak source strength.

The first priority in controlling a pollutant is the reduction of the source strength. If possible the source should be removed. The best solution would be to replace a polluting source with an alternative non-polluting product. In some cases, an alternative product may not be available, and the polluting source (such as paint thinners) could be stored elsewhere, perhaps in an unattached garage. If the source can't be removed, it is often possible to reduce its strength. For example, sometimes formaldehyde emitting materials can be sealed to reduce the rate of emission. Source reduction techniques are generally the most effective and can often decrease pollutant concentrations by a factor of 3 to 10 or more.

The second priority is to increase the rate at which a pollutant is removed from the indoor air. An increase in the ventilation rate of a home will reduce the concentration of indoor air pollutants by removing more of the polluted indoor air while introducing an increased amount of outdoor air to mix with and dilute the pollutant concentration of the remaining indoor air. It is generally difficult to reduce pollutant concentrations by much more than about 50 percent through increased ventilation since this increases the winter energy bill. The winter energy cost of ventilation can be reduced by recovering heat from the exhausting air before it leaves the building, and equipment currently available for heat recovery ventilation can recover 50-70 percent of the heat that would otherwise have been lost.

The effectiveness of ventilation can also be increased by "spot ventilation," the removal of a concentrated source of pollutants before they are dispersed throughout the home. Removal of moisture from the bathroom immediately after taking a shower is a good example.

Ventilation can also affect the rate of emission of a given pollutant source, in some cases increasing emission rates and in other cases reducing them. For example, ventilation that increases negative pressures in a building may increase the entry rate of radon contaminated soil gas or contribute to backdrafting from combustion appliances. Ventilation that decreases relative humidity levels may help reduce the emission rate of formaldehyde gas.

Air cleaning is another possible removal strategy for reducing indoor air pollutants. Both air filtration and electrostatic air cleaning are effective methods for dusts and pollens, but they are currently not recommended for reducing radon levels.

The selection of a strategy for controlling air pollutants in a particular home will depend on answers to a number of questions, including:

- Which pollutants must be reduced?
- Where do the pollutants come from?
- How much of a reduction is needed?
- Has the home been constructed yet?
- What are the relevant construction characteristics of the home?

POLLUNTANT CONTROL MEASURES AND EXAMPLES

KEEP POLLUTANTS OUT

SOURCE REMOVAL

- Don't use unvented combustion appliances
- Store solvents and disi nfectants outside
- Avoid formaldehyde emitting materials
- Don't smoke
- Avoid unnecessary moisture generation

SOURCE REDUCTION

- Seal formaldehyde emitting surfaces
- Reduce radon entry by sealing between house and soil and by diverting pressure driven soil gas entry
- Provide filtered air supply to heating and ventilation systems

REMOVE THEM ONCE THEY'RE IN

SPOT VENTILATION

- Bathrooms after baths and showers
- Hobby rooms when painting/gluing/etc
- Basement to reduce radon levels

WHOLE HOUSE VENTILATION

- Dilute formaldehyde emissions from carpets and furniture

AIR CLEANING

- Reduce dust and pollen with an electrostatic air precipitator

Pollutant Control Measures

Major Household Pollutants

Many indoor air pollutants are generated inside the home, and modern life's commonly accepted building materials and home furnishings emit them. Particle board furniture, cabinets, flooring, oven cleaner, disinfectants, carpet shampoos, insecticides, paints, and furniture strippers are just a few examples. Some pollutants come from outside the home. They are drawn in with the outdoor air that either leaks into the home or is deliberately introduced by heating, cooling, or ventilating processes.

Radon

Radon is a radioactive gas that is continuously being created by the radioactive decay of radium, a naturally occurring metallic element that exists in all soils in varying concentrations. Radon sources can include soil, ground water, and earth- or rock-based building materials. Radon lasts but a few days before it decays into other radioactive elements. These radon "progeny" can be breathed into the lungs, where they are likely to attach to the lung lining and decay again, exposing the lung to radiation. Radon is associated with lung cancer and is estimated by the Environmental Protection Agency to cause between 5,000 to 20,000 deaths each year. Radon concentrations in the home can be measured and methods to effectively reduce radon concentrations are available.

Formaldehyde

Formaldehyde is a very reactive chemical that is used in a great many household products including particle boards, hardwood plywoods, furniture, drapes, carpet pads, and urea formaldehyde insulation. Formaldehyde outgasses from these and other materials for many years though the amount of outgassing decreases over time. In gaseous form it is very pungent and an irritant to eyes, nasal passages, lungs, and skin. Formaldehyde is currently classified as a potential carcinogen. Formaldehyde levels can be controlled by source removal, source reduction and ventilation.

Particulates

Particulates are particles (both solid and liquid ones) that are suspended in the indoor air in varying sizes and of various composition. Both organic and inorganic agents are found in the air, including pollens, spores, microbes, asbestos fibers, insect debris, food remnants, and pet dander. Those particles small enough to be inhaled are known as Respirable Suspended Particulates (RSP), and are of particular importance. Some are harmful in themselves. Others can carry harmful substances, such as radon progeny, into the lung. Source control, filtration, and ventilation are the mitigation approaches.

Combustion Products

Combustion Products enter the indoor air from both unvented and improperly vented combustion appliances, such as unvented kerosene heaters, gas ranges, furnaces, water heaters, woodstoves and cigarettes. The major products of concern are carbon monoxide, nitrogen oxides, and RSP. Carbon dioxide and nitrogen are odorless and colorless gasses that impair the bloods ability to carry oxygen. Carbon dioxide is lethal at higher concentrations. Nitrogen oxides can damage the lung and cause lung disease. Proper installation, use and maintenance of vented appliances is an essential control strategy. Unvented combustion appliances are major pollutant sources and should be used with caution only in well ventilated areas.

Organic Compounds

Organic Compounds can cause irritation of eyes, skin, nose, throat and lungs. They can affect many different metabolic processes; because there are hundreds of different organic compounds found in household products, and the full range of potential health effects is very large. Pesticides, aerosol sprays, synthetic plastics, adhesives, and cleaning agents are a few examples. Awareness of the chemical composition of products, substitution of less hazardous products, and proper use and storage are key control strategies.

Moisture

Moisture is not typically viewed as an indoor air contaminant, but it does have an effect on comfort level and it also influences the emission rate of some other pollutants, formaldehyde for example. In addition, condensation that occurs on building surfaces can sponsor th growth of fungi and promote microbial contamination. Source control and ventilation are methods of controlling moisture.

Is It Safe To Build An Energy Efficient Home?

One can imagine a house sealed as tightly as a pop bottle or plastic bag. If the air inside were initially healthy, the tight seal would prevent the entry of pollutants and the interior would be well protected from outside pollutant sources. If we were to then punch holes in our tightly sealed house, we would experience a weather driven air exchange between the outside, and pollutants such as radon, dust and pollen would enter. So house tightness, to the degree achievable, would be valuable for restraining the entry of exterior pollutant sources.

However, let's next imagine people living, breathing, bathing, cooking, using cleansers, carpet shampoos, using cabinets and tables with formaldehyde emitting materials, smoking and storing hundreds of potentially toxic chemicals inside the tight house. While a great deal can be done to reduce many and eliminate some indoor sources of pollutants, it is impossible to eliminate them all. We can readily realize the need to remove those pollutants generated indoors at a rate at least equal to that at which they are created. An air exchange with the outside air (assuming, of course, that the outside air source remains relatively unpolluted) is essential to the maintenance of healthy indoor air quality.

However, there are two types of air exchange that take place between a heated building and the unheated environment: Ventilation is the controlled air exchange - via exhaust fans, openable windows, whole house ventilation fans, etc. With a properly designed and installed ventilation system, one can control both when air exchange takes place and how much air exchange occurs. A common example is the bathroom exhaust fan which is usually controlled by a switch. Air leakage, on the other hand, is the uncontrolled air exchange that takes place as air exits and enters the building via cracks, holes, plumbing and electrical penetrations, around doors and windows, etc. Air leakage tends to be very great in winter (often much more than necessary) and very little in spring and fall (often less than necessary). The extra winter air exchange is expensive and the insufficient spring and fall air exchange may be unhealthy. (See WEES pamphlet "Reducing Home Air Leakage".)

If we keep our house tight to prevent leakage and provide deliberate ventilation, we have a number of advantages over the leaky home:

- We can provide the amount of air exchange we need but no more.
- We can provide a consistent amount of ventilation independent of wind and outside temperatures.
- We can filter the incoming outdoor air to remove dust, pollen, and other particles.
- We can recover heat from the outgoing stale air to reduce energy bills.
- We can increase comfort by eliminating drafts.

This general approach to the design of a new home allows us to maximize both energy efficiency and indoor air quality.

Written by Mike Nuess.

How Can I Learn More?

You can contact WEES for additional information on specific pollutants listed in this pamphlet, as well as for assistance in obtaining information listed in the references.

Suggested Reading

Citizens Guide to Radon and Radon Reduction Methods, A., U.S. Environmental Protection Agency, Region 10, 1200 Sixth Ave., Seattle Wa. 98101.

Clearing the Air, New Shelter, Rodale Press, Harvey Sachs, September 1984.

Home Weatherization and Indoor Air Pollutants, Bonneville Power Administration, Office of Conservation, 1984.

Indoor Air and Human Health, Gammage and Kaye, 1985.

Indoor Air Pollution: A Public Health Perspective, Ken Sexton and John Spengleer, *Science*, July 1983.

Indoor Air Quality and Building Energy Efficient Homes, Bonneville Power Administration, Office of Conservation, 1984.

Indoor Air Quality and Conservation: Putting the Problem in Perspective, November 1984 Conference Proceedings, WEES.

Indoor Air Quality, Toxic Substances Information, Health Division, Washington State Department of Social and Health Services, Olympia, WA. (206)753-2556.

Research Review: Indoor Air Quality Control Techniques, William J. Fisk, October 1986, Indoor Environment Program, Lawrence Berkeley Laboratories, University of California, Berkeley, Ca. 94720.

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