**Reducing Indoor Air Pollution**

**Sources of indoor pollution**

Even with the proliferation of microplastics, pollution from fossil fuels, and other human-made forms of pollution in the natural environment, the quality of the outdoor air, especially in our relatively unpolluted neighborhood, is generally better than the quality of the air inside closed residences. That indoor air pollution takes many forms. Particulates such as animal and human dander, dust mites, mold, and particles from fibers and from burning fossil fuels in gas stoves, wood stoves, heaters, fireplaces, and smoking products are common. Burning also emits carbon monoxide, carbon dioxide, and other harmful gases. Many modern furnishings contain plastics and harmful chemicals. Plastic bags and the many other plastic devices we use and that are part of a modern building infrastructure can break down over time, releasing microplastic particles and solvents into the ambient environment. Paints, solvents, and cleaning products are also sources of pollutants. Gasoline fumes from cars, mowers, and other power tools in an attached garage can leak into living spaces if the connecting door weatherstripping is not perfect or if the door is left open for any length of time. In this region, the radioactive gas radon is present is some soils and can leak into crawl spaces and openings in concrete slabs. Excessive moisture from whatever source can be a problem because in creates mold, degrades many materials, and can promote the growth of harmful organisms.

**Remedies**

Generally, the best solution is to attack the problem from several angles. As global pollution intensifies, viable product solutions are beginning to appear, including less toxic building and furnishing materials, clothing, packaging, cleaning products, and of course, sources of power. So it is to our benefit as individuals and members of the global community to reduce our dependence on environmentally harmful ways of living and try to make use of these less harmful strategies and products.

The main strategy I want to discuss is exchanging indoor air for outdoor air, primarily using a low-tech, low energy approach, and using mechanical equipment as necessary. Beginning after World War II, buildings began to be constructed with tighter envelopes and thermal insulation. Before then, buildings allowed a considerable amount of uncontrolled outside air infiltration, possibly enough to satisfy the current Environmental Protection Agency’s recommendation of about one complete air change every 3 hours. Tighter, well insulated buildings drastically reduced air infiltration and allowed better mechanical control of temperature and humidity, but allowed indoor pollution to increase. Scientists called attention to this problem at least 50 years ago, and since then codes require commercial, multi-use, and residential buildings with central heating and ventilating systems to include mechanical ventilation components. However, until recently residences with their individual mechanical systems, especially single family residences, had no specific provision for ventilation beyond regularly opening windows, which apparently most people fail to do. Such residences generally do have mandatory exhaust fans for gas stoves, but I have discovered that sometimes they are not vented to the outside! Bathrooms generally have exhaust fans, but in the case of both stoves and bathrooms, replacement air usually is uncontrolled infiltration from outdoors.

Controlling both indoor and outdoor air has two aspects: controlling its temperature and controlling its humidity. **Controlling temperature is by far the easier and less energy intensive of the two**. Water, as a liquid or a gas has a high heat capacity compared to dry air. In all but the driest areas of this country the annual cost of ventilation and dehumidification of outdoor air is 2 to 5 times more expensive than the annual cost of just heating or cooling dry air. In this hot, humid climate the cost is probably toward the high end of this spread. As the temperature of the air rises, its ability to hold water in the form of vapor increases. As the temperature of a specific volume of warm, moist air decreases, its relative humidity increases and its ability to hold water as a gas decreases. When the temperature decreases to the point where the relative humidity is 100%, the dew point, liquid water begins to condense from the air. Water condensing in living spaces, inside the building construction, and in crawl spaces is generally harmful to the building and occupants. Its control within the building’s walls, floors, and roof is a complex and important issue beyond the scope of this discussion, except that high humidity in the occupied space generally has an adverse impact on the building materials too. So high humidity in houses is best avoided or reduced promptly.

The best strategy for flushing out polluted indoor air is to let outside air into a building when its relative humidity is as low as possible, no matter what the time of year. This is usually at the warmest part of the day, which is usually late afternoon. The recommended goal is for indoor relative humidity to be between 30% and 50%. I have found that in spring, fall, and summer 60% or so is also acceptable in this climate. Thermometer/hygrometer devices for measuring both indoor and outdoor conditions are available online and in local stores for as little as $10 if your thermostat does not already record this information. A quick check online will give you lots of options.

In order to get a rough idea of what the indoor humidity will be once you completely flush out the indoor air and replace it with outside air, and change its temperature to whatever you want the inside temperature to be, you need to know three things. The first two are the temperature and humidity of the outside air and the third is the temperature you want to maintain inside your house. Plug this information into the simple chart shown on the website indicated below. It will automatically calculate the indoor humidity and show the result at the bottom of the chart. This value will probably change gradually as moisture is wicked out of, or absorbed by, the building construction, and by the addition of humidity from the activities in the building spaces. Below are some examples for the different seasons using values from the Markus Weimer calculator.

Weimer, Markus. “Calculate air’s relative humidity after changing its temperature”

[https://www.markusweiner.de/en/humidity-calculator/](https://www.)

**Summer**

This is the hardest season in which to open windows, mostly because of the amount of moisture in the air, even at the warmest part of a hot day. Assuming the outdoor conditions are 95 degrees F. and 50% relative humidity, and the target indoor temperature is 75 degrees, cooling that outside air to 75 will increase its humidity to 95%, requiring your air conditioner to lower it to a more acceptable 50% to 60%. If the outside relative humidity at 95 degrees is only 30%, then its relative humidity at 75 degrees would be 57%, a much more manageable situation that may not even require mechanical dehumidification. Realistically, the former condition is more likely, but it is still worth opening windows, paying the energy price, but having cleaner indoor air.

**Fall and Spring**

In these seasons the outdoor conditions are often just what would be comfortable indoors, so windows can be kept open for most of the daylight hours without the need for any mechanical conditioning. Because the building itself takes a long time to change its temperature, air warmer than what is desired indoors can be brought in, and the building will absorb the extra heat. Another example: If the outside air is 80 degrees and the relative humidity 40%, at 75 degrees indoors its relative humidity would be 47%.

**Winter**

This is also an easy season to manage because on cold, sunny days both the relative humidity and the amount of moisture in the air tend to be low. With the outside air at 40 degrees and 50% relative humidity, reaching an indoor temperature of 68 degrees, a reasonable temperature in winter, the humidity would be only 18%. The moisture in the house from respiration, cooking, and showering would easily and quickly bring the relative humidity up to at least 30% without any mechanical conditioning.

**Some additional considerations**

Opening windows every day is probably not a realistic goal in this climate. Just try to do it as often as you can. How long it takes to completely change the air in your house varies with the house configuration and whether you are using a fan to assist air movement. Whole house fans that were used in older houses in the South for many years can change the air in 10 to 20 minutes if windows are opened at the extremes of the house. Especially for single story houses, air is exchanged best on breezy days if you are not using a fan. Cross ventilation works best. Multistory houses are easier to ventilate because they are generally more compact and opening windows on multiple floors allows air to flow by gravity even when there is no breeze. A temperature difference from floor to floor assists air flow. You will probably notice that dry air will lower the humidity while windows are open, but the humidity may go up somewhat soon after, because, as mentioned previously, the building enclosure probably contains moisture that wicks out into the drier air. This should gradually diminish over long periods of dry weather and frequent window opening. If the indoor conditions are not ideal after just opening windows, the mechanical heating and cooling systems that most houses have will compensate. Finally new residential systems are available that incorporate outside air ventilation, and many existing systems can be retrofitted to include outside air ventilation. So if you are considering updating your HVAC system, it pays to look for this feature.

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