Indoor Air Quality Challenges in Existing Houses

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One of the primary purposes of houses
is to provide occupants
with a safe and healthy
indoor environment,
in all spaces that can be occupied.

Even if indoor air quality is poor when your get to a house, it should be good to excellent when you leave it!

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Defining Indoor Air Quality

Defining Indoor Air Quality

- There is still considerable discussion about which levels and pollutants are important.
- We have poor indoor air quality when any indoor concentration is above levels suspected of being unhealthy.
- The actual levels that cause problems, for a given set of occupants, can vary widely from ‘accepted’ concentrations.
- People are in different categories as to what is too much for their state of sensitivities.

Poor IAQ

- Since the long and expensive health studies to establish acceptable levels for pollutants have not been completed yet (and most are not even going on yet), we must suit the problem levels to the actual occupants in our houses.
- Poor IAQ exists when a least once occupant is reacting to the house in question and they feel better when away.
- This may seem unacceptable, but it is as it is.

Pollutants of Concern

- Mold, both visible and hidden;
- Dust mites at levels that trigger asthma;
- VOC that cause occupants problems;
- SVOC (including pesticides) that cause reactions;
- Dust (fine & very fine) that illicit reactions;
- Lead, even if in friable paint;
- Asbestos that is not fully enclosed;
- Other fibres that are free to be dispersed; etc., etc.

Problems in Existing Houses

Some one calls you saying they suffer from headaches and fatigue. They wonder if it could be something in their house

What would you ask to determine if this is an urgent, serious issue that requires immediate action?

What questions would you ask to help decide if there the house may be affecting their problem?

Problems in Existing Houses

- Almost all of the houses that I get called into have moisture problems; mold also abounds.
- Ventilation is also a problem in most houses, even though some are old and ?leaky?.
- A few houses have combustion spillage issues; the indications are there, but provoking a reaction can be hard to do.
- Most houses with furnace-attached humidifiers have very dirty humidifiers and ducts.
- Formaldehyde is a serious problem in some.

Other IAQ Problems

- Formaldehyde is accepted by WHO as a known human carcinogen; in time we will.
- Some houses have toxic dust from old mold, although mold is not apparent at the time of investigation (whole-body reaction).
- Many houses have badly-adjusted duct registers.
- Radon is a problem in a few houses.
- Asbestos is friable in a few houses.
- Dust mites are growing in a fair bit of bedding.

More IAQ Problems

- Toxic cleaners, fabric softeners and air fresheners are in use in most houses.
- Most reported problem houses have more than three significant problems:
  * moisture problems galore;
  * high source problems; and,
  * ventilation problems.
- My recommended list of fixes is seldom less than 20 long; most have to do with occupant activities.

Sources of Pollutants

Sources of Pollutants

- Engineered beams often emit huge amounts of formaldehyde.
- Personal care and cleaning products are very significant sources of toxic VOC and of SVOC as well.
- Moisture-related sources dominate in the houses to which I am called.
- As much mold is hidden as is visible, but it is usually possible to find it.
- Garages are seldom well sealed from the house.

Sources

- Since the solution to pollution is seldom dilution, reducing or eliminating sources is preferred.
- You can move the decimal place with source control, but only the first or second significant figure with improved ventilation.
- Removing sources is best, if you can do it.
- Isolating sources from the indoor air, is usually the next best thing to do.
- To just reduce a source's strength isn't enough.

More on Sources

- People bring many sources indoors & don't even know that they release pollutants (education is the key here).
- Some sources are intermittent from outside (sealing and air-exchange control can work).
- High Relative Humidity (RH) increases many VOC, SVOC and formaldehyde release rates.
- Use Greenguard (or equiv.) to find low emission paints, finishes and materials.
- Note that green materials may be **very** toxic.

Ventilation Requirements

Ventilation Requirements

- All houses need good ventilation,
  if they are to be healthy homes.
- A century ago, women learned to ventilate,
  but it is a very time-consuming process.
- Ventilation consists of four sets of processes:
  * air exchange (fresh air in and stale air out);
  * air distribution (to and from rooms);
  * air circulation (within rooms and spaces); and,
  * air treatment
    (filtration, humidification & dehumidification).

Air Exchange

- Bringing fresh air in, and
  taking an equal amount of stale air out,
  is a desirable process (I call it air exchange);
- When all costs are factored in,
  an HRV is the most cost-effective way
  of doing this process well.
- It is very important that the inflow and exhaust
  be properly balanced
  (to avoid depressurization of pressurization).
- HRVs do not cost the consumer; they pay!

Distribution and Circulation

- Forced-air systems can be installed and adjusted to provide both distribution and circulation.
- Energy-efficient windows do not drive room air flows, with cold drafts during heating and hot upflows during cooling.
- Get fresh air to all occupied rooms and retrieve stale air from all polluting rooms.
- In a house without a forced-air system distribution and circulation can use HRV ducts.
- Central walls are good for supplies **and** returns.

Air Treatment

- Humidifiers are best left off forced-air systems (they are almost never kept clean enough).
- Dehumidifiers may be necessary, when the region has long periods of hot and muggy weather. Use the 'best' of the Energy Star units.
- Filtration should be efficient for fine and very-fine particulate but that may mean a larger filter and local duct.
- Few occupants need VOC filtration (some do).

Limitations of Natural Ventilation

Limitations of Natural Ventilation

- Open windows do not have much air flow unless there are large-enough pressure differences across them.
- During extended spells of low wind and low temperature difference, there will only be low driving forces for flow.
- This is especially true when the house is in an area with a heat island and the house has a brick structure.
- The house & occupants still need air exchange.

Natural Ventilation

- Many attempts have been made to get acceptable ventilation using only natural processes.
- **All** have failed, most of them miserably-so.
- There are still many systems being peddled with no quality performance measurements.
- When we finally get energy-efficient HRVs (most now have low ventilation efficiency, even if they have good heat efficiency), it will be even better to ventilate that way.

Sealing to Avoid Pollutant Inflow

Sealing to Prevent Pollutant Inflow

- Sealing to prevent pollutant production, and flow of pollutants into the indoor air, will deliver more energy saving benefits than sealing just for conservation.
- When you have two reasons for air sealing the driver should be the most demanding, not the lowest standard for acceptance.
- Sealing all indoor cracks and openings is desirable for air quality reasons, but also stops flow in more complex paths.

Sealing to Keep Radon Out

- Sealing to prevent radon entry from the soil under and around the house also helps keep out other soil gases.
- Moisture in soil gas can be a major cause of moisture problems inside houses.
- Pollutants in soil gases can range from chemicals to methane; methane has even been concentrated to the point where it can be ignited.

Testing for Radon

- Any tests done for radon should be done by the owner, or on their behalf.
- The tests should be for a minimum of the larger of five days or the length of a full weather cycle, from a low to a high to a low again.
- This ensures a proper average reading.

Benefits of Sealing All Openings

- Air leaks, even complex ones, usually have some energy impact.
- Sealing indoor cracks and openings, after an HRV is up and running, closes off hiding spaces for insects and also makes it harder for large vermin (like mice, rats and squirrels) to move about along hidden pathways.
- Paths used by insects and larger vermin are usually contaminated by their feces.

Where to Seal Indoors

- Use energy sealing techniques at the bottom of all drywall, even on interior walls.
- Seal off all openings for plumbing entry, and for all wiring (power and communication) so that no indoor openings are evident.
- A combination of spray urethane foam and lite-type sealing compound, will do most cracks and openings quite well.
- Seal garage-to-house pathways as well.

Moisture as a Pollutant

Moisture as a Pollutant

- We need enough moisture in the indoor air, but there can be too much as well.
- For sensitive clients I recommend keeping the indoor RH between 25% and 45%, for as much of the year as is possible.
- A wider range of 25 to 60% may be acceptable if you don't mind dust mites.
- Mold will not continue to grow below 65% RH, but that has to be the RH at all local surfaces.
- Dust mite larvae grow at 55%.

Polluting Moisture

- When indoor RH, in sensitive areas, is outside the acceptable range, moisture-in-air is a pollutant.
- Sources of moisture that you cannot control should be minimized:
  * stop leaks quickly;
  * control soil surface slopes;
  * dehumidify as necessary;
  * shut off humidifiers as soon as possible: and,
  * use insulation and air sealing for warming.

Insulating for Warming

- Insulating,
  to make indoor surfaces warm enough,
  may be much more demanding than
  justified by simple conservation.
- Use of indoor, insulating blinds
  can cause serious mold and health problems,
  even destructive rot, both visible and hidden.
- The energy cost of replacing rotted structures
  is usually much higher than badly-chosen
  energy savings that cause rot.

Mold as a Pollutant

Mold as a Pollutant

- In the early 1990's,
  a Canadian study showed that moldy houses resulted in sick occupants
  (the results were significant & the effect large).
- The mechanism is likely by toxicity, not allergy.
- This is usually ignored in the USA,
  but the study has not been properly repeated,
  just ignored as though irrelevant
  (none-the-less it is valid in the USA).
- Similar results have occurred in Europe.

Mold Exposure

- The primary exposure route for mold
  is via fine and very-fine particulate.
- Mold VOC, MVOC, may also be a factor,
  at least while mold is growing & shortly after.
- Air transport is the major mechanism
  that causes exposure,
  so stopping air flow from moldy areas
  should be one way to deal with disease.
- Source control, including elimination,
  should be the primary control mechanism.

Preventing Mold Growth

- Mold only grows when materials
  (even dirt on hard surfaces)
  are wet enough for long enough.
- The mold that grows under the driest conditions
  requires a local RH of > 65%.
- Long enough is not very long;
  on soaking wet materials
  germination starts within days -
  complete involvement is measured in weeks.
- Keep materials dry enough & mold growth stops.

Health Canada Position on Mould

- In May of 2007 Health Canada finally released a
  Residential Indoor Air Quality Guideline
  on Moulds (they got the spelling wrong!).
- Their recommendations were to:
  * control humidity and diligently repair
    any water damage, to prevent mold growth;
  * thoroughly clean any visible or concealed mold
    growing in residential buildings.
- These are powerful and sensible guidelines!
- They set the new standard for residences.

Position on Mould, Cont'd

- The need for repair of water damage is to **prevent** mold growth, so you must act in hours if you know there is water damage.
- You are to thoroughly clean both visible and concealed mold; just because it is concealed does not mean that it OK to leave it there!
- The research to determine acceptable levels has not yet been adequately done.

Conclusions

Conclusions

- Houses should provide healthy environments.
- Acceptable concentrations of most pollutants are not known, but you should **act anyway**.
- Many things can cause poor IAQ.
- Many houses have moisture and mold problems.
- Chemical pollutants can be a problems as well.
- Urea formaldehyde resin should **never** be used.
- HRVs do not cost the owners, they pay them.
- Natural ventilation does not always work well.

Conclusions, Cont'd

- Sealing indoor cracks and openings, for pollution prevention and containment, safely increases energy savings.
- Moisture itself can be a pollutant, because of what it causes to happen.
- Mold is a known health problem, even though the research was not done in the USA (just Canada and Europe).
- If you use a system approach, you can get both energy reductions and IAQ improvements.

Recommendations

Strategies for Avoiding & Solving IAQ Problems

1. Remove the sources of pollutants – remove the “skunks”
2. Seal or isolate pollutants
3. Ventilate or dilute them
4. Filter the air

These strategies are in order of importance.

Radon Control
– an example of seal and ventilate strategies

A. Gas Permeable Layer
(4" clean gravel)

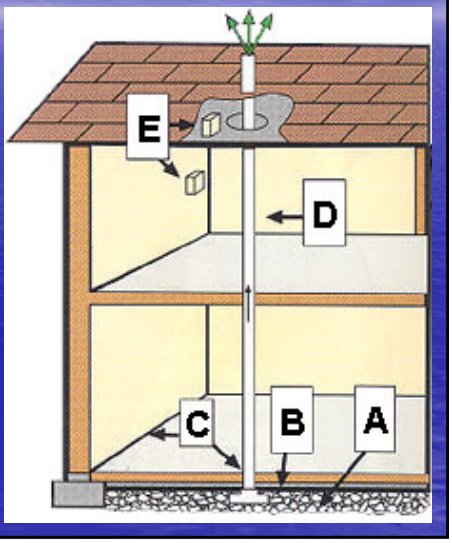
B. Plastic Sheeting
(under slab or over crawl space)

C. Sealing and Caulking
(all openings in concrete floor)

D. Vent Pipe
(3 or 4 inch PVC pipe)

E. Junction Box
(if fan needed later)

Provide test kits to homeowners



Recommendations

- Look at housing retrofits using a systems approach (remember that everything interacts).
- Take the job seriously and do it well; the 'house' should be healthier after you leave.
- Believe the occupants when they tell you what bothers them, even though those things do not bother you.
- Use low-emission products when you can get them.

Recommendations, Cont'd

- Install HRVs knowing that they will save the owner energy and money.
- Seal beyond energy efficiency standards; seal for pollutant movement control as well.
- Prevent moisture problems each and every way that you can.
- Believe that mold makes many occupants ill, even though moneyed organizations are saying differently.
- Be proud of what you do!

Jim H. White

- Jim is a scientist trained in an engineering faculty, to move new science into practice.
- He did the system design of the Canadarm on the US Space Shuttle.
- He invented the term "The House As A System"
- He started the investigation of why some houses make occupants ill (at CMHC in 1981).
- He did original research into how much power and energy housing processes really need.
- He owns System Science Consulting.

Any time you reduce power
(the flow of energy)
you reduce the house's ability
to move air and moisture.
Reduce
pollutant and moisture sources
more
than you reduce energy losses.

What tools would you need?