Helping clients to manage MOLD



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Mold and IAQ overview



You can help clients manage many common IAQ issues with 2 basic principles.

- 1. All mold problems are moisture problems.
- 2. Amplification (excessive growth) of mold can start with indoor air **relative humidity** over 65%.

The field of IAQ includes:

- Fungi and bacteria
- Formaldehyde, VOCs, Semi-VOCs
- Particulates, Allergens
- Toxic gases, Radon



Fungi



○ Fungi are essential for life on earth.
 ✓ They decompose
 ✓ They release nutrients
 ○ Part of a healthy eco-system.



- Fungi do not care about "indoor" or "outdoor"!
- They will do their work anywhere that conditions are favourable.



Mold components



- Active fungal growth inside the home may expose occupants to these mold components:
 - Spores
 - \checkmark Fragments of hyphae / spores
 - ✓ Mycotoxins (toxic chemicals)
 - ✓ Beta Glucans (cell wall)
 - ✓ NAHA (enzyme: beta-N-AcetylHexosAminidase)
 - ✓ Microbial VOCs (gases)

Cell membrane and cell wall

Fungi have features of both **plants** and **animals**.







Mold health effects

- \odot Fungi affect human health with a wide range of symptoms:
 - ✓ Allergic reactions (respiratory and skin)
 - ✓ Infections.
 - \checkmark Toxic responses.
 - Neurological disorders, including vertigo, partial paralysis, depression, memory loss, blurred vision, and tremors.
- High levels of NAHA activity in air samples were found in homes of subjects with sarcoidosis, particularly among those with recurrent disease.

Airborne enzyme in homes of patients with sarcoidosis. Terčelj M, Salobir B, Rylander R. Env Health 2011; 10:8-13.

 \odot A correlation was seen between NAHA activity and Nocturnal Asthma.

Nocturnal asthma and domestic exposure to fungi. Terčelj M, Salobir B, Narancsik Z, Kriznar K, Grzetic-Romcevic T, Matos T, Rylander R. Indoor + Buil 2012

Active fungal growth COMBINED with geopathic stress and e-smog may cause especially severe health problems. Due to genetic factors, sensitivity to mold varies greatly between people = **different** impacts in the **same** family.



Mold health effects





Bacterial endotoxins

- Endotoxins are found on the outer cell wall of gram-negative bacteria.
- Endotoxins can cause serious inflammation responses because they stimulate the release of cytokines in the body.
- Endotoxins are associated with fever, flu-like symptoms and asthma symptoms.
- Research also supports the synergistic effect of being exposed to endotoxins AND mycotoxins, a likely scenario in waterdamaged buildings.



What does mold need to grow?



- Oxygen (0.14 0.25%). This means mold can grow inside porous building materials.
- A carbon source to grow on.
 Wallpaper, wood, carpets, furniture, clothing (esp. leather), washing machines, air conditioners are preferred growth substrates, but mold can also grow on apparently clean materials like new wall insulation.
- **pH** between **2 and 11** (most places).
- Relative humidity over 65%. Over this level for <u>6 hours per day for 5</u> <u>days</u>, active mold growth can begin.





Air relative humidity gives
 a snap shot of conditions.

- Material conductivity gives an average of previous conditions.
- Thermal imaging can show areas of water damage and cold walls at risk of

condensation.



- A spot measurement does not confirm the moisture trend, but can support other observations.
- If you suspect a humidity problem in the home, a spot measurement can help start a discussion about:
 - starting data logging to monitor humidity.
 - other humidity related issues in the home (health issues, mouldy clothing, etc.)
 - starting better moisture control **strategies**.





- Sorption isoltherms are used to correlate material moisture to the air humidity.
- This is a more reliable indicator of **average humidity** in the home.





- Wood and concrete moisture contents can therefore be used to estimate the average relative air humidity.
- Material moisture can also show the state of water damage (*active or not active*).







- Near air conditioners, and behind furniture (A).
- Next to open windows with the air conditioning or heating on (B).
- Water damage from flooding or leaks (C).





 Condensation outside aircon vents when the ambient house humidity is high.





○ "I don't see mold in my home."



Healthy



• On ceilings and under mattresses that have no ventilation.







- Construction dust trapped in new air conditioner.
- \bigcirc A perfect growth medium for mold.











Damaged caulking / flashing / siding.
 Rain enters around windows + doors.
 <u>Wet walls promote mold growth.</u>





Mold sampling



- Tape lift sampling.
- Helps therapist and building biologist to work together.
- Molds found in the home can be tested for disturbance in family members.



Mold sampling



- Bulk sampling can be used for mycotoxin testing.
- Bulk samples can come from anywhere, including walls, furniture, vacuum cleaner bag, clothing, and air samples.



Measuring moldiness



Traditional mould sampling

- Passive air sampling
- Indoor/outdoor comparison
- Cultivation of spores
- Looking at mold species



Measuring moldiness

Challenges with traditional mould sampling

- \odot Only 1 25% of spores are viable.
 - ✓ Difficult to culture.
- Mould ecosystems change with humidity levels.
 - ✓ Difficult to connect one mold species to a specific health problem.

How can we measure moldiness effectively?

Table 1. Moisture levels required for growth of selected microorganisms in construction, finishing and furnishing materials

Moisture level	Category of microorganism
High (a _w , > 0.90; ERH, > 90%)	Tertiary colonizers (hydrophilic)
	Alternaria alternata
	Aspergillus fumigatus
	Epicoccum spp.
	Exophiala spp.
	Fusarium moniliforme
	Mucor plumbeus
	Phoma herbarum
	Phialophora spp.
	Rhizopus spp.
	Stachybotrys chartarum (S. atra)
	Trichoderma spp.
	Ulocladium consortiale
	Rhodotorula spp.
	Sporobolomyces spp.
	Actinobacteria (or Actinomycetes)
Intermediate (a _w , 0.80–0.90; ERH, 80–90%)	Secondary colonizers
	Aspergillus flavus
	Aspergillus versicolor ^a
	Cladosporium cladosporioides
	Cladosporium herbarum
	Cladosporium sphaerospermum
	Mucor circinelloides
	Rhizopus oryzae
Low (a _w < 0.80; ERH, < 80%)	Primary colonizers (xerophilic)
	Alternaria citri
	Aspergillus (Eurotium) amstelodami
	Aspergillus candidus
	Aspergillus (Eurotium) glaucus
	Aspergillus niger
	Aspergillus penicillioides
	Aspergillus (Eurotium) repens
	Aspergillus restrictus
	Aspergillus versicolor ^b
	Paecilomyces variotii
	Penicillium aurantiogriseum
	Penicillium brevicompactum
	Penicillium chrysogenum
	Penicillium commune
	Penicillium expansum
	Penicillium ariseofulvum
	Wallemia sebi





- 1. Culturable spores
- 2. Viable but non culturable spores
- 3. Dead spores
- 4. Hyphal fragments (> 1 μ m)
- 5. Lumps or chains of spores
- 6. Micro-fragments ($\leq 1\mu m$) (subcellular)

Advantages

- Gives reproducible results independent of the activity in the room prior to sampling.
- Gives a better representation of the level of mould in the room.
- $\odot\,$ Reduces false negative results.



○ All filamentous fungi contain the enzyme NAHA: <u>beta-N-AcetylHexosAminidase</u>

- NAHA is part of the Chitin system, located in every part of a mould.
- The amount of fluorescence when exposed to UV light (365nm) is proportional to the amount of mold in the original sample.



Aggressive air sampling

- Filter (0.8 micron)
- Flow meter
- Air pump
- Blower







Surface sampling

- \bigcirc Template (3x3 cm = 9 cm²)
- Sampling swab
- $\odot\,$ Sterile saline solution







- On-site **sampling** and **analysis** is possible *no need to send to a laboratory*.
- Easy way to track mouldiness over time, and to compare different rooms or sites.



Why do biocides not control mold?

- **1.** Biocides do not control the humidity problem (re-growth).
- 2. Biocides do not "kill" mold components (mycotoxins).
- **3.** Repeated cleaning of mold can increase exposure (fragments).
- **4.** Applying biocides may increase the moisture problem (bleach).
- 5. Biocides do not reach all mold growth areas (inside walls).
- **6.** Biocides themselves are an IAQ hazard (occupants and pets).

Some organisations that suggest **not to use** chemicals to control mold:

- The US Environmental Protection Agency USEPA
- The New York City Department of Health NYCDH
- The American Industrial Hygiene Association AIHA
- The Occupational Safety and Health Administration OSHA
- The Institute of Inspection, Cleaning and Restoration Certification IICRC



Moldy home solution: install fresh air system













Cabinet passive louver



Graphical user interface

Fresh air system results - humidity





Fresh air system results – CO₂





Thank you for your attention.

Any questions or comments?

