

The Link between Energy Costs and Environmental Quality, the latest HVAC and Energy Efficiency Technologies

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The Frenzy Over Mold

Settlements for mold claims in 2001 topped \$85 billion.

 Toxic mold litigation cases have increased 10 fold over the past year
 An estimated 10,000 mold suite are

An estimated 10,000 mold suits are already pending

 Large verdicts against building owners, property managers, contractors, architects, etc.

Mold and IEQ

Chronic Sinusitis affects millions



Millions of People

Source: Institute for Health Statistics, 1995

Mold Spores

decompose plant and animal structural materials
 help (probably all) plants absorb water and minerals
 Mold easily cross continents and oceans



Source: Science, 297,26 July 2002

© Michael K. West, Ph.D., P.E December 4, 2002 AHLA Orlando, Florida You cannot escape THEM

Asthma is on the rise



Source: American Lung Association

The Hygiene Hypothesis: Lack of 'normal' human

exposures shifts the immune system to allergic responses

IgE

allergens

H

interlukens



Vaccines, hygiene, & antibiotics, little T_H1 stimulus, increased T_H2

Helminth parasites, Strong T_H2 responses

Low exposure to pathogens: weak regulatory network

Allergic responses:

High exposure to pathogens: Inflammatory responses

Positive skin test for allergens: but little allergic disease

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Source: Science, **296**.12 April 2002

Expect continued increase in mold-related health effects worsening existing asthma symptoms¹ causing chronic allergic fungal sinusitis² aggravating or causing allergic rhinitis¹ reducing productivity - lost time, medical costs no proven medical cures in sight

Sources:

1. *Clearing the Air: Asthma and Indoor Air Exposures*, National Academy of Science, Institute of Medicine 2. J.U.Ponikau, "The Diagnosis and Incidence of Allergic Fungal Sinusitis" Mayo Clin. Proc. 1999;**74**:877-884

Moldy Ceiling Tiles



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Moldy Ceiling Return Air Plenum



Moldy Cooling Coils



Mold on Roof Near Fresh Air Intakes



Mold in Roof Ponds



Cooling Tower Near Intakes



Tower Water Contaminated



Moldy Wallpaper, etc., etc., ...







Mold is a part of Life on Earth, It Is Not Going Away
 Mold Causes Serious Health Effects
 Any Active Mold Growth Indoors is Unacceptable
 Excessive Humidity Causes Active Mold Growth
 Control the Moisture, Control the Mold

Controlling Mold Growth

- Contaminated HVAC systems are incubation sites for biologics and readily distribute spores and toxins
- Mold and other biologics need high moisture, moderate temperature, and food
 Growth of mold can be minimized by controlling moisture and humidity
 LINKS MOLD TO ENERGY USE

Mold and Energy Efficiency

Some energy efficiency measures can result in Mold problems VAV with fixed system outdoor air flow reduction in outdoor air flow rates extreme temperature setbacks Some Mold prevention measures can increase energy costs raising OA flow and/or exhaust flow installing HEPA filtration controlling high humidity with reheat





MOLD SOLUTION ENERGY PROBLEM



Active dehumidification using heat Also, portable dehumidifiers Pressurization without air-tightening Lowering chilled water setpoint **Changes in OA - Exhaust CFM** Activated carbon / HEPA filtration Low-efficiency HVAC equipment Lower Humidity, Higher Energy Costs





Reduction of fresh air CFM Certain high-efficiency HVAC units Row-split or intertwined evaporator coil High airflow and evaporator temperature **Roof or ceiling insulation Reducing solar gain from windows** High-efficiency lighting Lower Energy Costs, Higher Humidity

... High Efficiency Lighting?

Heat from lighting helps keep humidity down



- Ventilation Sensible 8%
- Ventilation Latent 25%

■ Roof 8%

- Lights 43%
- Equipment 3%
 - Wall 6%
- Skylight Solar 1%
- 185 People Sensible 2%
- 185 People Latent 2%
- Fan Heat 2%
- Glass Conduction 1%

How lighting is related to Mold

Energy efficient lighting shifts HVAC loads



Ventilation - Sensible 12%
Ventilation - Latent 35%
Roof 11%
Lights 21%
Equipment 4%
Wall 8%
Skylight Solar 1%
185 People - Sensible 2%
185 People - Latent 3%
Fan Heat 2%
Glass Conduction 1%

IAQ-ENERGY PROJECT NO PROBLEM Examples:

Re- or retro-commissioning **Energy-efficient dehumidification** Air-tighten building windows, doors, ... Balance fresh air and exhaust air **Optimize HVAC** settings and controls Select high-efficiency HVAC upgrades **Lower Humidity Lower Energy Costs**

IAQ Management Software

🗃 I-BEAM

IOC Forms Glossary RelatedSites Resources Conversions EPA/IAQ EPA/EnergyStar Help Exit



Comprehensive Approach

Indoor Air Quality Building Education and Assessment Modeling (I-BEAM) software capabilities: Track energy, maintenance and IEQ costs **Document, track and improve productivity Refine maintenance program for IEQ Better manage housekeeping services for IEQ** Track an indoor air quality audit Provide documentation that the building is following IEQ building practices **Reduce liability exposure from IEQ complaints**

Symptomatic vs. Real Solutions

- Problems often shift or resurface following symptomatic treatments.
 > using reheat as a band-aid to lower humidity
 > carbon filters or ozone to reduce odors
- Identification of the Root Causative Factors leads to a permanent solution and lower energy costs.
 - Investigation to determine the source of contamination, amplification/incubation sites, and pathways to the occupants.

Example: Ventilation

Problem: Mold Growth and 70-80% relative humidity Measure: Owner shut OA dampers **Result:** Lowered humidity to 45-65%, slowed mold growth, complaints of stuffy air and increase in staff absences



Mold-Related Design Practices

Required fresh air flow rates were greatly increased in 1989 to improve IAQ
 Key HVAC system dehumidification practices date back to the very earliest days (c. 1935)
 Increased R-values and lighting efficiencies have reduced the sensible cooling load

For these and many other reasons, HVAC systems do not adequately dehumidify



'Top 10' Design Warnings

1. Constant or uncontrolled outside air flow 2. Outside air fraction greater than 20% 3. High efficiency lighting system 4. High R-value roof and windows, shaded site 5. Complex footprint with many joints 6. Numerous wall and roof penetrations 7. Large exhaust fans or exhaust hoods 8. Equipment oversized for rapid cool-down 9. Variable or unpredictable occupancy 10. Suspended ceiling used as return air plenum

Energy Efficient IAQ Measures

Coil Cleaning Eliminate or control incubation sites Ventilation Pressurize the space with filtered and dehumidified air to keep moisture out Air Cleaning Removal of airborne spores Dehumidification Active control without reheat

Coil Cleaning



Ultraviolet Light: Short-wavelength (UVC)
 Deactivates the DNA of bacteria, viruses and molds and thus destroys their ability to multiply
 Maintains cooling coil condition and energy efficiency while killing mold and bacteria
 Key is Dosage = Intensity x Duration

Ventilation

Exhaust outflow less than OA inflow Keeps outdoor contaminants out Minimum 0.03 to 0.05 in.wg (7 to 12 Pa) Differential cfm depends on airtightness Define airflow between building zones Predict zone pressures using software Test, adjust & balance upon installation Control via airflow tracking or dP sensor

Air Cleaning

52.2 Efficiency Rating Pollen, Dust Mites MERV-4 Mold, Spores **MERV-8** Some Bacteria MERV-12 Smoke, Toner • MERV-16 Viruses - HEPA



Dehumidification

REHEAT

Electric Reheat Hot-gas Reheat (Humiditrol™) Subcool Reheat (Moisture Miser™) **OPTIMAL CONTROL** (all are patented) Subcool-Bypass (Comfort Stat™) **Controllable Heatpipes Crossflow Moisture Exchange**





Precool

Reheat





IAQ Projects can pay for themselves

PROJECT SAVINGS AND COSTS					
	SAVINGS	% SAVED	COST	AROR	PAYBACK
ENERGY SAVING PROJECTS					
CHILLER VARIABLE SPEED DRIVE	\$ 10,037	5%	\$ 50,000	9.4%	5.0 yrs
SUPPLY FAN VARIABLE SPEED DRIVES	24,971	12%	50,443	32.9%	2.0
CHW PUMP VARIABLE SPEED DRIVE	4,835	2%	10,575	29.9%	2.2
ECONOMIZER [86,000 CFM]	2,861	1%	8,000	21.9%	2.8
CHILLER - TOWER DDC OPTIMIZATION *	1,969	1%	4,500	28.3%	2.3
LIGHTING CONTROLS	7,079	4%	15,303	30.3%	2.2
REDUCE NIGHT LOAD BY 40%	5,679	3%	7,750	52.0%	1.4
SUBTOTAL SAVINGS PROJECTS	\$57,432	28%	\$146,570	24.7%	2.6
REPLACE COILS AND FILTERS †					
REPLACE COOLING COILS			\$52,738		
INSTALL HIGH EFFICIENCY AIR FILTERS			14,438		
SUBTOTAL COILS AND FILTERS			\$67,175		
REMEDIATION					
ENGINEERING AND OVERSIGHT			21,375		
CONTAMINANT REMOVAL [♥]			\$52,040		
TOTAL*	\$57,432	28%	\$287,160	9.3%	5.0

MAIN POINTS

- The best solution permanently solves the root cause of the mold at the lowest cost - *including energy costs*
- Symptomatic solutions are rarely permanent ones
- Real solutions provide lower energy costs
- The best solution can be identified with a phased diagnostic approach
- Mold remediation projects can pay for themselves with energy savings

Thank You!

