Residential Humidity Control Strategies

Armin Rudd

Affordable Comfort Conference
3/28/2012 Baltimore

Humidity control goals

- Comfort, and Indoor Air Quality
  - Control indoor humidity year-around, just like we do temperature
- Durability and customer satisfaction
  - Reduce builder risk and warranty/service costs

Humidity control challenges

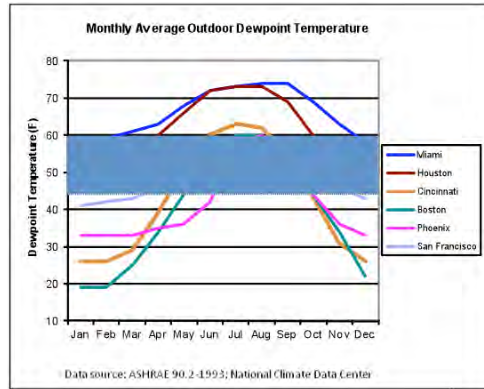
1. In humid cooling climates, there will always be times of the year when there is little sensible cooling load to create thermostat demand but humidity remains high
   - Cooling systems that modify fan speed and temperature set point based on humidity can help but <u>are still limited in how much they can over-cool</u>
2. More energy efficient homes have less sensible heat gain to drive thermostat demand but latent gain remains mostly the same
   - Low heat gain windows
   - Ducts in conditioned space
   - More, and better-installed, insulation
   - Less heat gain from appliances and lighting

Humidity control challenges, cont.

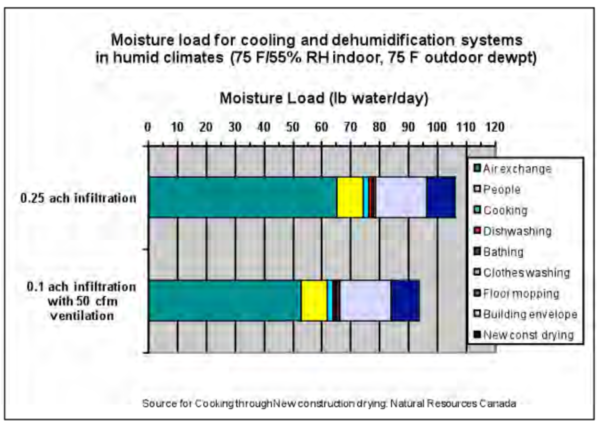
3. More energy efficient cooling equipment often has a higher evaporator coil temperature yielding less moisture removal
   - Larger evaporator coil by manufacturer design, or up-sized air handler unit or airflow by installer choice
4. Conventional over-sizing to cover for lack of confidence in building enclosure or conditioning system performance causes short-cycling yielding less moisture removal

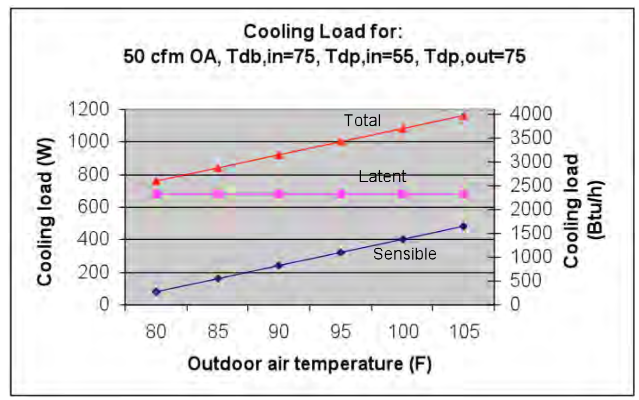
System engineering trade-offs

- Start with high-performance building enclosure
  - Improves the more permanent features of a home which has longer-term sustainability benefits
    - Bulk water management, low loss/gain glass, controlled air change, ducts inside conditioned space, pressure balancing
  - Allows for reduced cooling system size
    - Helps pay for the enclosure improvements
    - More compact duct system lowers cost and helps get the ducts inside
  - Makes overall building performance more predictable
    - Gives confidence for right-sizing equipment
      - No short-cycling: Better moisture removal, Higher average efficiency, Better spatial mixing
    - Controlled ventilation instead of random infiltration
  - Results in decreased energy consumption along with increased occupant comfort



	Typical Indoor (humid climate)		
	Tdb	RH	Tdp
winter	72	40	46
spring	75	45	52
summer	77	50	57
fall	75	45	52





Conventional Cooling System Dehumidification Enhancements

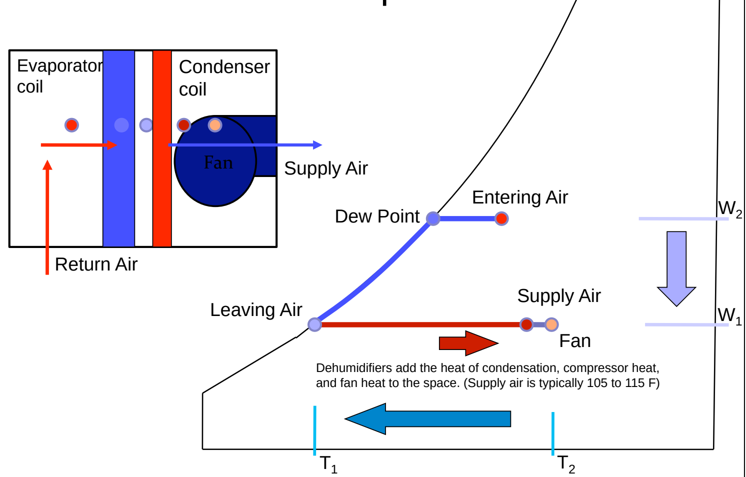
AHU Dehumidification Enhancement Features	Carrier[1]	Lennox	Goodman[2]	ICP[3]	Nordyne[4]
Variable speed airflow	FV4	CBX32MV	AVPTC	FVM	B4VM
Selectable cooling/heat pump/heating fan speed/airflow	√	√	√	√	√
Selectable airflow Adjustment (+/- %)	√	√	√	√	
Selectable constant fan speed/airflow	√		w/ communicating tstat	√	√
Selectable fan delay after cooling can be zero	√	√		√	√
Dehum fan profile with lower airflow for a time		82% for first 7.5 min	82% for first 7.5 min		75% for first 10 min
Receives Dehum signal from tstat or dehumidistat	√	√	√	√	√
Dehum logic is 0 Vac on humidity rise	√	√	√		√
Dehum logic is 24 Vac on humidity rise				√	
Lower cooling airflow if RH is above RH setpoint	80%	60% to 70%		80%	√
Extended cooling after thermostat setpoint reached	√	√			
Intermittent super-low cfm/ton during extended cooling	50%, 10 min on/off				

[1] Carrier includes Bryant
[2] Goodman includes Amana
[3] ICP includes Comfortmaker, Tempstar, Heil, Arcocaire, Day&Night, Keep Rite
[4] Nordyne includes Frigidaire, Gibson, Westinghouse, Tappan, Kelvinator, Philco, Nutone

Dehumidifier and ventilation duct in interior mechanical closet with louvered door

Ducted dehumidifier in conditioned space with living space control

Dehumidifier process

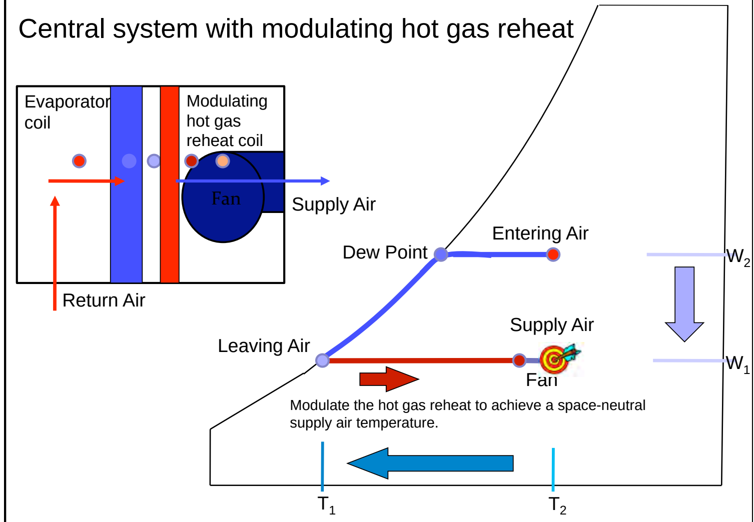


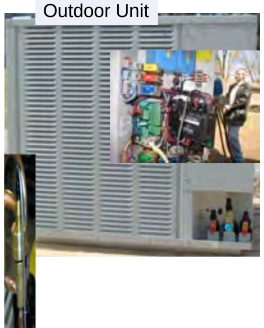
What about making the existing cooling or heat pump equipment also do the supplemental dehumidification?

Goals:

- Provide year-around relative humidity control in high-performance (low-sensible gain) houses
- Without over-cooling the space
- At lower installed cost than the same efficiency heating and cooling system with an additional high efficiency dehumidifier
- By making standard DX cooling equipment switchable between normal cooling and dehumidification-only using condenser reheat

Central system with modulating hot gas reheat



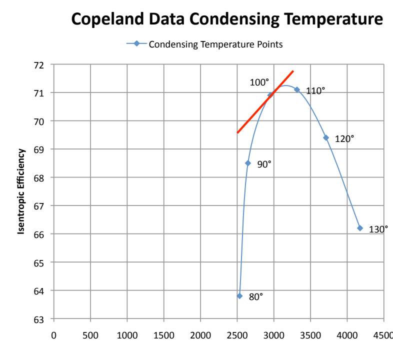


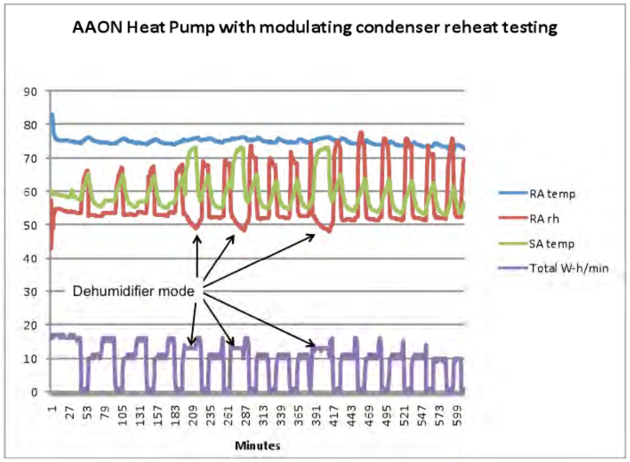
Modulating Hot Gas Reheat Valve
3193 steps between open and closed

Efficiency AMPLIFIED by tracking an optimal condensing temperature by condenser fan cycling

Copeland Scroll UltraTech®

ECM® Condenser Fans





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ASHRAE RP-1449

Energy Efficiency and Cost Assessment of Humidity Control Options for Residential Buildings

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No	System Description	Level of Improved Dehumidification	Ventilation Options		
			Exhaust Only	Supply – Central Fan	Balanced ERV/HRV
1	Conventional DX System	None	X	X	X
2	Conventional DX System with Lower Air Flow and Thermostat Overcooling	Enhanced	X	X	X
3	Two-Speed Conventional DX System	Enhanced	X	X	X
4	Variable Speed Mini-Split DX System	Enhanced	X	-	X
5	Stand-Alone Dehumidifier with Conventional System Mixing	Explicit	X	X	-
6	Ducted Dehumidifier with Conventional System Mixing	Explicit	X	X	-
7	Ducted Dehumidifier with Outdoor Air Preconditioning	Explicit	-	-	-
8	Enhanced Cooling with Partial-Condensing/Subcooling Reheat (2-speed compressor)	Enhanced	X	X	X
9	Enhanced Cooling with Full Condensing/Subcooling Reheat (2-speed compressor)	Explicit	X	X	-
10	Conventional DX System with Lower Air Flow	Enhanced	X	X	X
11	Conventional DX System with Thermostat Overcooling	Enhanced	X	X	X
12	Conventional DX System with Sensible-Only AAHX	Enhanced (w/o control)	X	X	X
13	Gas-Regenerated Desiccant Dehumidifier	Explicit	X	X	-
14	DX Condenser-Regenerated Desiccant Dehumidifier	Explicit	X	X	-

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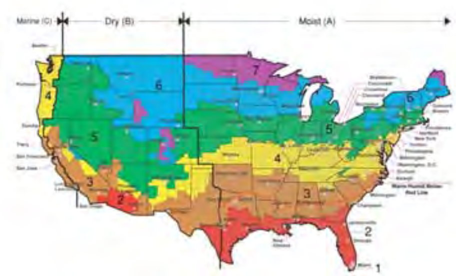
Climates

The cities shown below, representing each of the IECC Climate Zones 1A through 5A shown in Figure 3, were chosen to represent locations that have, at least for part of the year, substantial latent loads, and cover a temperature range that includes both conditions with little coincident sensible load and significant coincident sensible load. TMY3 weather data is used.

IECC Zone 1A – Miami
IECC Zone 2A – Houston
IECC Zone 3A – Atlanta
IECC Zone 4A – Nashville
IECC Zone 5A – Indianapolis



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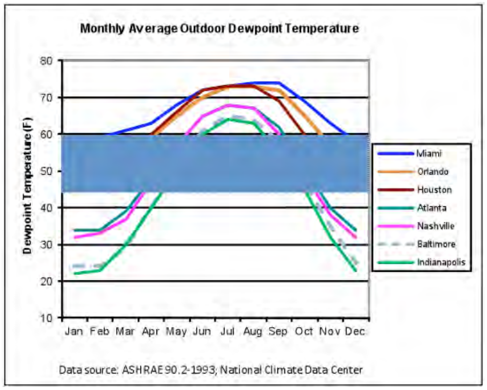
Outdoor humidity, it is only part of the problem: Indoor moisture and heat generation, sensible cooling load and the timing of cooling operation plays a big role in elevated indoor humidity



Building Size and Foundation Type

The house foundation type will be modeled as slab-on-grade for all climate zones. A range of house sizes will be evaluated as follows:

Small — 1200 ft^2 conditioned floor area, 2 bedroom
Medium — 2000 ft^2 conditioned floor area, 3 bedroom
Large — 3500 ft2 conditioned floor area, 4 bedroom

The medium size house will be modeled for all parametric cases. A sensitivity study will be completed for the small and large size houses for the HERS Index 100 and 70 levels, in climate zones 2A and 4A, for the Conventional DX System (System 1) and the Ducted Dehumidifier with Conventional System Mixing (System 6).

Building Enclosure Air Leakage

A range of building enclosure leakage rates, expressed as air changes per hour at 50 Pa pressure differential (ach50), will be linked with the levels of building enclosure thermal performance as follows:

10.0 ach50 for Typical existing home (HERS Index≈130)
7.0 ach50 for HERS Reference house (HERS Index≈100)
5.0 ach50 for Energy Star house (HERS Index≈85)
4.0 ach50 for USDOE Builders Challenge house (HERS Index≈70)
3.0 ach50 for USDOE Building America prototype house (HERS Index≈50)

Duct Air Leakage and Duct Insulation

The entire air distribution system will be modeled as being inside conditioned space for the HERS 50 house, with zero duct leakage to/from outdoors. The air distribution system will be located in the vented attic for all of the other HERS levels. Where duct leakage is non-zero, it is modeled with 40% of the leakage being on the return side of the air handler and 60% on the supply side. Duct leakage amounts will be modeled according to Table 2.

Table 2. Duct leakage amounts

HERS Level	Duct leakage percent of operational airflow	Sensitivity study at given percent leakage
130	20%	5%, System 1, 6
100	10%	5%, System 1,6
85	5%	--
70	5%	--
50	none	--

Internal Heat and Moisture Generation

The magnitude and scheduling of internal heat generation will be taken from the Building America Benchmark Definition (Hendron 2008). The Benchmark internal heat gain total amount is applied unadjusted for the HERS 130, 100 houses. For the HERS 85, 75 and 50 houses, the internal heat gain amount will be lower to reflect installation of more efficient lighting and appliances as follows: HERS 85 is 10% lower; HERS 75 is 20% lower; HERS 50 is 30% lower.

Internal moisture generation will modeled as 12 lb/day for the medium size house (about 50% of ASHRAE Standard 160). A sensitivity study will be conducted for 24 lb/day (about 100% of ASHRAE Standard 160) for zones 2A and 4A, for the HERS 100 and 70 houses, and for the Conventional DX System (System 1) and the Ducted Dehumidifier with Conventional System Mixing (System 6). The internal moisture gain will be scheduled throughout the day according to the Building America Benchmark Definition.

Reductions below the ASHRAE Standard 160 moisture generation rate of 31.2 lb/day (1.3 lb/h) for a 3 bedroom house can account for lower than full-time occupancy. These reductions have been shown to be realistic based on BSC comparison to monitored indoor environmental conditions.

HERS Reference House (HERS Index ≈100)

Parameter	Climate Zone 1	Climate Zone 2	Climate Zone 3	Climate Zone 4	Climate Zone 5
Wall insulation R-value (nominal)	13	13	13	13	19
cavity	13	13	13	13	19
sheathing	0	0	0	0	0
framing factor	0.23	0.23	0.23	0.23	0.23
Ceiling insulation R-value	30	30	30	38	38
Slab insulation R-value (2' down)	0	0	0	10	10
Window U-value	1.20	0.75	0.65	0.40	0.35
Window SHGC	0.40	0.40	0.40	0.40	0.40
Building enclosure air leakage (ach50)	7	7	7	7	7
Duct air leakage to outside (%)	10	10	10	10	10
AHU location	attic	attic	attic	attic	attic
Supply duct area in attic (ft^2)	544	544	544	250	100
Return duct area in attic (ft^2)	100	100	100	100	100
Duct R-value	6	6	6	6	6
SEER, EER	13, 10	13, 10	13, 10	13, 10	13, 10
HSPF, COP	7.7, 2.3	7.7, 2.3	7.7, 2.3	7.7, 2.3	7.7, 2.3
AFUE	85	85	85	85	85
Internal heat gain (lumped) (people+lighting+appliances/equip)	BA Benchmark (72.7 kBtu/day)	BA Benchmark (72.7 kBtu/day)	BA Benchmark (72.7 kBtu/day)	BA Benchmark (72.7 kBtu/day)	BA Benchmark (72.7 kBtu/day)
Internal moisture generation	BA Benchmark (16.9 lb/day)	BA Benchmark (16.9 lb/day)	BA Benchmark (16.9 lb/day)	BA Benchmark (16.9 lb/day)	BA Benchmark (16.9 lb/day)
DHW (EF)	0.56	0.56	0.56	0.56	0.56
HERS	102	106	108	108	107

Building America House (HERS Index ≈50)

Selected simulation input parameters for Building America house (HERS Index 50)

Parameter	Climate Zone 1	Climate Zone 2	Climate Zone 3	Climate Zone 4	Climate Zone 5
Wall insulation R-value (nominal)	23	23	23	30	30
cavity	19	19	19	19	19
sheathing	4	4	4	11	11
framing factor	0.17	0.17	0.17	0.17	0.17
Ceiling insulation R-value	48	48	48	54	60
Slab insulation R-value (2' down)	0	5	5	10	10
Window U-value	0.35	0.35	0.30	0.30	0.30
Window SHGC	0.30	0.30	0.30	0.35	0.35
Building enclosure air leakage (ach50)	3	3	3	3	3
Duct air leakage to outside (%)	none	none	none	none	none
Air distribution system location	interior	interior	interior	interior	interior
SEER, EER	17, 14	17, 14	17, 14	17, 14	17, 14
HSPF, COP	8.8, 2.6	8.8, 2.6	8.8, 2.6	8.8, 2.6	8.8, 2.6
AFUE	93	93	93	93	93
Internal heat gain (lumped) (people+lighting+appliances/equip)	BA Bnchmrk*0.7 (50.9 kBtu/day)	BA Bnchmrk*0.7 (50.9 kBtu/day)	BA Bnchmrk*0.7 (50.9 kBtu/day)	BA Bnchmrk*0.7 (50.9 kBtu/day)	BA Bnchmrk*0.7 (50.9 kBtu/day)
Internal moisture generation	BA Benchmark (16.9 lb/day)	BA Benchmark (16.9 lb/day)	BA Benchmark (16.9 lb/day)	BA Benchmark (16.9 lb/day)	BA Benchmark (16.9 lb/day)
DHW (EF)	0.93	0.93	0.93	0.93	0.93
HERS	53	53	51	53	56

AC Systems for each HERS Level

	System 1 Conven AC	System 2 Enhanced AC	System 3 Two-Spd AC	System 4 Var-Spd AC	System 5 AC w/ DH
HERS 130	SEER 10 1-Spd (16)	SEER 10 1-Spd (16)	SEER 17.7 2-Spd (19)	SEER 19 V-Spd (20)	SEER 10 1-Spd (16)
HERS 100	SEER 13 1-Spd (17)	SEER 13 1-Spd (17)	SEER 17.7 2-Spd (19)	SEER 19 V-Spd (20)	SEER 13 1-Spd (17)
HERS 85	SEER 14.5 1-Spd (18)	SEER 14.5 1-Spd (18)	SEER 17.7 2-Spd (19)	SEER 19 V-Spd (20)	SEER 14.5 1-Spd (18)
HERS 70		SEER 17.7 2-Spd (19)	SEER 17.7 2-Spd (19)	SEER 19 V-Spd (20)	SEER 17.7 2-Spd (19)
HERS 50		SEER 17.7 2-Spd (19)	SEER 17.7 2-Spd (19)	SEER 19 V-Spd (20)	SEER 17.7 2-Spd (19)

Summary of simulation cases

	Number of simulation cases
Typical Existing house (HERS Index 130)	70
HERS Reference House (HERS Index 100; 2006 IECC Code)	150
Energy Star house (HERS Index 85)	150
Builders Challenge house (HERS Index 70)	210
Building America house (HERS Index 50)	210
subtotal	**790**
Sensitivity 1 (lower cfm/ton and overcooling)	48
Sensitivity 2 (heat pipe and desiccant)	28
Sensitivity 3 (house size)	80
Sensitivity 4 (duct leakage)	60
Sensitivity 5 (ventilation rate)	80
Sensitivity 6 (moisture generation)	40
Sensitivity 7 (duct insulation)	60
subtotal	**396**
total	**1186**

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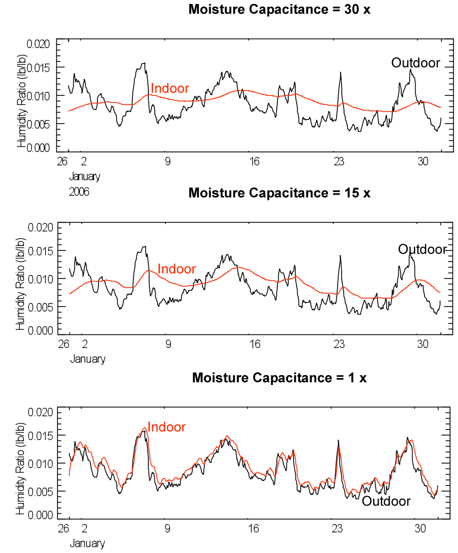
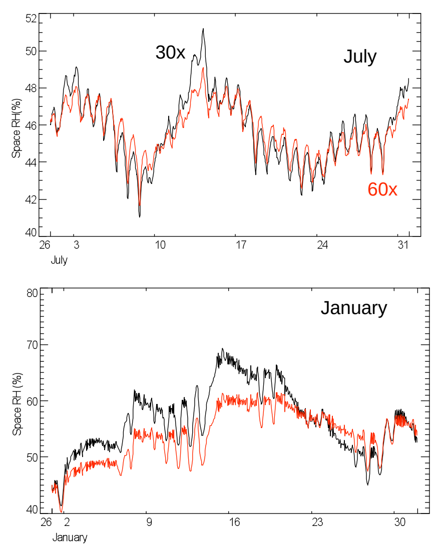
Impact of Moisture Capacitance Term

Orlando



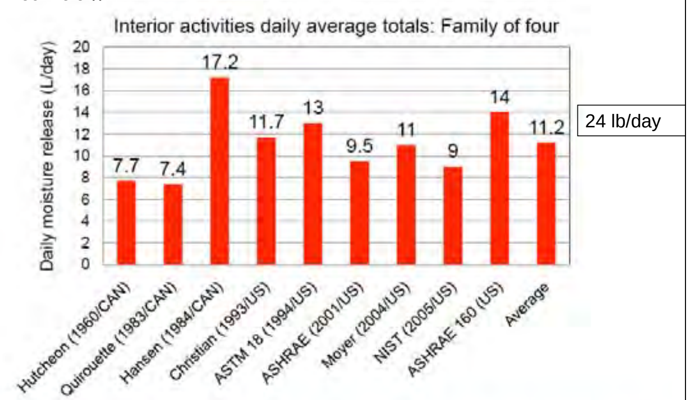
Capacitance at 30x and 60x

Orlando



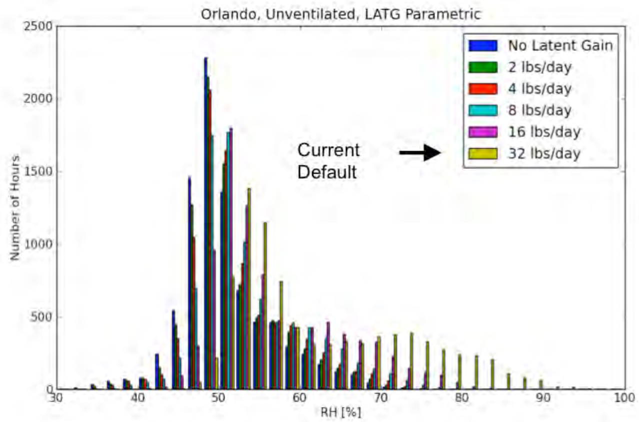
Internal Moisture Gains

from Boualem Ouazia, NRC-CAN, Humidity Control in Houses ERV Technology

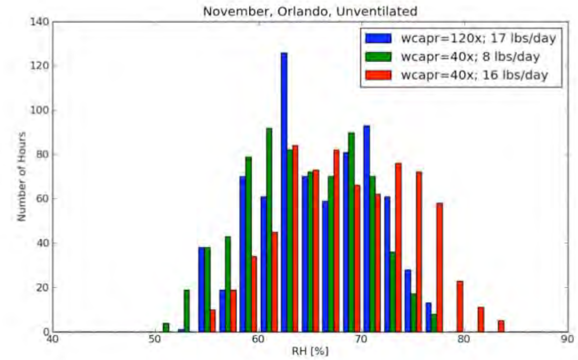


Jeffrey E. Christian "A Search for Moisture Sources" Workshop on Bugs, mold & Rot II Proceedings, 1993

Impact of Different Moisture Gains



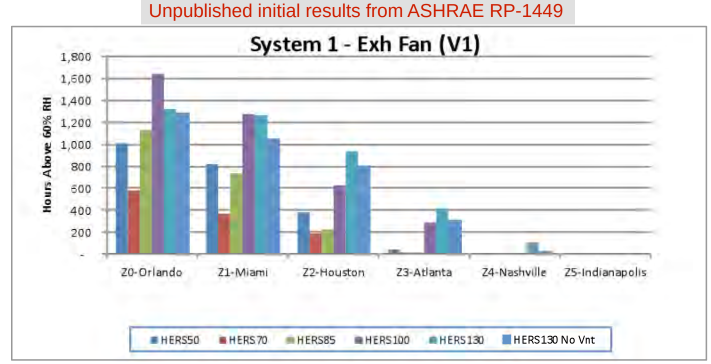
Trade-off of Moisture Capacitance and Moisture Gain



Recommendations Going Forward

- Use 12 lb/day as default (24 lb/day for sensitivity)
- Use moisture capacitance of 30x
- Change Set points to be 72F / 78F for humid climates (two zones: Miami, Houston)

Unpublished initial results from ASHRAE RP-1449



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Elevated indoor humidity analysis criteria

Run ID	Hours Above 50% RH	Hours Above 55% RH	Hours Above 60% RH	Hours Above 65% RH	Run ID	4+ hrs	8+ hrs	4+ hrs	8+ hrs	4+ hrs	8+ hrs	4+ hrs	8+ hrs
z0h50s1rh50v0	3,340	2,412	**1,565**	992	z0h50s1rh50v0	26	**12**	34	**26**	38	**31**	21	**18**
z0h50s1rh50v1	7,379	3,037	**975**	215	z0h50s1rh50v1	63	**54**	103	**79**	51	**35**	17	**9**
z0h50s1rh50v2	7,268	2,803	**1,079**	238	z0h50s1rh50v2	87	**79**	78	**62**	51	**34**	19	**9**
z0h50s1rh50v4	7,450	3,427	**1,402**	359	z0h50s1rh50v4	80	**72**	73	**53**	61	**43**	26	**16**
z0h70s1rh50v0	2,894	1,682	**904**	461	z0h70s1rh50v0	34	**25**	43	**33**	27	**22**	19	**15**
z0h70s1rh50v1	6,410	1,965	**600**	142	z0h70s1rh50v1	98	**84**	83	**63**	32	**19**	9	**4**
z0h70s1rh50v2	6,589	2,314	**789**	156	z0h70s1rh50v2	117	**95**	85	**70**	45	**28**	10	**8**
z0h70s1rh50v4	7,031	2,876	**994**	201	z0h70s1rh50v4	103	**92**	93	**80**	56	**35**	15	**9**
z0h85s1rh50v0	3,549	2,407	**1,443**	521	z0h85s1rh50v0	53	**45**	62	**49**	58	**46**	31	**21**
z0h85s1rh50v1	5,687	2,397	**1,127**	305	z0h85s1rh50v1	133	**109**	81	**58**	58	**43**	18	**10**
z0h85s1rh50v2	5,341	2,495	**1,198**	352	z0h85s1rh50v2	142	**106**	81	**62**	63	**46**	23	**13**
z0h85s1rh50v4	5,448	2,760	**1,324**	427	z0h85s1rh50v4	121	**95**	92	**67**	64	**51**	33	**18**
z0h100s1rh50v0	4,084	2,976	**1,823**	843	z0h100s1rh50v0	57	**43**	56	**48**	53	**45**	47	**39**
z0h100s1rh50v1	6,260	2,967	**1,636**	684	z0h100s1rh50v1	129	**108**	91	**68**	53	**40**	40	**29**
z0h100s1rh50v2	6,087	3,020	**1,671**	730	z0h100s1rh50v2	139	**115**	96	**76**	61	**47**	43	**34**
z0h100s1rh50v4	6,395	3,331	**1,742**	791	z0h100s1rh50v4	126	**113**	105	**80**	63	**47**	46	**40**
z0h130s1rh50v0	4,571	2,440	**1,282**	505	z0h130s1rh50v0	113	**96**	70	**60**	60	**54**	31	**20**
z0h130s1rh50v1	6,759	3,109	**1,320**	559	z0h130s1rh50v1	131	**124**	117	**83**	66	**49**	35	**26**

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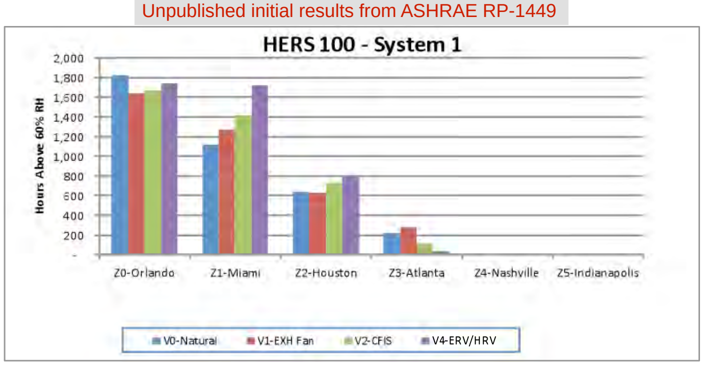
Ventilation Systems

AHU Fan	375
cfm/ton clg	275 cfm/ton
htg & vent	

- **V0** - No Ventilation
  - Was Only for HERS 130, ELA = 175.3
- **V1** – Exhaust Only
  - 58 cfm continuous, 0.4 W/cfm,
- **V2** – Central Fan Integrated Supply
  - 174 cfm (3x), 33% of time
  - 10 min ON / 20 min OFF, damper closes @ 10 min
- **V3/V4** – HRV/ERV (into AHU return)
  - 116 cfm (2x), 50% of time
  - HRV 30 min ON / 30 min OFF, AHU fan interlocked

Unpublished initial results from ASHRAE RP-1449



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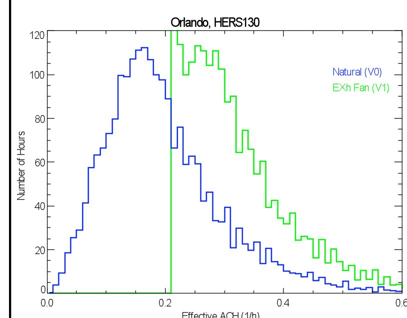
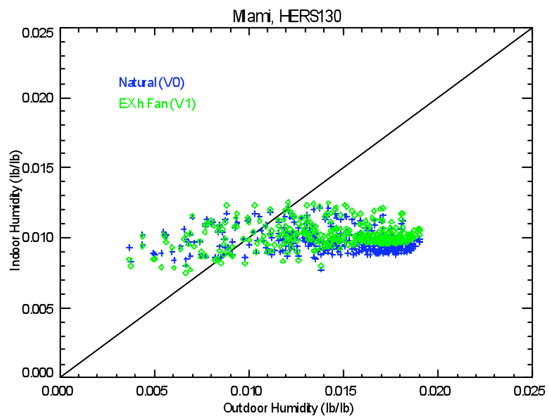
Impact of Ventilation

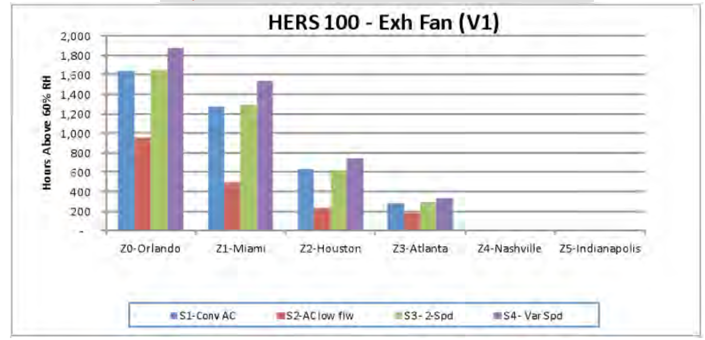


	Avg Airchange Rate (1/h)					
	Orlando		Miami		Houston	
	Natural (V0)	Exh Fan (V1)	Natural (V0)	Exh Fan (V1)	Natural (V0)	Exh Fan (V1)
January	0.242	0.350	0.190	0.301	0.280	0.388
February	0.245	0.353	0.295	0.403	0.263	0.371
March	0.244	0.353	0.289	0.397	0.268	0.376
April	0.215	0.325	0.233	0.346	0.209	0.317
May	0.190	0.300	0.250	0.361	0.183	0.293
June	0.174	0.290	0.194	0.310	0.149	0.271
July	0.173	0.288	0.145	0.264	0.148	0.274
August	0.136	0.264	0.177	0.295	0.127	0.259
September	0.158	0.280	0.167	0.287	0.184	0.296
October	0.200	0.315	0.177	0.294	0.184	0.294
November	0.204	0.315	0.220	0.333	0.231	0.340
December	0.208	0.318	0.199	0.311	0.259	0.367
ANNUAL	**0.199**	**0.313**	**0.211**	**0.325**	**0.207**	**0.321**

Comparing V0 & V1



Unpublished initial results from ASHRAE RP-1449



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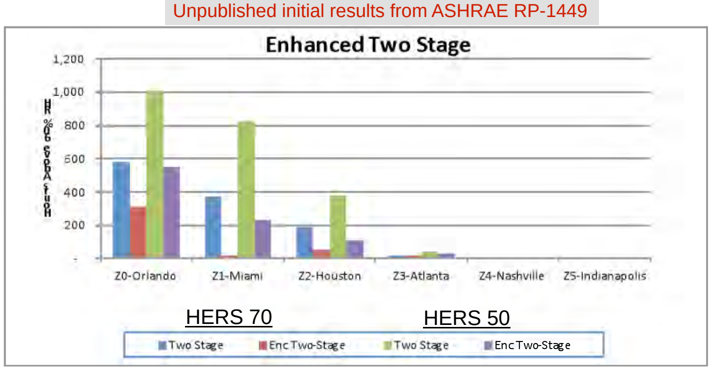
Two-Stage Cooling with all Enhanced Approaches
(low airflow and overcooling with intermittent very-low airflow)

Unpublished initial results from ASHRAE RP-1449



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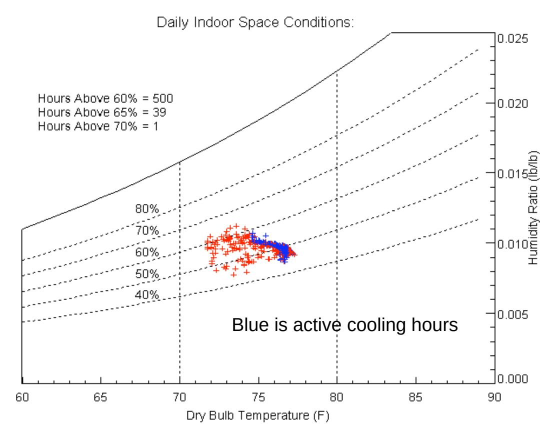
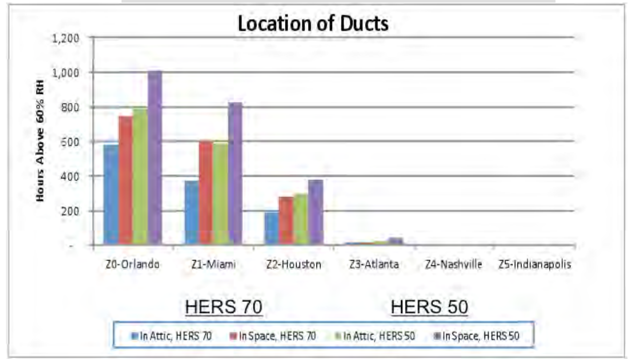
Impact of Low Airflow and Overcooling (S2) in Miami



Separating the Impact of Lower Airflow and Overcooling in Houston

		Hours Above 60% RH	AC Runtime (hrs)	AC EER (Btu/Wh)	AC Energy (kWh)	Htg Energy (kWh)	AHU Fan Energy (kWh)	Exh Fan Energy (kWh)	Total Electric w/o HT (kWh)	Total Costs ($)
HERS 100 Single Spd	S1 - Conv AC	625	1,943	15.0	4,507	7,667	1,273	203	5,982	806
	S10 - Lower Airflow	487	1,970	14.9	4,533	7,673	1,178	203	5,915	801
	S11 - Overcooling	328	2,005	15.0	4,632	7,737	1,309	203	6,145	822
	S2 - Both	236	2,014	14.9	4,620	7,724	1,190	203	6,013	811
HERS 70 2-Stage	S1 - Conv AC	188	3,838	19.3	2,832	2,042	345	203	3,380	358
	S10 - Lower Airflow	114	3,934	19.3	2,862	2,043	341	203	3,406	360
	S11 - Overcooling	78	4,193	21.7	2,365	2,066	191	203	2,760	309
	S2 - Both	52	4,263	21.6	2,377	2,051	183	203	2,763	309

Unpublished initial results from ASHRAE RP-1449



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Gaps, Barriers, and Future Work

- √ Smaller capacity ducted dehumidifier equipment
- Further cost reduction of dehumidifiers and central dehumidifying equipment through design and manufacturing optimization
- Better understanding of actual dehumidification design load, including moisture storage effects and occupant behavior
- √ More laboratory testing of dehumidifiers to establish better design criteria and performance maps for simulation models
- More laboratory and field testing of central dehumidifying equipment to establish better design criteria and performance maps for simulation models

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Gaps, Barriers, and Future Work, cont.

- Work with industry (AHRI) on new rating standard for dehumidifiers and central dehumidifying equipment to aid in proper humidity control design and equipment selection
- More buy-in from cooling equipment manufacturers regarding the need for a focus on dehumidification performance
- Better understanding of humidity control impacts of sensible heat gain reduction in mixed-humid climates
- All BA teams working in warm-humid and mixed-humid climates should be routinely collecting temperature and relative humidity data in several indoor locations

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Proposed humidity control test conditions for central dehumidifying equipment

Performance map data needs at each test condition and at each equipment control state
For dehumidifer equipment with both indoor and outdoor heat transfer components

		Outdoor T/RH/Tdp (F/%/F)	Inlet T/RH/Tdp (F/%/F)	Outlet T/RH/Tdp (F/%/F)	Indoor Wet-coil Airflow (cfm)	Sensible Cooling Capacity[1] (Btu/h)	Latent Cooling Capacity (Btu/h)	Moisture Removal Capacity (L/h)	Total Power (kW)	Moisture Removal Efficiency[2] (L/kW-h)
Summer, full sensible load[3]	Test 1a	95/58/78	80/60/65							
	Test 1b	""	78/55/61							
	Test 1c	""	75/50/55							
Summer, part sensible load[3]	Test 2a	80/85/75	80/60/65							
	Test 2b	""	78/55/61							
	Test 2c	""	75/50/55							
Spring-Fall, part sensible load[3]	Test 3a	75/85/70	78/60/63							
	Test 3b	""	78/55/61							
	Test 3c	""	75/50/55							
Winter, latent load only[3]	Test 4a	65/90/62	72/60/57							
	Test 4b	""	70/52/52							
	Test 4c	""	68/45/46							

[1] Negative cooling capacity denotes net heat added from inlet to outlet
[2] Same units as the USDOE and USEPA Energy Factor for dehumidifiers
[3] All tests with steady wet coil

	Air entering outdoor unit			Air entering indoor unit			Comment
	drybulb (F)	RH%	dewpoint (F)	drybulb (F)	RH (%)	dewpoint (F)	
ARI ratings (67 indoor wetbulb)	95	40	67	80	51	60	45 F saturated suction
AHAM dehumidifier rating				80	60	65	

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Thank you!

Questions?

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