

Laboratory Evaluation of Supplemental Dehumidifiers and Energy Recovery Ventilators

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Project Affiliations and Objectives



Energy Efficiency &
Renewable Energy

- Supplemental Dehumidifiers (SDH)

- PNNL project sponsorship
- NREL test plan collaboration
- Emerging product selection
- Performance evaluation
- Test point envelope generation
- Curve fit algorithm for EnergyPlus
- Work to be completed by October



- Energy Recovery Ventilators (ERV)

- BA-PIRC project sponsorship
- Work to get underway in August
- Upcoming test plan formulation



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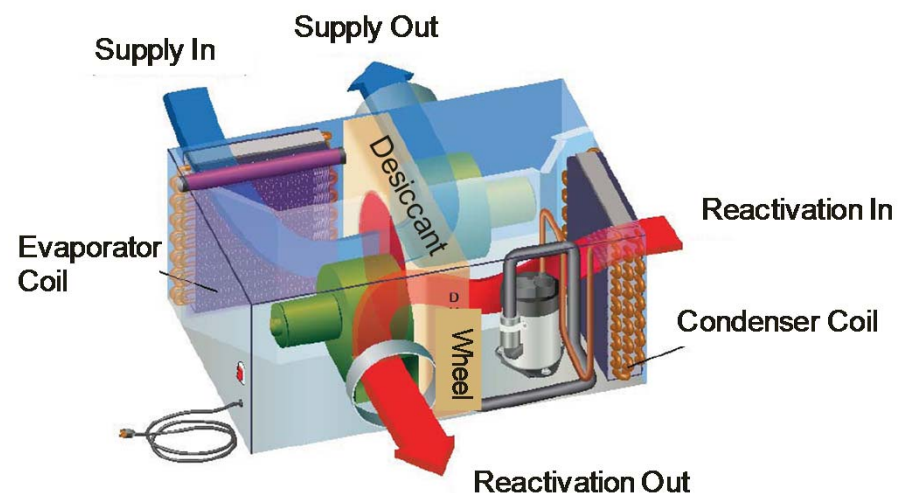
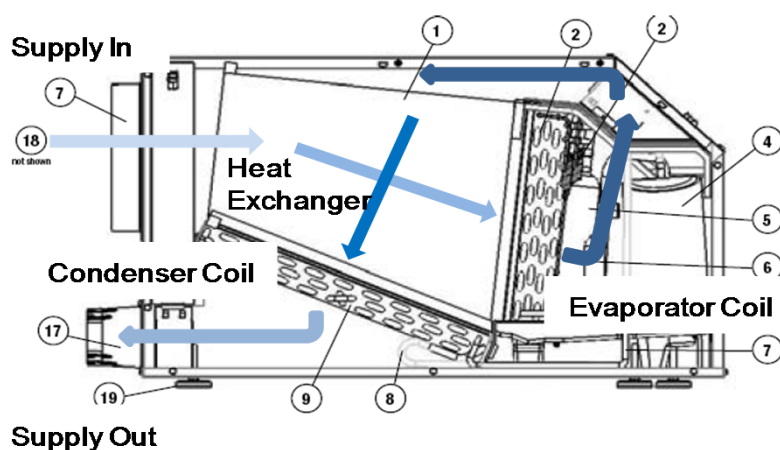


SDH State-of-the-Art Background

Vapor Compression Based System Type	80 °F/60 %RH Energy Factor	75 °F/50 %RH	
		Energy Factor	Sensible Heat Added
Conventional	1.8 L/kWh	1.4 L/kWh	5000 Btu/L
Recuperative HX ¹	3.6 L/kWh	2.9 L/kWh	4700 Btu/L
Desiccant Wheel ²	3.3 L/kWh	2.4 L/kWh estimate	600 Btu/L estimate

¹ Performance based on NREL testing of Thermastor Ultra-Aire XT150H (Technical Report NREL/TP-550-47215).

² Does not meet formal equipment criteria for AHAM/CSA Energy Factor (EF) certified rating. Performance based on Munters DryCool HD literature/software for condenser coil entering air at 95 F/42 %RH (105 gr/lb).



SDHs Being Evaluated

Vapor compression based systems with integrated desiccant wheel regenerated with condenser heat

- Munters DryCool HD
 - 200 CFM @ 0.4" ESP
 - 120 pints/day and 7 pints/kW @ 80°F, 60% RH condition

Source: www.munters.us/en/us/Products--Services/Dehumidification/Dehumidification/Residential-Dehumidification/?Product=B4763DB6-F455-4097-8E16-F96D6493CCD9

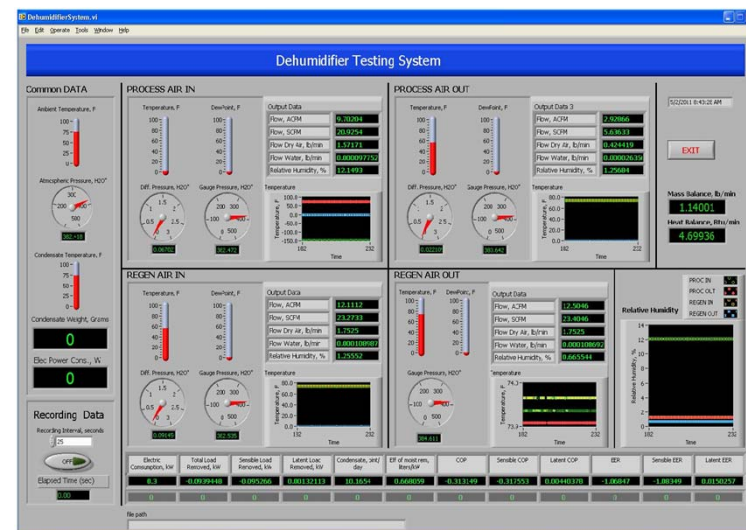
- NovelAire ComfortPlus 300
 - 300 CFM
 - 200 pints/day @ 78 °F, 60% RH condition

Source: www.novelaire.com/comfortplus-300-dehumidifier.html



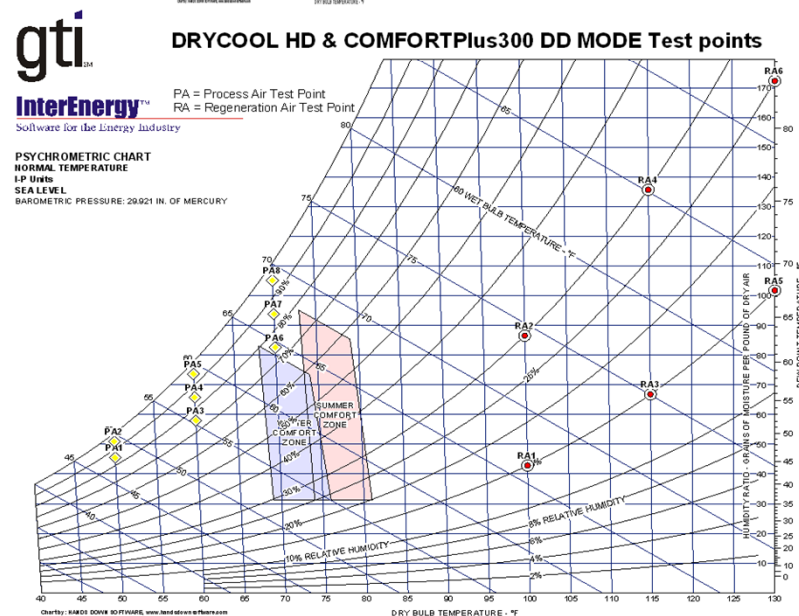
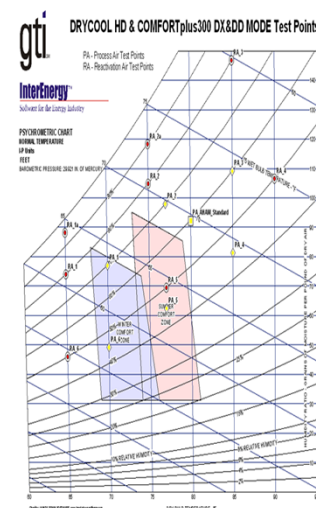
SDH Test Loop

- Standard compliance
 - ANSI/ASHRAE 174-2009
 - ANSI/AHAM DH-1-2003
 - ANSI/ASHRAE 37-2005
 - and measurement MOTs
- Airflow – laminar flow elements with differential/absolute pressure
- Humidity – DP hygrometers
- Temperature – TC arrays
- Condensate – electronic scale
- Electrical – watt meter
- Data collection/reduction - Labview



SDH Test Envelope

- Current EnergyPlus component based model (FYI – we need “black box” model) requires:
 - Testing full system in direct expansion (DX) and desiccant dehumidifier (DD) operating mode
 - 43 test points
 - 7 process conditions
 - 8 regeneration conditions
 - Testing in desiccant dehumidifier (DD) only operating mode
 - 26 test points
 - 6 process conditions
 - 6 regeneration conditions
- Difference between DX&DD and DD only yields DX only



Using established EnergyPlus equation forms for HVAC models

$$\text{Parameter} = a + b * \text{CWI} + c * \text{CTI} + d * (\text{CWI}/\text{CTI}) + e * \text{EWI} + f * \text{ETI} + g * (\text{EWI}/\text{ETI}) + h * \text{RFV}$$

where performance parameters are:

RWOc = Regeneration outlet air humidity ratio (kg/kg)

RTOc' = Regeneration outlet air dry-bulb temperature (°C)

PWOc = Process outlet air humidity ratio (kg/kg)

PTOc' = Process outlet air dry-bulb temperature (°C)

H2ORU = Unit condensate removal rate (liters/hour)

ElecPU = Unit electric power consumption (kW)

and equation variables/measured values are:

CTI = Condenser inlet air dry-bulb temperature (°C)

CWI = Condenser inlet air humidity ratio (kg/kg)

ETI = Evaporator inlet air dry-bulb temperature (°C)

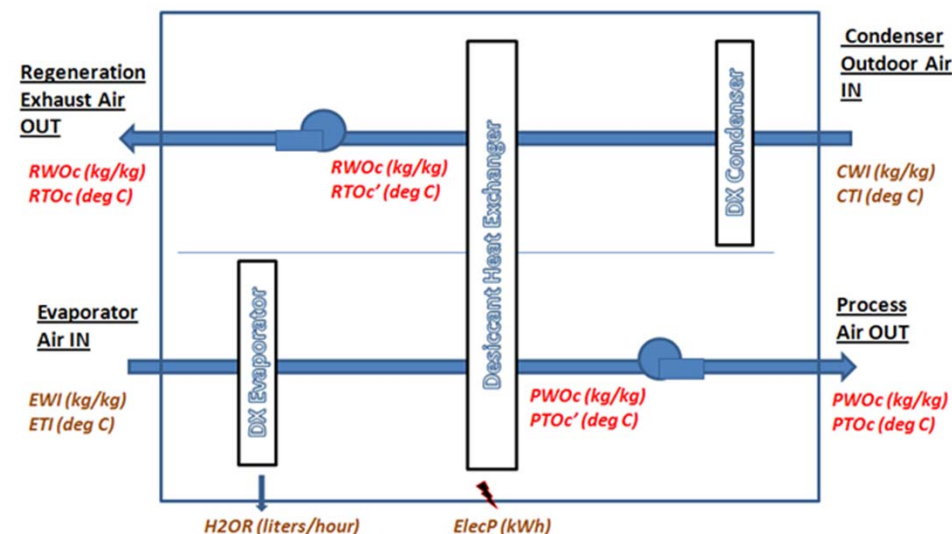
EWI = Evaporator inlet air humidity ratio (kg/kg)

~~RFV~~ = Regeneration (and process) face velocity (m/s)

H2OR = Condensate removal (liters/hour)

ElecP = Unit electric power consumption (kW)

with the constants/coefficients a through g to be determined by the curve fit solution using the measured values. Also note dew point temperatures may be used instead of humidity ratios in final curve fit.

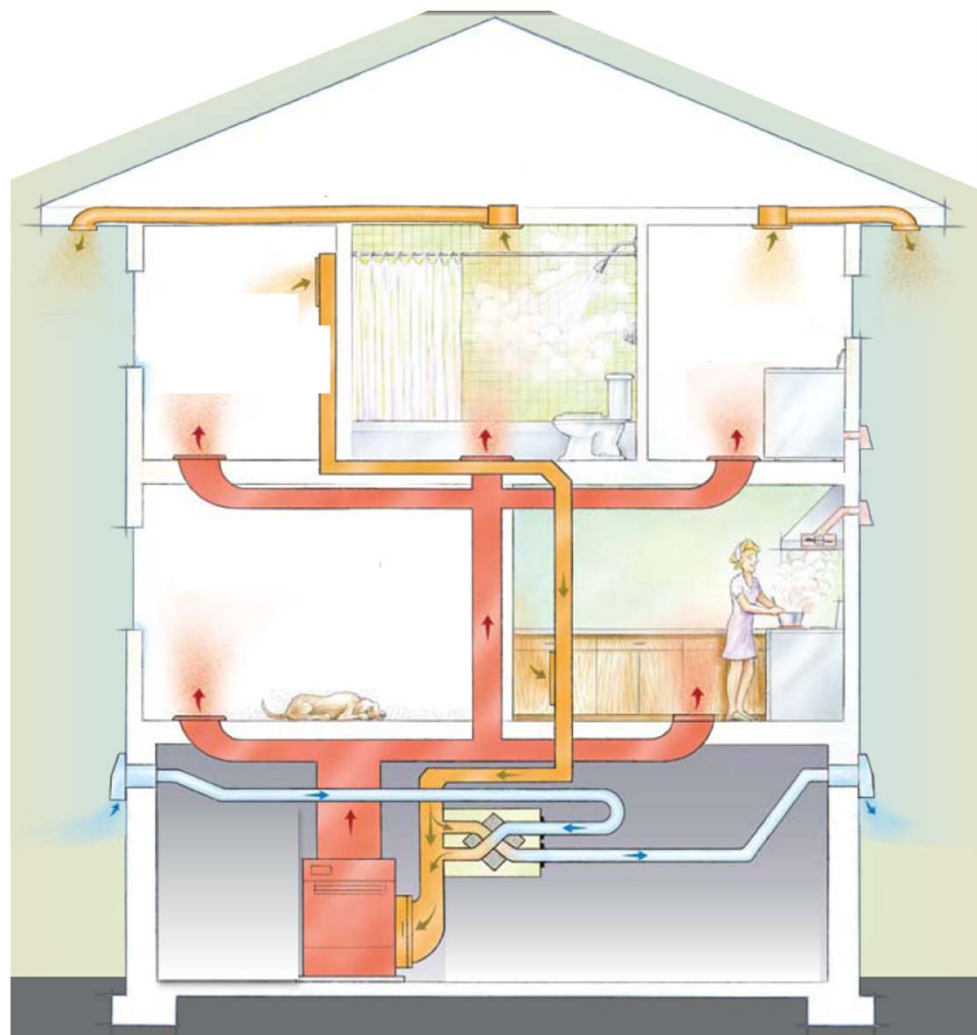


Note: PTOc' and RTOc' values are calculated from PTOc and RTOc after subtracting fan heat impact on air temperature

- Modeling algorithms for emerging SDH equipment class with integrated condenser heat regenerated desiccant wheel could be incorporated by EnergyPlus development team in next release of EnergyPlus, sometime in 2012
- EnergyPlus analysis could then compare recuperative heat exchange and desiccant dehumidification augmented SDH equipment on annual operating issues:
 - Electrical energy use of SDHs for equivalent moisture removal
 - Added AC electrical energy use due to sensible heat from SDH
 - Combined SDH and AC annual electrical energy use
- However value proposition for use of SDH, even in high performance homes, still needs further definition

ERV Test Topic Input Needed

- ERV performance
 - Single rating point data
 - Broader data mapping (capturing bathroom and kitchen exhaust recovery)
- Tight home construction and depressurization
 - Passive ERV unbalancing
 - Active ERV unbalancing
- Appliance exhaust
 - Depressurization levels
 - Performance effects
 - On appliance
 - On ERV



Source: RenewAire

Questions

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Energy Efficiency &
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