SEMCO Ventilation System

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IWESS Workshop

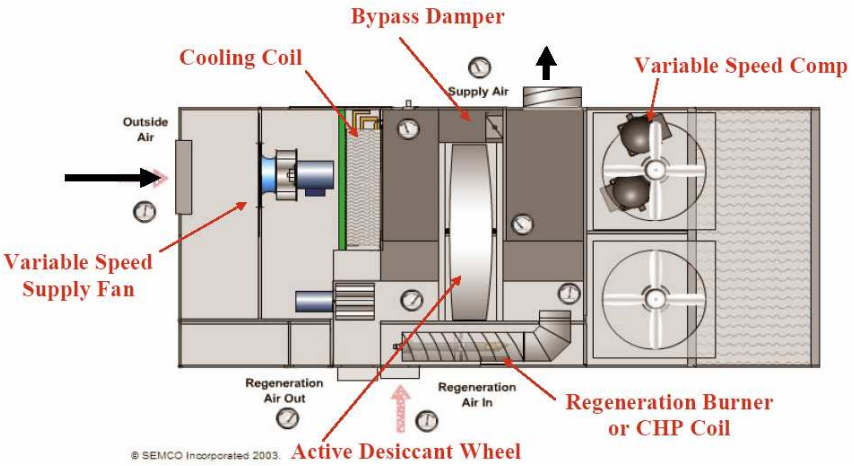
Oct. 4, 2006

Outline

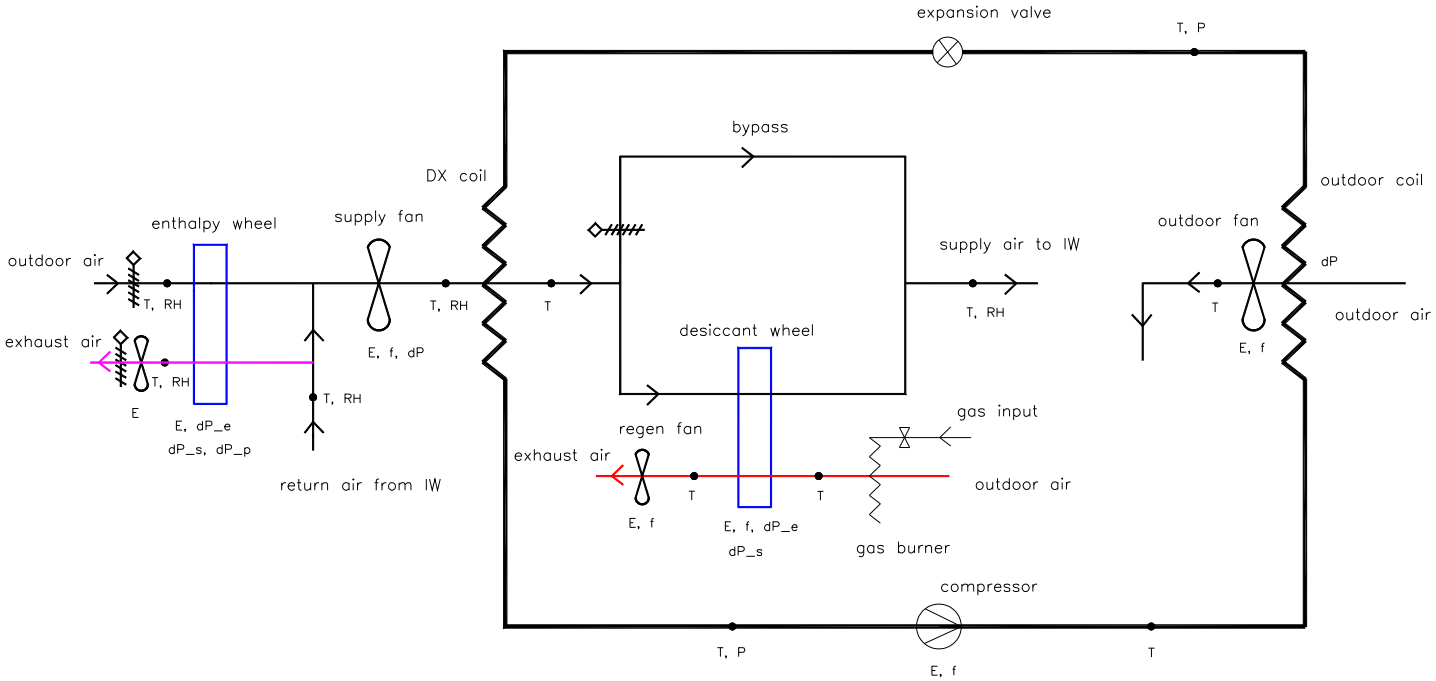
- Overall system and its components
- Field performance testing
- Computational modeling
- Preliminary Conclusions and further work

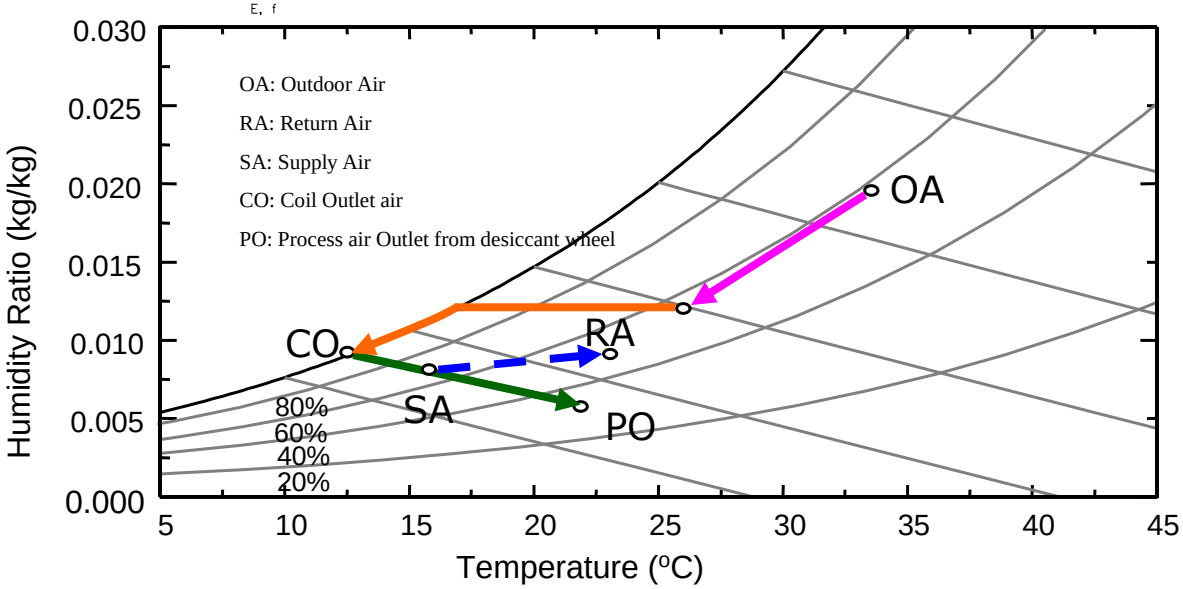
SEMCO REV 2250 & FVR 2000

- REV-2250 Revolution™ active desiccant-vapor compression hybrid rooftop unit
- FVR-2000 solid desiccant energy recovery module
- Nominal air flow 2250 cfm, maximum 3000 cfm
- Heating provided primarily by heat pump with gas assist
- Active solid desiccant for air dehumidification

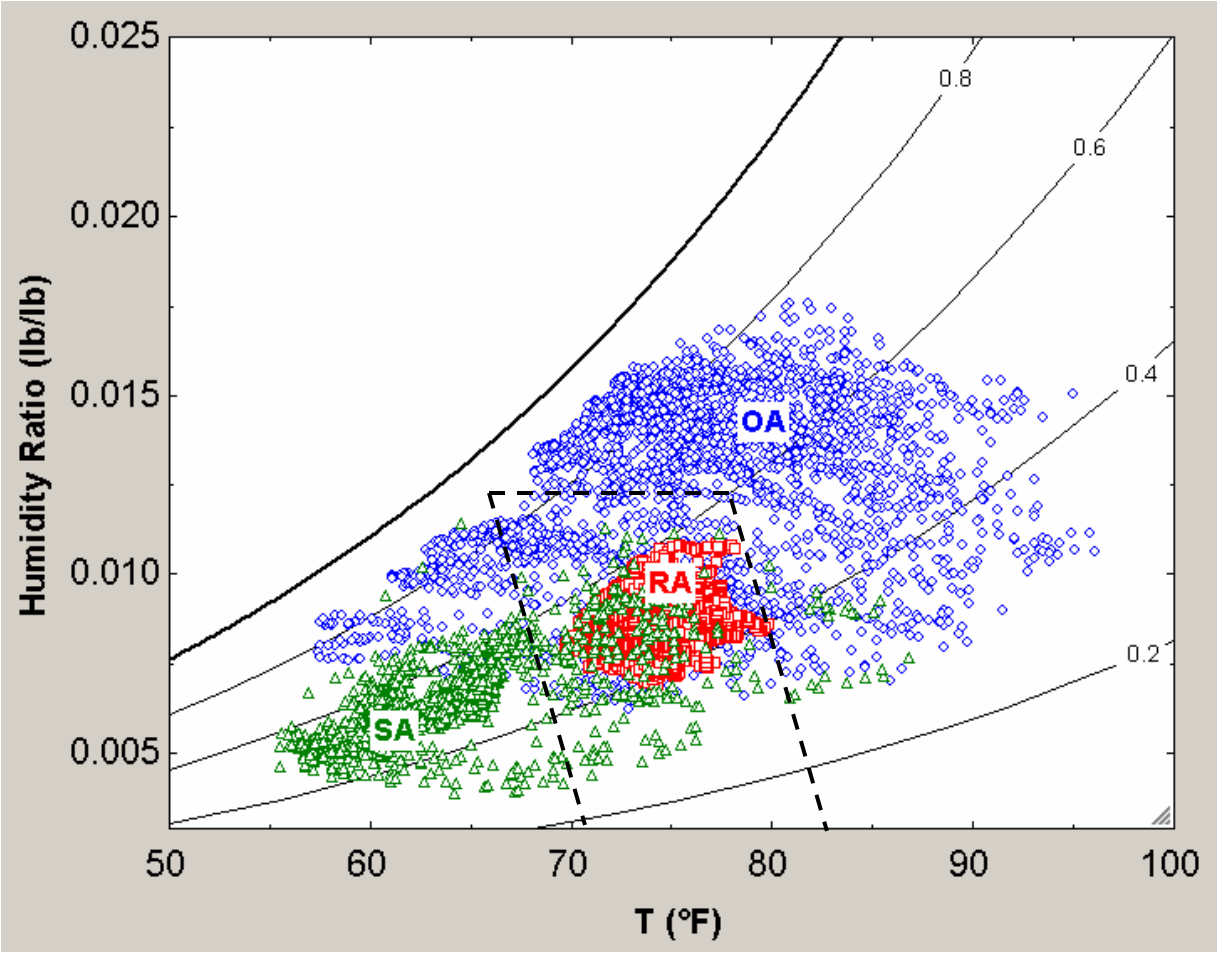


Flow Diagram of SEMCO at IW



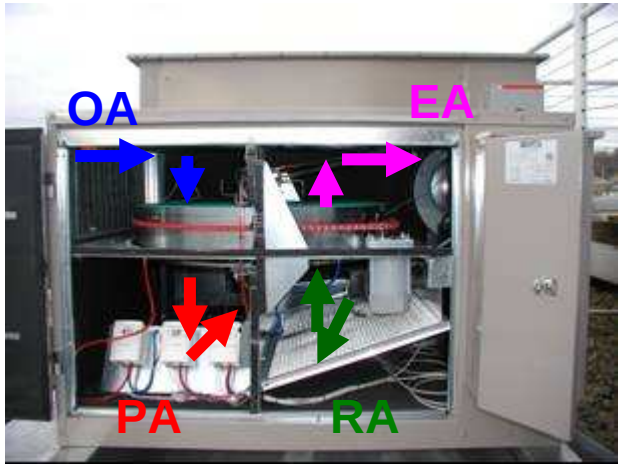


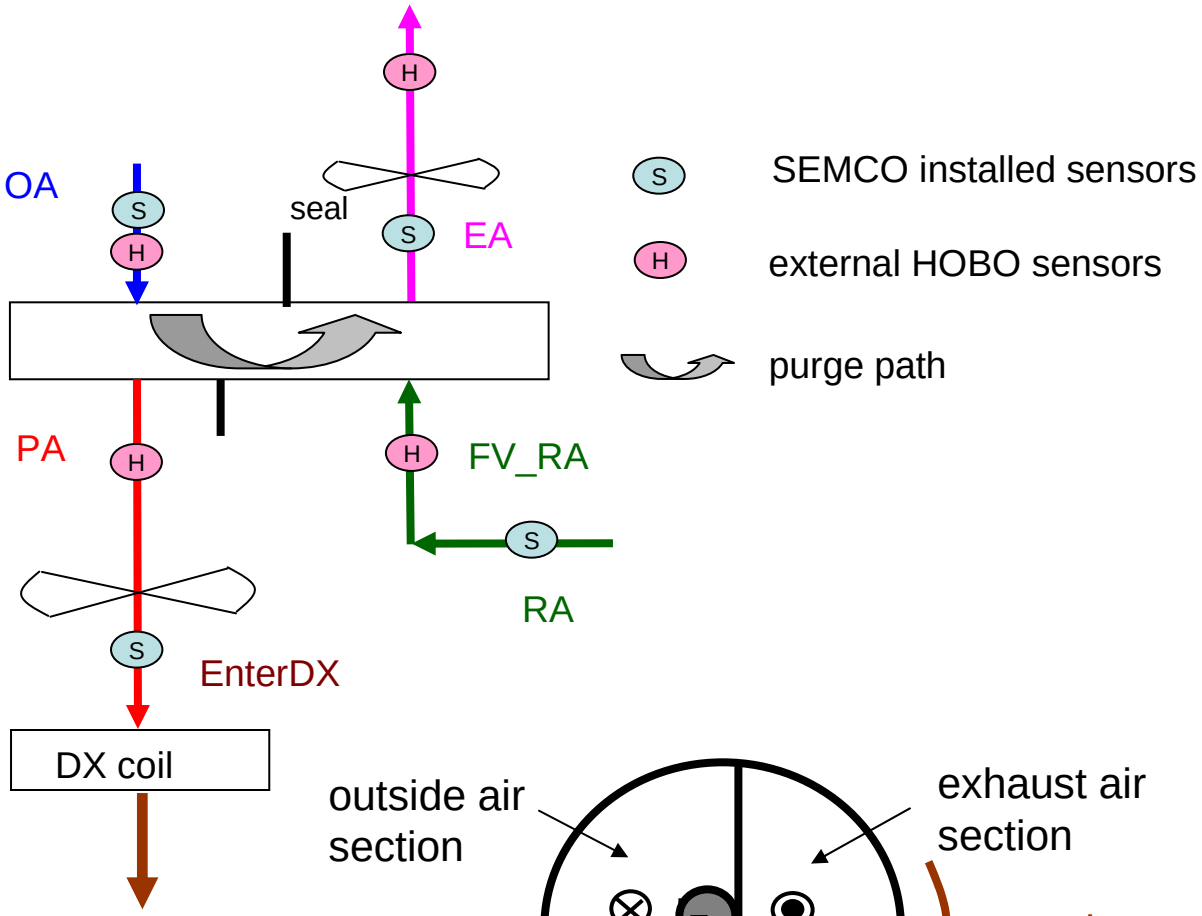
Performance of Overall System

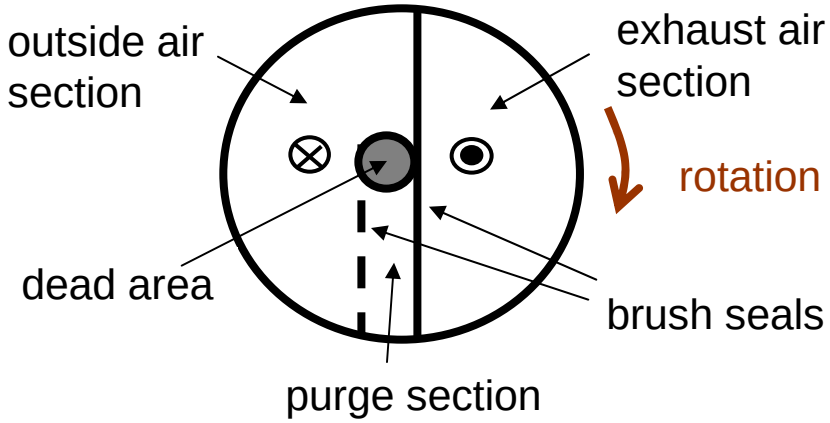


Plotted for July 2006

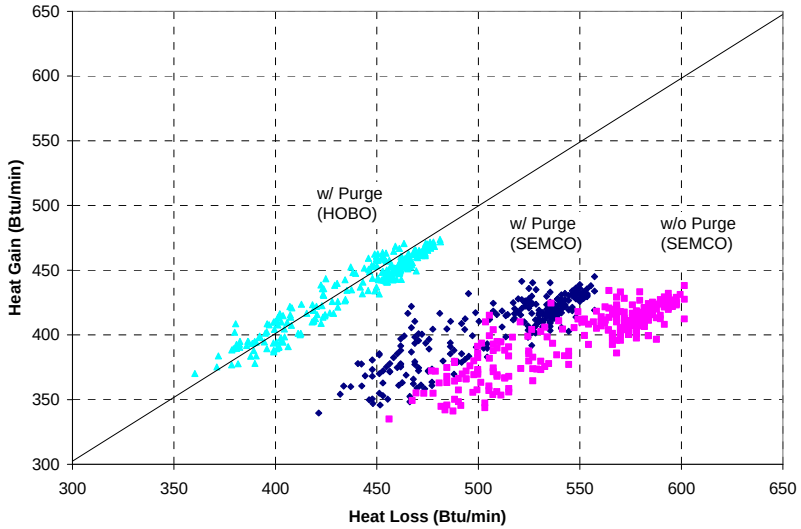
Enthalpy Recovery Wheel in IW

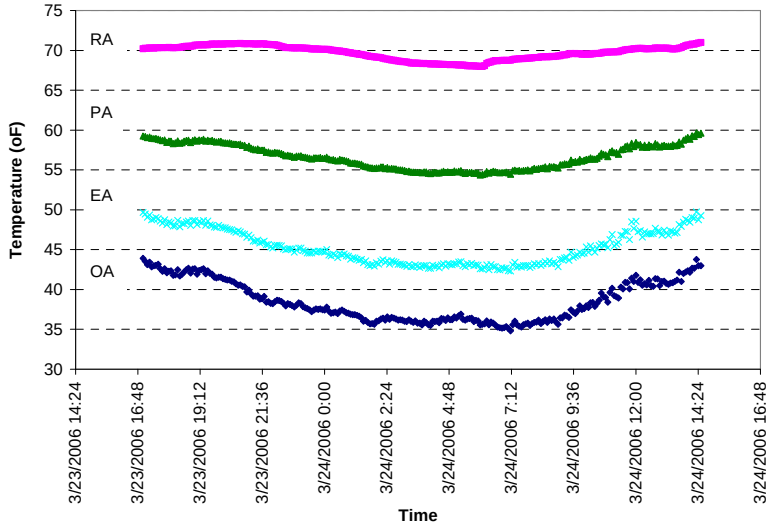


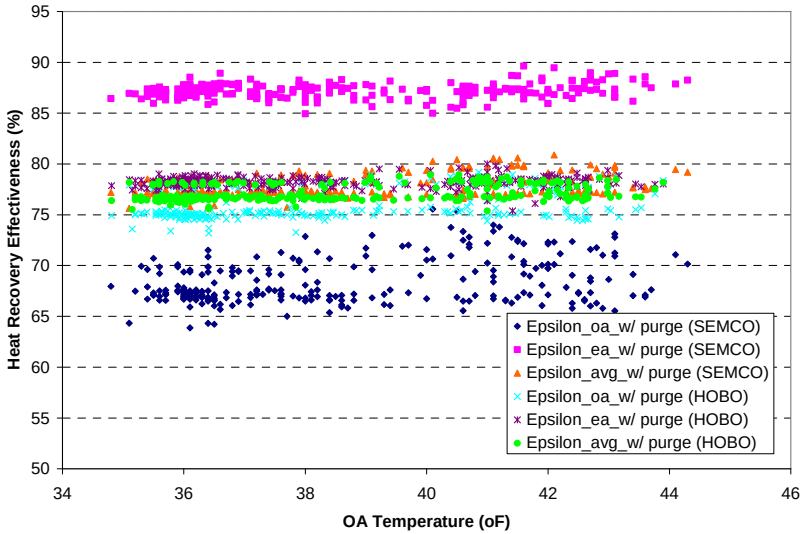




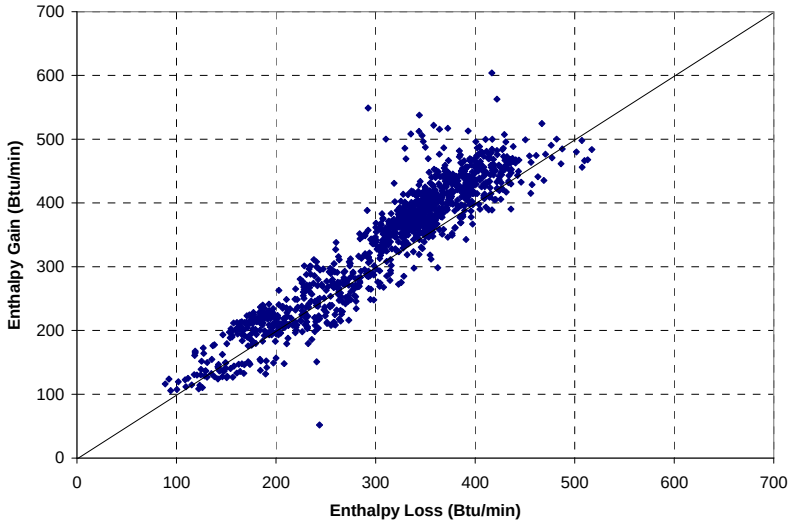
Winter Testing of Enthalpy Wheel

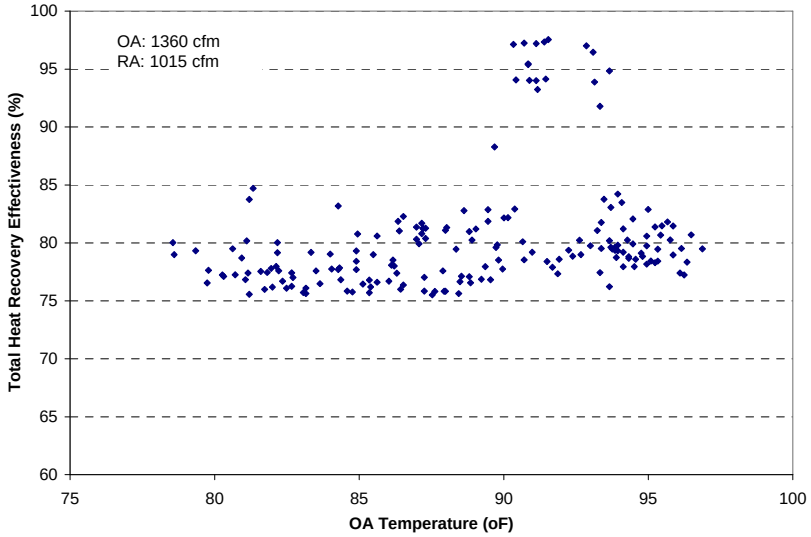


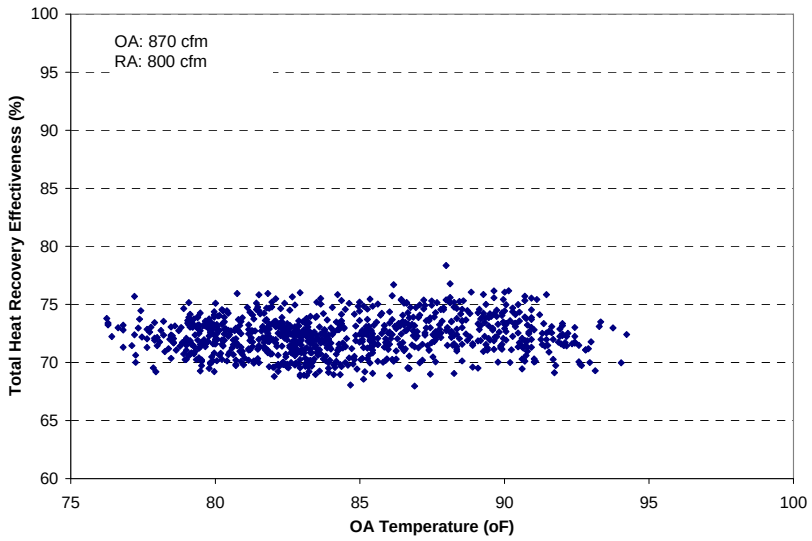




Summer Testing of Enthalpy Wheel







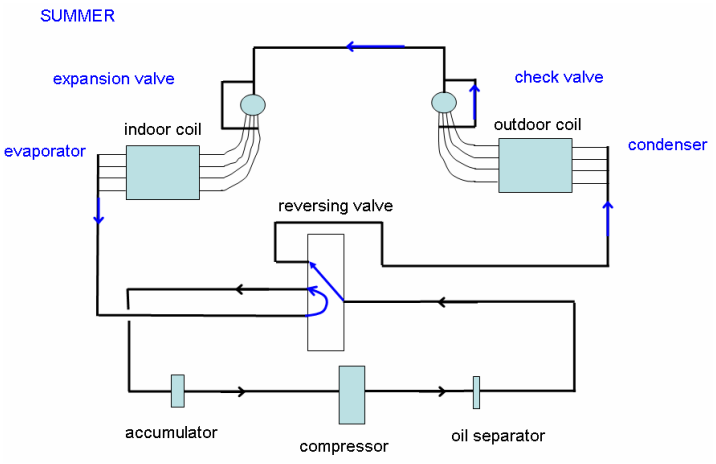
Performance of Heat Pump System

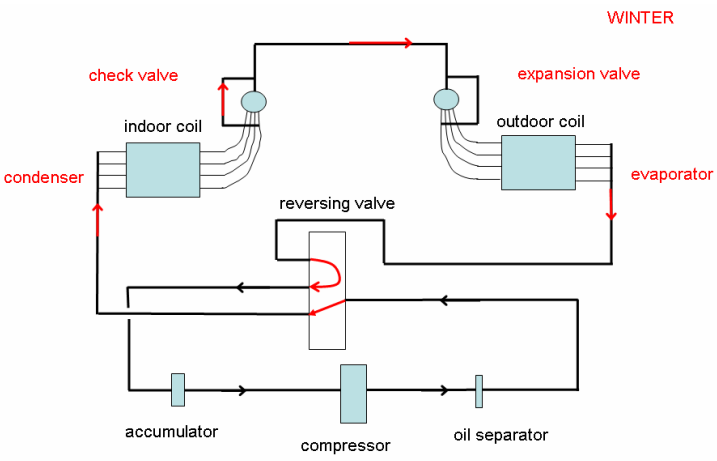
- Summer performance

  COP = cooling output/power input to compressor and condenser fan

  Average COP for July: 4.4
- Winter performance

  Difficulties encountered during defrost operation, defects in expansion valve or outdoor coil were suspected, further evaluation and correction planned for this winter.





Performance of Active Desiccant Wheel

- Winter performance

  Used as a sensible heating device when outside is extremely cold or heat pump is in defrost cycle

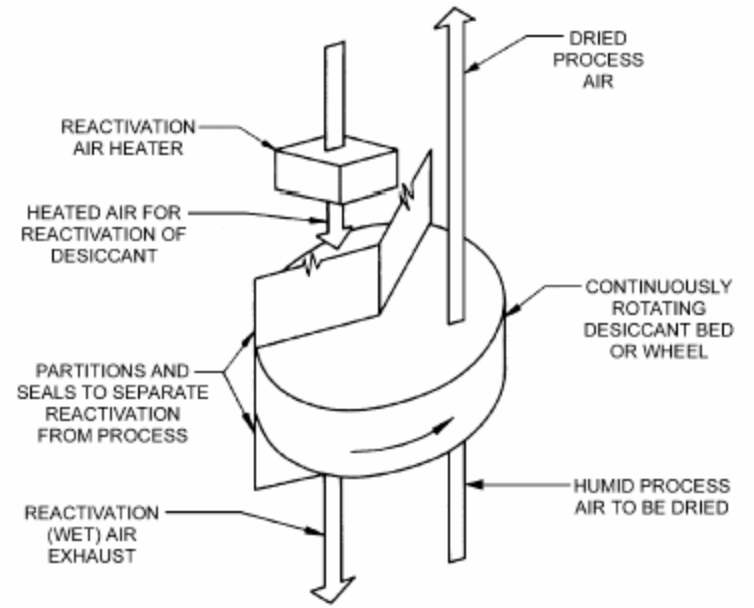
  efficiency = heat transferred to process air/heat input

  efficiency ~70%
- Summer performance

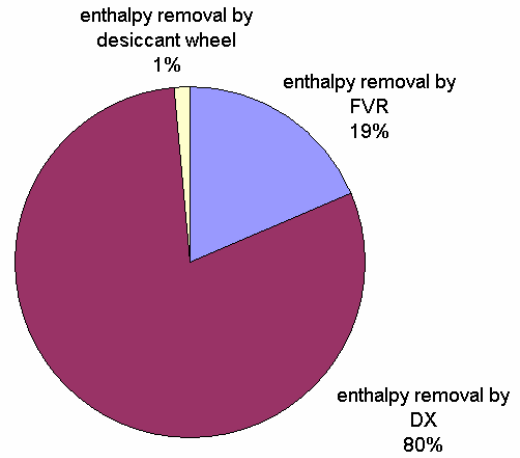
  Used for air dehumidification

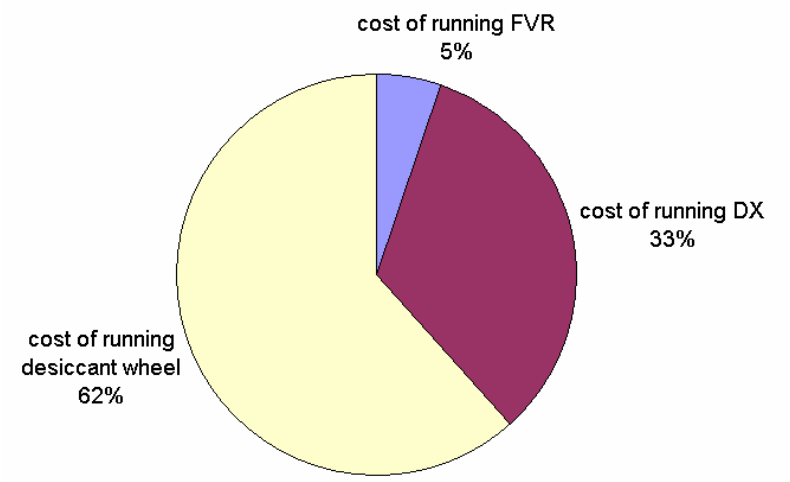
  latent COP_thermal = latent heat removal by the wheel/heat input

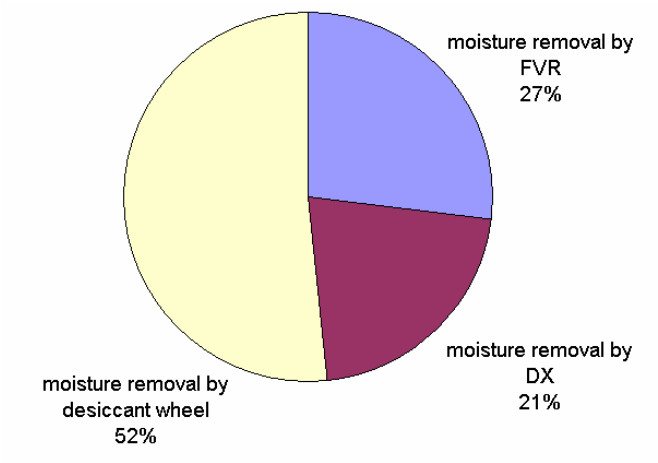
  latent COP_elec = latent heat removal by the wheel/power input

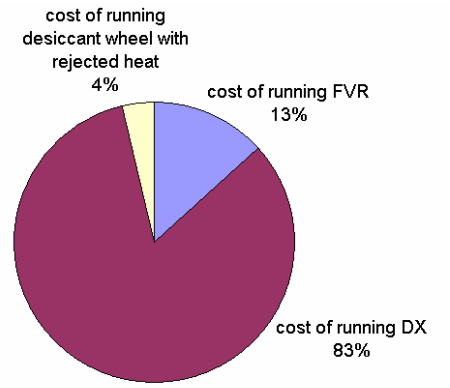


Performance of Overall System



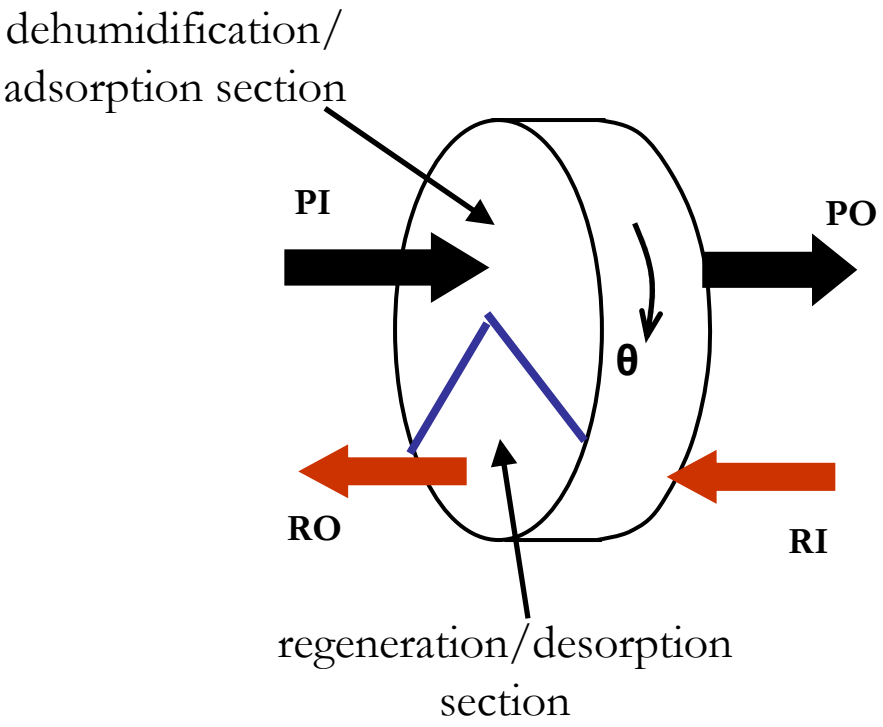


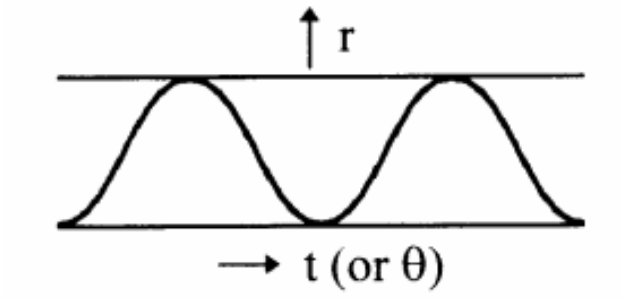


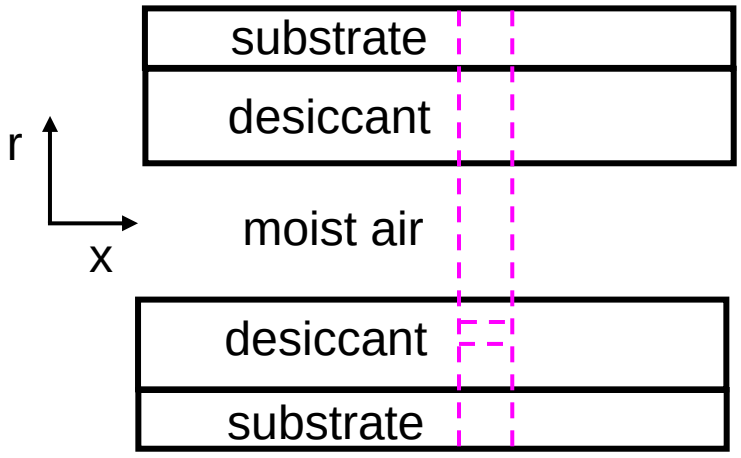


OA condition: T = 84.0 oF, RH = 52.0%, w = 0.0139 lb/lb, v = 1329 cfm
RA condition: T = 75.1 oF, RH = 50.7%, w = 0.0090 lb/lb, v = 563 cfm
SA condition: T = 66.3 oF, RH = 53.5%, w = 0.0073 lb/lb, v = 1892 cfm
Total heat removal: 1253 Btu/min (22.0 kW)
Total moisture removal: 0.63 lb/min

Modeling of Desiccant Wheels







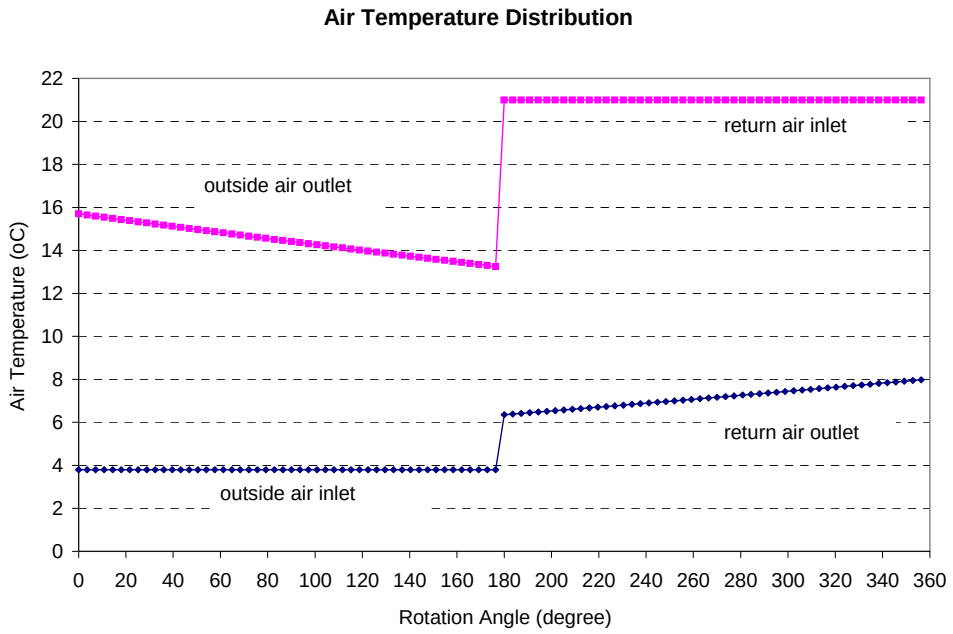
PI: Process air Inlet

PO: Process air Outlet

RI: Regeneration/return air Inlet

RO: Regeneration/exhaust air Outlet

Modeling of Desiccant Wheels



OA inlet: 3.8ºC (39ºF) , 0.61 m^3/s(1300 cfm)

RA inlet: 21ºC (70ºF), 0.47m^3/s (1000 cfm)

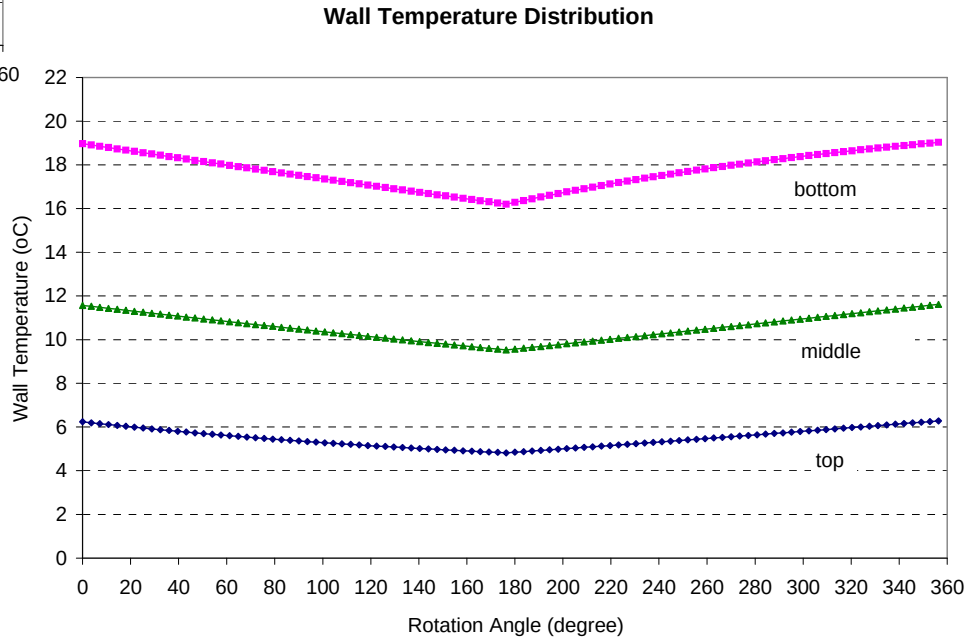
Average OA outlet: 14.4oC (58oF)

Average RA outlet: 7.2oC (45oF)

Heat recovery: 7879 W (448 Btu/min)

Heat recovery effectiveness: 80%

Model prediction agrees with field experimental data within 3%.



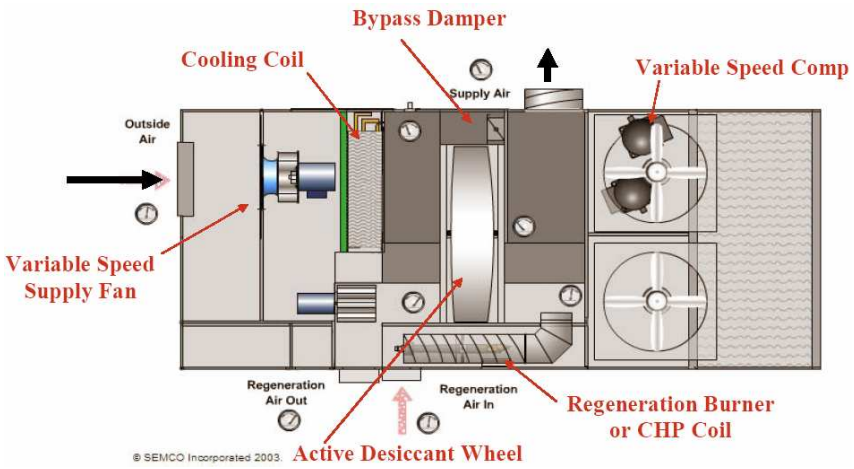
Preliminary Conclusions and Further Work

- In winter, deliver air at user specified temperature by means of heat pump and gas heating through the desiccant wheel
- In summer, keep the space dewpoint low enough to allow for the operation of radiant panels, water mullions and fan coils
- In both winter and summer, enthalpy recovery effectiveness over 70%, save energy on ventilating IW
- Heat transfer analysis confirms enthalpy recovery performance corresponding to its design and operating parameters
- Combined heat and mass transfer modeling which analyzes enthalpy recovery and active desiccant wheel performance in summer operation in process

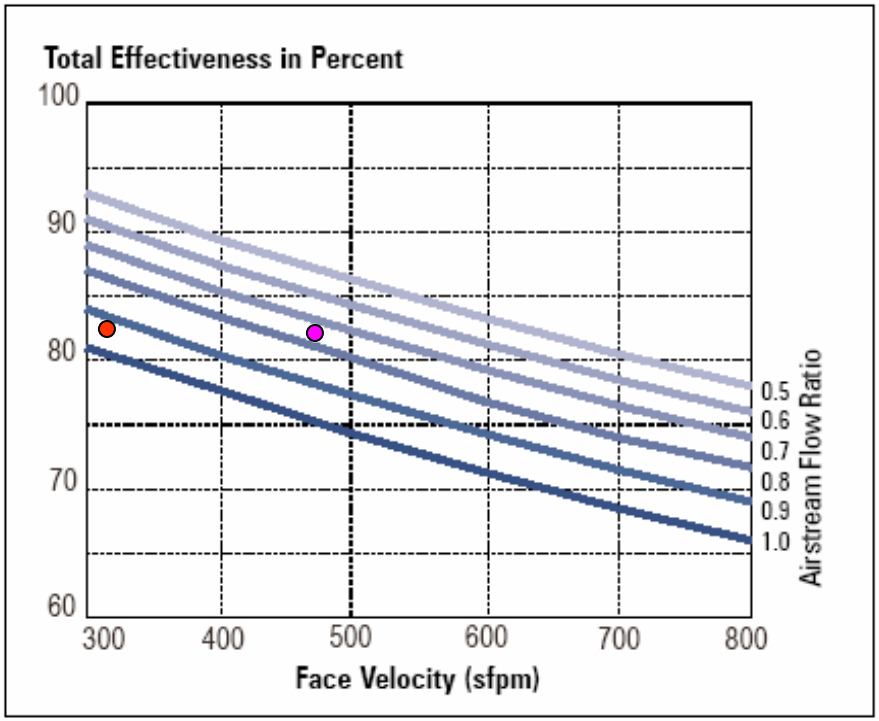
Backup

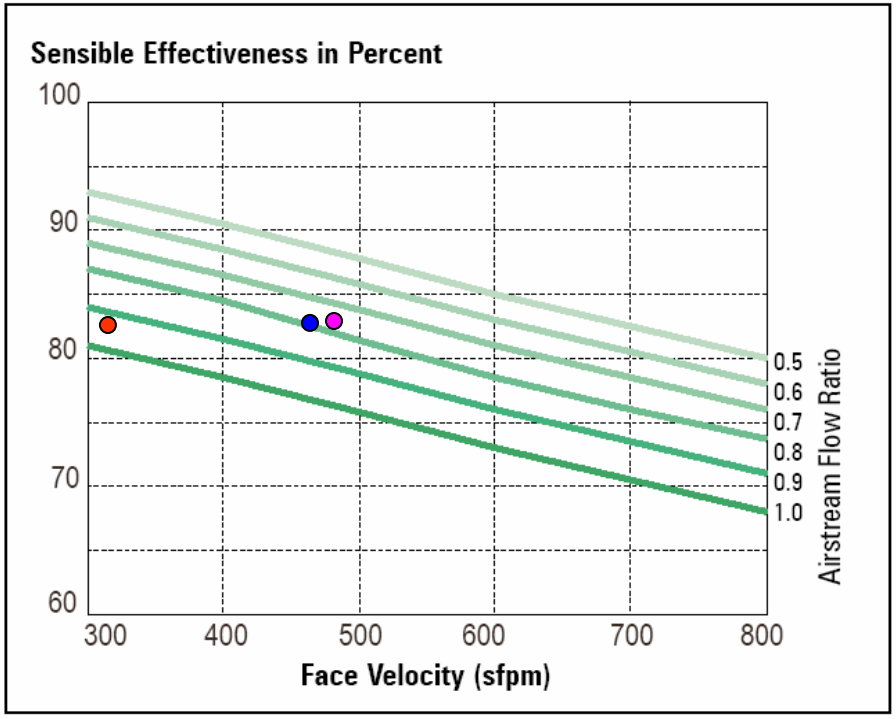
Control Capability

- External adjustment:
  - On/off
  - Supply air (or space) temperature and humidity
  - Supply air flowrate
  - Outside air and exhaust air flowrate (manually adjusted)
  - Heat source: heat pump or gas
- Internal adjustment:
  - Supply fan VFD
  - Compressor VFD
  - Condenser fan VFD
  - Desiccant wheel VFD
  - Regeneration fan VFD
  - Regeneration gas valve
  - DX heating or cooling
  - Bypass damper
  - Switch from heat pump to gas heating



FVR Performance under Lab Conditions





- winter field testing
- summer field testing
- summer field testing