Advanced Heat Reclaim Systems

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Outline

• Basic refrigeration cycle
• Conventional “series” heat reclaim
• Full-condensing “parallel” heat reclaim
  – Direct
  – Hydronic
• Water-cooled condensing heat reclaim
• Results
Basic Refrigeration Cycle
- No heat reclaim

Rejected Heat

Condenser

Evaporator
Superheat & Latent Heat of Vaporization
De-superheater

- Captures superheat
- How to control?

Rejected Heat

Condenser

Evaporator

Useful Heat
Conventional “Series” Heat Reclaim

- Captures superheat+ to water or air, when needed
- Controlled by 3-way valve; on/off logic

Rejected Heat

Condenser

Evaporator

HW Reclaim tank, or reclaim coil in HVAC unit

Useful Heat
Conventional “Series” Heat Reclaim

Pros:
• Captures superheat+
• Controllable (on/off)
• Temperatures can be compatible with water and air heating systems
• “Free” heat
• Traditional

Cons:
• Doesn’t capture full latent heat of vap.
• Hard to know how much condensing occurs
• Can interfere with floating head strategy (so is it really “free”?)
Economics

4,000 mmBtu Annual Space Heating Load; Maine Weather

**Annual Heating Cost vs. Fuel Price**
For Various Modes of Heat Reclaim; Elec = $0.13/kWh

- No Reclaim
- Series
- Full-condensing

Fuel Price per mmBtu

$0, $20,000, $40,000, $60,000, $80,000, $100,000, $120,000

$4, $6, $8, $10, $12, $14, $16, $18, $20
Full-Condensing “Parallel” Heat Reclaim
- Captures full heat of rejection; direct or hydronic
- Controlled by 3-way valve; either/or logic

Diagram:
- Condenser
- Evaporator
- Useful Heat
Full-Condensing “Parallel” Heat Reclaim

Pros:
• Captures 100% of heat of rejection
• Controllable (but not like typical HVAC)
• Reclaimed heat can be more economical than purchased fuel
• Flexible; air or glycol

Cons:
• Lower temperatures
  – Too low for water htg
  – Requires more coil area and cfm for space heat
• HVAC coil sizing and zoning can be tricky
• Charge management can be challenging
• Higher up-front cost
Full-Condensing “Parallel” Heat Reclaim

DIRECT = Refrigerant piped to HVAC coil(s)

Condenser

Evaporator

Useful Heat

Heat Reclaim coil in HVAC unit
Heat Reclaim Coils for HVAC

Ref. KeepRite Tech Bulletin K70-KHR-PDS-11
Full-Condensing “Parallel” Heat Reclaim
HYDRONIC = HX and glycol loop

Condenser
Evaporator

Useful Heat
Plate HX connected To glycol loop
Water-Cooled Condensing Heat Reclaim
- Captures full heat of rejection to water /glycol, full-time
Why pursue water-cooled condensing?

- Climate change concerns; need to reduce emissions
  - Reduced charge on high side; 600 vs. 1,000 lbs/rack
  - Stable operation allows for receiver level monitoring
- Easier to pipe reclaimed heat to remote HVAC units (e.g., front lobby/vestibule, back room); can displace more purchased fuel
- Economics work in cold climates; approx. 4 year payback on incremental investment in northern New England
Water Cooled Condensing Heat Reclaim; Similar to Full-Condensing plus…

Pros:
• Reduced charge/leaks and better charge mgt
• Can pipe to all HVAC coils to displace purchased fuel

Cons:
• Higher up-front cost to equip and pipe all racks and HVAC units
Water-Cooled Condensing Options
- 3-way valve to glycol reclaim coils in parallel

On a call for heat, 3-way valve diverts warm glycol to HVAC coils.
Hydronic Module
Receiver Level Monitoring

Daily Receiver Level
Portsmouth Rack B

Hilton
Minneapolis, MN
September 19-22, 2010

E+sd2010
Energy & Store Development Conference
Integrating HR with HVAC

• Bigger coils and higher airflow (cfm) due to lower delta-T
• HR supply controlled by 3-way valve at rack
• HR loads can be:
  – Dedicated system per rack (on/off), or
  – Common HR loop (stages)
• HVAC zoning and control is different!
Hydronic System Layout
Performance Data

2000: No heat reclaim.

2002: Added full-condensing heat reclaim to “cold aisles”.

2005: Added series HR to dedicated outside air unit.

2009: Water-cooled condensing heat reclaim from all racks (3 or 4) to all HVAC units.
References

- KeepRite Tech Bulletin K70-KHR-PDS-11