DUCTLESS HYDRONIC DISTRIBUTION

Alliance for Residential Building Innovation
David Springer, Davis Energy Group
Target: Builders of high performance new homes & deep retrofits

Why is this technology key to meeting performance goals of future homes?

Distribution Efficiency
- Distribution efficiency for well insulated, tight ducts in attics ≈ 85%
- Duct energy losses drives placement of ducts inside conditioned space, which adds cost and interferes with structure and architecture
- Ductless hydronic systems can approach 100% distribution efficiency; piping needs little space

Delivery Energy
- Fans: 0.58 W/cfm or 9 (heating) to 27 (cooling) W/kBtuh
- Pumps: 8 W/gpm, or 0.8 W/kBtuh
Context

- **Sizing**
  - Conventional systems tend to be too large for low load homes
  - Thermal storage allows hydronic systems to have variable capacity

- **Addresses future changes in refrigerant regulations (GWP reductions)**
Technical Approach

- A design and cost estimates were completed for a typical system using distributed small fan coils
- Feasibility was evaluated using TRNSYS models
- Two field tests are underway with radiant distribution – others planned
- Application issues: climate, building type, etc.
- Unresolved areas
  - Limited compact air handler products
  - High cost of chilled water sources for heating/cooling climates
  - Trade conflicts & training
Simulated Energy Use

Air-to-Water Heat Pump with Forced Air Distribution

TRNSYS-estimated annual site heating & cooling energy use for selected climates

<table>
<thead>
<tr>
<th>Energy Use (kWh/yr)</th>
<th>Sacramento</th>
<th>Houston</th>
<th>Phoenix</th>
<th>Denver</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Base Case</td>
<td>Ductless Hydronic</td>
<td>Base Case</td>
<td>Ductless Hydronic</td>
</tr>
<tr>
<td>Heat Pump Heating</td>
<td>7,574</td>
<td>5,690</td>
<td>3,838</td>
<td>3,153</td>
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<tr>
<td>Heat Pump Cooling</td>
<td>1,229</td>
<td>1,195</td>
<td>4,238</td>
<td>4,057</td>
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<tr>
<td>Fan and Pump</td>
<td>1,470</td>
<td>609</td>
<td>1,367</td>
<td>769</td>
</tr>
<tr>
<td>Total</td>
<td>10,273</td>
<td>7,494</td>
<td>9,443</td>
<td>7,979</td>
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<tr>
<td>% Savings</td>
<td>27%</td>
<td>16%</td>
<td>20%</td>
<td>27%</td>
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Recommended Guidance

- **Applications**
  - Hot-dry and cold climates: radiant distribution on first floor, forced air on second floor
  - Humid climates: forced air distribution only

- Engineering is required for sizing & layout of components (including storage) and controls

- Contractors should be familiar with “wet” systems

- Utilize small air handlers with short duct runs until lower cost cassette type units become available
Value

- Practitioners
  - Builders: Lower cost to achieve higher distribution efficiencies; simpler construction (no duct chases)
  - Contractors: Fewer callbacks due to comfort issues resulting from duct restrictions & air balance, duct losses, noise

- End users
  - Lower energy costs through improved distribution efficiency, and in some cases improved equipment performance by using thermal storage to shift times of operation
  - More usable space
  - Comfort through improved zone control
Market Readiness

- What evidence is there that hydronic distribution can be successfully applied in new and existing homes?
  - Pipes are as common in residential buildings as ducts
  - Equipment is available now, and with recognition of the value and increased demand, equipment availability and costs should improve
  - The popularity of combined hydronic systems can lead the way to a more aggressive approach that eliminates ducts

- But more work is needed
  - Develop standardized designs
  - Installer training & certification
  - Better/more/lower cost product offerings
Pros and Cons

- **Pros**
  - Efficient heating/cooling energy production and distribution
  - Improved comfort
  - More architectural and structural freedom
  - Addresses likely trend toward single package systems and elimination of refrigerant piping when low GWP refrigerants are mandated
  - No combustion safety issues
  - Demand-response potential

- **Cons**
  - Current cost constraints
  - Need for engineering
  - Limited equipment availability
  - More filters to change
  - Requires cooperation between plumbing & HVAC trades
  - Lack of design & installation guidelines and training programs
References


- ASHRAE Standard 152: Method of Test for Determining the Design and Seasonal Efficiencies of Residential Thermal Distribution Systems
