Lean On Me...Radiant Walls - Part II

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Why a radiant wall? Our objective for the space was to create an environment, which was thermally stable with constant humidity for the woodwork including floors, guitars, antique decoys and the other furnishings. Although the room has a vaulted ceiling, we chose not to lose any height from a floor installation and access to the basement ceiling was not scheduled until this year. A heated vertical surface was a natural choice.

The design of a radiant wall is almost identical to any other type of site built radiant surface, addressing such issues as fluid and surface temperatures, back losses, and venting.

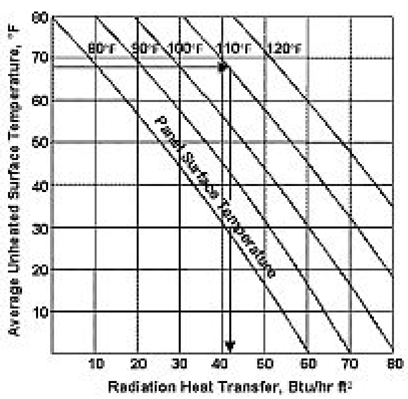

Figure 1 Radiant Transfer

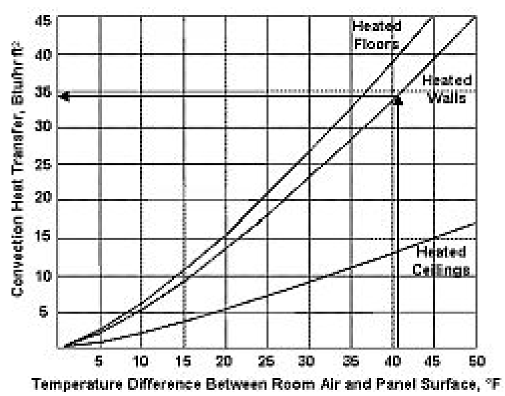

Figure 2 Convective Transfer

In terms of performance, radiant transfer from a heated panel is the same for floors, walls, and ceilings. As shown in figure 1, the Btu/hr ft2 transfer is a relationship between the panel surface temperature and average unheated surface temperature. The greater the difference between the two the more heat gets released from the panel. In the case of our project, we had a large surface area to work with, and 140 deg F fluid temperature available. At a 110 deg F maximum design surface temperature and a nominal 1.8 Btu/hr/ft2/ deg F combined radiant and convection heat transfer coefficient - we had a potential at 68 deg F average unheated surface temperature of transferring 72 Btu/hr/ft2.

Where did the heat transfer coefficient of 1.8 Btu/sf/ft2/ deg F come from?

The temperature difference between the panel in our project was 110 deg F heated surface temperature less 68 deg F average unheated surface temperature for a delta T of 110-68= 42 deg F.

The combined radiant convective output from Figure 1 and Figure 2, is equal to 42 Btu/hr/ft2 (radiant) plus 34 Btu/hr/ft2 (convective)for a combined panel out of 42 + 34 = 76 Btu/hr/ft2

The heat transfer coefficient then becomes:

(76 Btu/hr/ft2) / 42 deg F = 1.8 Btu/hr/ft2 / deg F

This means for every degree difference between the heated wall and unheated room, a nominal 1.8 Btu/hr/ft2 will be delivered from the panel.

The natural convection influence on radiant surfaces (Fig. 2) is significant depending on where the panel is located and in what function, heating or cooling. Ceilings have a better heat transfer coefficient for cooling in comparisons to floors, which have a higher heat transfer coefficient for heating. Radiant walls are closer to floors in heating performance.

This entire wall is a radiant heater.

The benefit to radiant walls is they are not restricted as much by surface temperatures, as such can use higher fluid temperatures to deliver greater Btu/sf. Having higher output surfaces allows mechanical and interior designers greater flexibility in specifying physical dimensions and location.

For example if the heat loss in our space was 1400 ft2 x 55 Btu/hr/ft2 then our load becomes 1,400 x 55 = 77,000 Btu/hr.

Our radiant surface design area then becomes:
(77,000 Btu/hr) / 72 Btu/hr/ft2 = 1070 ft2 required panel surface area.

If we didn't have the space for such a large radiator we could evaluate the recommended safety and manufacturers limitations of the wall materials and if permitted, raise the surface temperature by either increasing the tube spacing, fluid temperature or both. Often you will hear designers talking about limiting the height of a panel to 4 ft but this is not a design or performance parameter and has more to do with preventing damage to the tubes located behind the wall. If the surface area is such that tall panels are required by design then so be…as long as there is a temperature difference between the panel and the room, the Btu will be released from the wall and contribute to heating the space. In our example, we had a large available area and were somewhat restricted as the design temperature for other areas of the home was 140 deg °F. We were not prepared to add more controls when a simpler solution of adding more tube would do the trick.

Wall installations, like most other radiant systems can be correctly fabricated in a number of different ways. For our system, the radiant surface was framed out to match the architectural profile of the wall. Once the strapping was mounted to the studs, reflective insulation was fastened to the back surface followed by the installation of plastic pipe tracking. The tracking provided an air space between the foil backed insulation and finished drywall. A single 1/2" loop of PEX was then routed to and from the prefabricated zone control panel located in the boiler room through the tracking system. A manual air vent was piped vertically from highest point on the loop and is hidden out of site at the pinnacle of the profile. Following the first pressure test the wall was then boarded, taped, and finished. Prior to painting, a second pressure test confirmed no damaged had occurred during the dry walling stage. Once the surface was completed the system was commissioned, and room stabilized at 68 deg F and 40% RH. At this point, the hardwood flooring was brought in for a week of acclimation and then installed. The final concern was possible damage to the PEX tubing when the paintings were hung and potential harm to the artwork from the heated surface. To prevent panel damage the wall was blueprinted and photographed prior to boarding. All dimensions and details recorded in the Operation and Maintenance Manual for the next lucky homeowner. Paintings were backed with reflective insulation before hanging reducing both radiant and conductive transfer to the backside of the canvases.

End of Part II.

You can see our photo's of this renovation project at our blog:
http://wonderfulwombs.typepad.com/

You can post your questions to Robert Bean at our on-line forum:
http://www.healthyheating.com/bb/