Technical Notes

Radiant Panel Assocation, PO Box 717, Loveland, CO 80539 (970) 613-0100

RADIANT FLOOR COOLING

We get inquiries at the RPA office regarding radiant floor cooling on a regular basis. It is a natural question. Once the decision is made to use radiant floor heating, cooling becomes the next issue to resolve.

Compromise

It is reasoned that a forced air distribution system can be used to both heat and cool, why not radiant floors? This is logical reasoning and needs to be addressed, but first we should recognize that adding air-conditioning to a forced air heating system requires compromise as well. In most forced air heating systems the heat is delivered via floor registers. Because warm air rises, floor registers are designed to blow the air horizontally along the floor as far as possible before it rises to the ceiling. Even though this is fairly ineffective with hot air, it works quite well with cold air which would like to stay on the floor anyway. The result is cold air moving across the floor to the cold air return which is normally located low on a central wall. Chilly drafts of very cold air can be unpleasant even when it is 90°F outside. The better place, of course, for forced air cooling ducts is the ceiling, dispensing low velocity cool (not cold) air evenly across the ceiling where it gently drops to cold air returns in the floor. This is seldom done.

A similar compromise is made with radiant floor cooling. The cool surface ends up being at the low point where the coolest air is, therefore little natural convection takes place. Close to half the output of a heated floor is from natural convection, cool air coming in contact with the warm floor, rising, giving up heat and falling to be heated once again. Without the assistance of natural convection, floor cooling capacity is about half that of floor heating. As may be obvious at this point, a cooled ceiling has much more cooling capacity than a cooled floor because rising warm air will contact the ceiling, be cooled, fall to the room below where it will absorb heat and rise to be cooled again.

Humidity Issue

Whether a chilled ceiling or a chilled floor is used for space cooling, both systems need to be in a humidity controlled environment. If the system is installed in one of the arid regions of the country, humidity control may not be an issue but in most parts of North America a cooled floor or ceiling will cause moist air to condense on the surface if the surface temperature is below the dew point. With 70% relative humidity condensation will occur on a 68°F surface, 62.2°F at a 60% relative humidity. This means that some type of air handling device which removes humidity must also be incorporated into the system to keep the relative humidity below 70%.

Added Dimension

Does this mean that radiant panels should not be used for cooling? Not necessarily. Radiant cooling adds a dimension not attainable by forced air cooling systems. It is the same component that is missing in forced air heating... radiant transfer. Since some of the heat we reject is in the form of radiation, a large cool surface provides a heat sink to draw heat away from our bodies. Heat that can be radiated away reduces the amount that must be convected away and therefore allows us to feel comfortable at a higher air temperature. This, of course, converts into energy savings as well as overall better comfort.

Guidelines

Bjarne W. Olesen, Ph.D. is head of research and development at D.F. Liedelt "Velta" GmbH, in Norderstedt, Germany, president of the European Radiant Floor Association, and an active participant in ASHRAE. In his paper "Possibilities and Limitations of Radiant Floor Cooling" presented at ASHRAE, Dr. Olesen gives the following guidelines for designing radiant floor cooling systems. In spaces with seated or standing people, the floor temperature should not be lower than 66°F for comfort reasons except in areas of higher activity level. The heat exchange coefficient between a cooled floor and the room is typically around 1.23 Btu/ft2·hr·°F where 0.97 Btu/ft2·hr·°F is radiant heat transfer. Taking into consideration the maximum

operative temperature comfort limit of 79°F for seated individuals, the maximum cooling capacity for a floor system is about 16 Btu/hr·ft2. Dr. Olesen also points out that in spaces with significant direct sunshine on the floor, capacity may double or even triple.

Tube size and spacing can also have an affect on cooling capacity. A floor heating system is often designed with tube spacing of six inches or more. To increase the cooling capacity, it may be necessary to design with closer spacing. Carpet and pad may decrease the cooling capacity by as much as 50%. To avoid supply water temperatures that are too low, supply and return water temperature differences should be kept between 5° to 9°F.

Where it makes sense

Floor cooling makes the most sense when it is being used in conjunction with an air system. The floor may handle most of the sensible load, while the air system will take care of the latent load. The result is a comfort level not attainable by either system independently. It will also be more energy efficient.

Making choices

While waiting for the floor cooling market to develop and manufacturers to provide packages, it may be wiser to invest in alternative cooling options such as split ductless and high velocity air conditioning systems. Even a simple ducted fan coil can be cost effective. On the other hand, if you like adventure and willing to do some experimentation, radiant cooling could play a significant part in the future of our industry and you may get in on the ground floor. After all, radiant ceiling and floor cooling is the biggest thing to hit Europe since radiant heating.