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Coast2Coast Comfort Report

Westside Report

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Healthy HEATING

Comforting Your Mind, Body & *Soles*

Human Comfort Factors

What do You Need For a Proper Building Comfort System?

By Geoff McDonell P.Eng.

When we HVAC engineers talk about human comfort, it means "thermal comfort". Unlike interior designers, we HVAC engineers don't often deal with colour, texture or juxtaposition of the counters which is a much different human comfort topic!

Traditionally most of the thermal comfort systems developed in the last 100 years have revolved around "air temperature" as the fundamental basis of measuring and controlling human thermal comfort. It was easy to measure and easy to control with the conventional heating and cooling devices that have been developed so far. Many of the older heating systems like cast iron radiators and wall-fin baseboard "radiators" provided some radiant heat, but predominantly they heated air and made warm buoyant plumes the dominant room heating source - they "convected" the air in the room. Cool air entered the lower part of the "radiator" and the warmed air rose and circulated in the room to replace the cool air being drawn to the bottom of the heating source. The wall thermostat controlling that "radiator" only sensed the air temperature in order to control how much hot water or steam entered the heating element.
Many folks working in the human comfort field recognized that

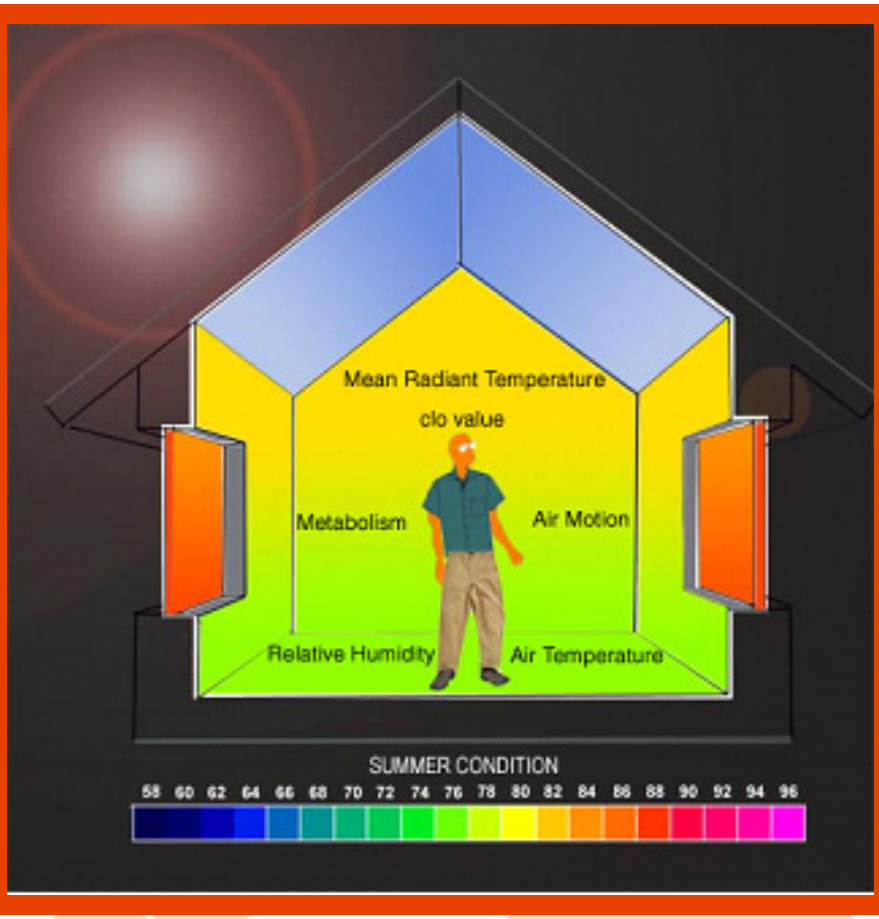
radiant thermal comfort was a big part of the human comfort equation. Trouble was, though, that measuring radiant heat exchange and comfort was not easy, and required some non-traditional devices (read: expensive), so it was never pursued by the commercial HVAC building equipment suppliers, designers and system installers.

Many human physiology studies in the past have determined that human comfort results from three fundamental factors: [ref.1, 2, 3]

"Up to 50% radiant heat exchange
"40% convection/air movement/air temperature
"10%-20% humidity/perspiration

So, what that tells us is that in order to provide a total comfort system in your home or office, you need some kind of radiant heating and cooling system, an air moving ventilation system and some form of room humidity control system. Anything less is like a car without an engine.

A total approach to human comfort and interior climate control takes into account mean radiant temperature, clothing, air temperature and movement, and the humidity of the air.



Graphic from the State University of Arizona Human Comfort website, created by David Schaetzle, used with permission.

Radiant comfort (and dis-comfort) is becoming better understood and studied in many parts of the world as a result of sports medicine studies, industrial applications, and military studies. Who hasn't sat beside a conventional double glazed window in a room in a cold

winter climate and felt cold, even though the thermostat in the room indicated an air temperature of 74F? That cold window is acting like a large radiant cooling panel. Similarly in the summer time, the window acts like a large radiant heating panel, along with the non-thermally broken window frame members. [Reference 4] floor and ceiling panel heating systems have been well known and in wide use for some time, and are generally well understood. The radiant floor heating industry has used the overall comfort of that system as a sales pitch, along with the fact that comfortable conditions and heating energy efficiency can be maintained with radiant heating systems with lowered ambient air temperatures. The Romans knew this thousands of years ago with their hypocaust systems, and new evidence is being unearthed in China (Mongolia) indicating similar masonry wall and floor heating systems were used over 6000 years ago.

Radiant cooling systems are less well known, but follow the same laws of physics as radiant heating systems. The nice thing about radiant heat exchange is that it is virtually instantaneous and operates at the speed of light as long wave infrared energy. Radiant systems are also self compensating - if there are no objects in the room hotter or colder than the radiant surface, then no heat exchange takes place. As soon as an object which is at a different temperature than the radiant surface enters a space, the heat exchange begins instantly and continues at the speed of light.

Now that we have the mean radiant temperature under control, we also need good ventilation, both for air movement, fresh air to breathe, to replace air exhausted from range hoods and bathrooms, and for ambient humidity control. Once the radiant temperature is addressed, a good ventilation system is also required for a Healthy House. The most cost-effective way to deal with this for a small home system is to use an air to air heat exchanger type ventilator, so the heat from the exhausted air can be recovered to reduce energy costs. Filtering the incoming fresh air can take many forms-standard panel filters, high efficiency panel filters, to very high efficiency HEPA (High Efficiency Particulate Air) filters, right up to ultra high efficiency electrostatic filters to remove pollens and allergens. One thing to keep in mind is that the higher the efficiency of the filter, the more fan power is needed to maintain the design airflow through the system, so a bit more fan energy is consumed to overcome the resistance of the filters. (fig. 3)

This ventilation system can be kept fairly small since it is not

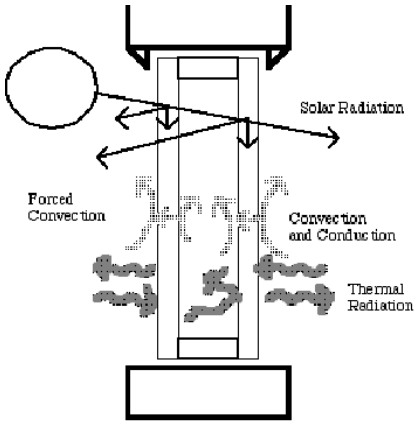


Figure 1. Modes of heat transfer through a window.

"We don't have words for high-quality space. We don't have words for anything other than quantities. Realtors have a real challenge on their hands because if they're trying to say, 'This is a cool house,' they have to use words like spacious, and if you can say high ceilings, it sounds better. Or cathedral ceiling-that sounds pretty cool. But when you say cozy, it's a euphemism for too small. And there is nothing in-between. So what I am trying to do is develop some words that help people to understand that there is more to a house than just size."

Sarah Susanka Architect

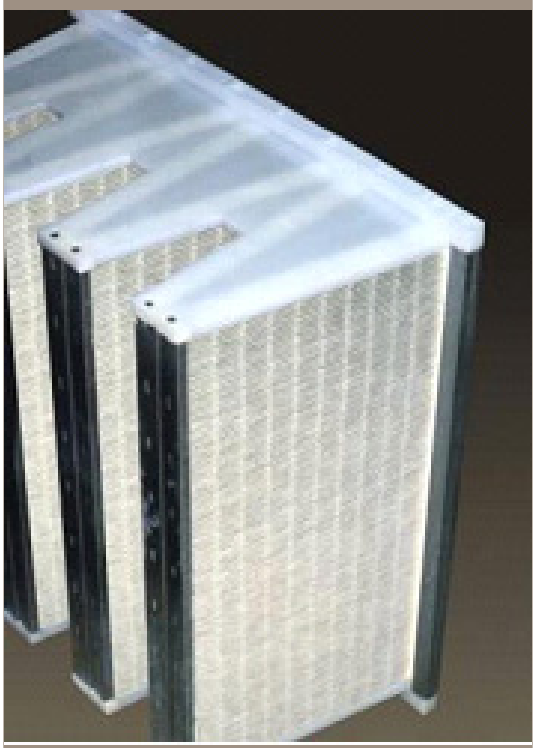


Fig. 3

High performance rigid pleated panel filters with an arrestance efficiency of over 85%. High initial cost, but long life and much higher indoor air quality.

performing any of the heating or cooling function (the radiant system does that). A house ventilation system needs to be sized for a basic air change rate to maintain the fresh air in the home, and be big enough to provide the make-up air for bathroom, kitchen and laundry exhaust. Careful consideration of fireplaces also needs attention so that the House can be maintained at a neutral or slightly positive air pressure relative to the outdoors to prevent infiltration through opening windows, doorways and other wall cracks.

In climates where the ambient humidity is low (Midwest North America, and generally in wintertime all over North America) then adding humidification to the ventilation system will address the last part of the human comfort equation. There are many types of humidifiers that can be used, depending on the quantity of humidification to be added into the House. In humid climates like the southeast United States and in many areas in summertime, there can be excess humidity in the ambient outdoor air, which needs to be removed. Again some kind of cooling coil or dehumidification system integrated into the ventilation system will dry out the incoming air and maintain the humidity comfort conditions inside the House.

This takes a really integrated "Whole House" design approach and requires the House designers and Contractors (builders) to work together right from the beginning of the design in order to make sure that ALL of the human comfort conditions are dealt with properly in an energy efficient manner, for today and for the future life of the House. A properly designed and operating Whole House System should consist of a radiant heating (and possibly cooling) system, a ventilation system, and a humidification (and/or dehumidification) system.

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