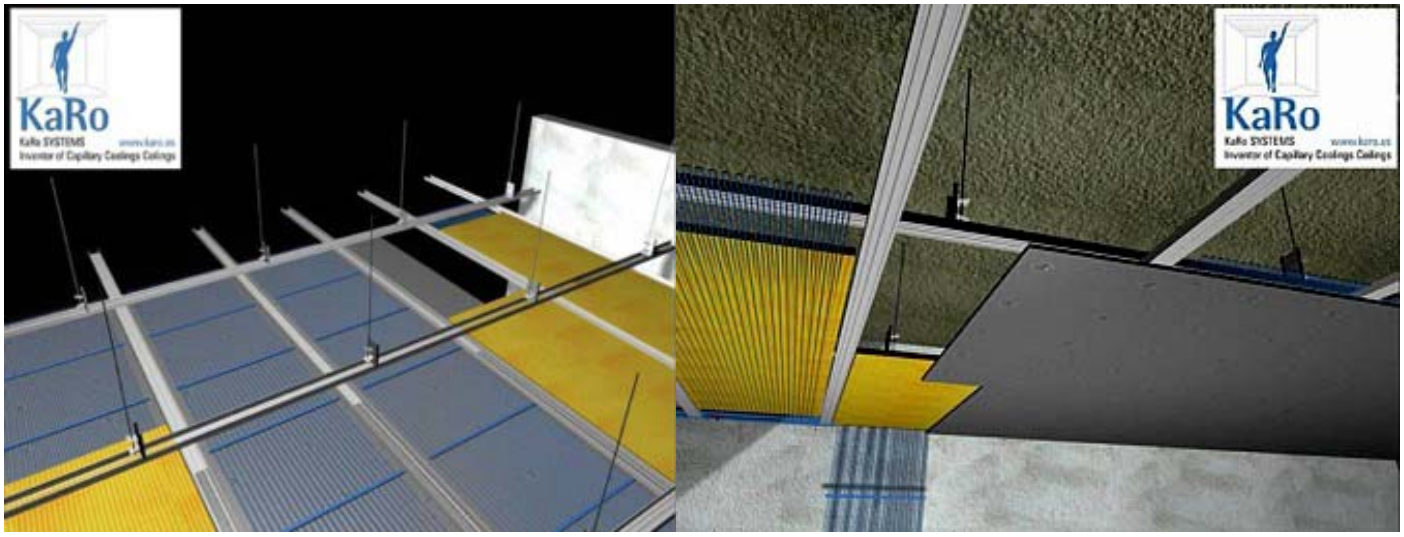


This explains the thermodynamics of Radiant Energy.

Thermodynamics 101!

A brief explanation on Radiant Energy!

"What exactly is radiant energy?" Hold your hand over a hot cup of coffee and feel the heat. The logical conclusion is that heat rises. Logical maybe, but incorrect! "Hot air" rises but "heat" can travel in any direction. That is why you can feel the heat of the cup when you place your hand to the side of it. Radiant energy transfer is caused by a warm surface giving up its heat to a cooler surface.

Whenever there is a temperature difference between two surfaces, both surfaces will attempt to equalize. Radiant energy travels through space without heating the space itself. It only turns into heat when it contacts a cooler surface. Our human comfort relies just as much on radiant heat transfer as it does on air temperature, yet the majority of heating and air-conditioning professionals think only in terms of air temperature. As a result, Americans are missing out on a truly comfortable living environment in their own homes or places of business. By controlling both the air temperature and the radiant transfer, radiant panel systems deliver a comfort that is unsurpassed.

Remember heat rises it is called convection, radiant heat tend to heat every which way direction, and it will always migrate to cooler objects.

Heat (q), like work, is a form of energy. Heat energy moves from a hotter body to a colder body upon contact of the two bodies. If two bodies at different temperatures are allowed to remain in contact, the system of two bodies will eventually reach a thermal equilibrium (they will have the same temperature).

CONDUCTION is direct heat flow through matter, such as the conduction of heat from the hot surface of a stove to a cooking pot.

CONVECTION is the transport of heat within the air. The heat travels upward with the natural upward movement of air.

RADIANT HEAT is the transmission of electromagnetic rays through space. These rays have no temperature, only energy. Every material or object with a temperature above absolute zero emits these rays in all directions, in a straight line, until they are deflected or absorbed.

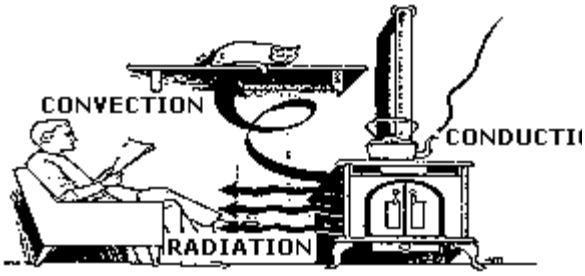
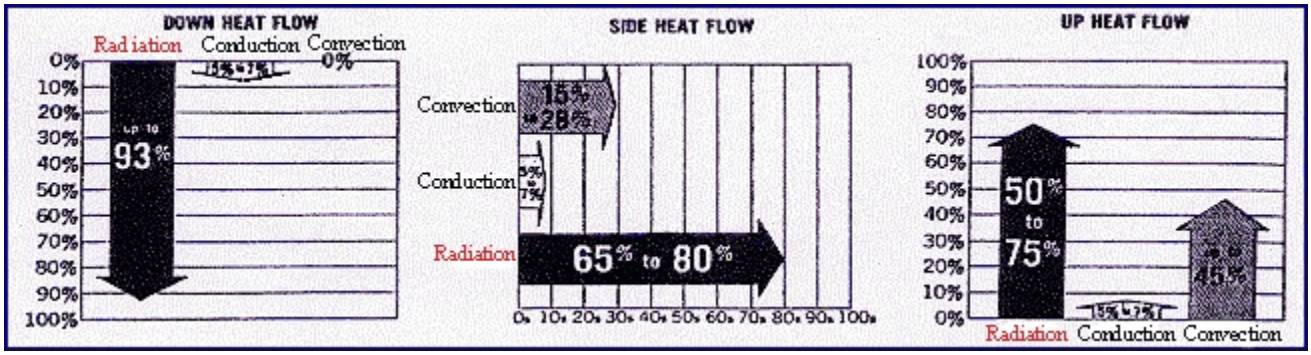


Figure 1



Even though classic heating systems use the convection mode, radiation is the most efficient of the three heat transfer modes (**conduction, convection and radiation**). Convection is secondary and comes into play only as matter interrupts or interferes with radiant heat transfer. The radiant heating systems allow savings up to 50% compared to classic heating systems.

The figures below show modes of heat

You can feel the heat of a campfire even though you are not directly above it. Radiant energy transfer is caused by a warm surface (the campfire) giving up its heat to a cooler surface (your body). This radiant energy travels through space without heating the space itself. It only turns into heat when it contacts a cooler surface.

The interesting thing is that our human comfort relies just as much on radiant heat transfer as it does on air temperature, yet the majority of heating and air-conditioning professionals think only in terms of air temperature. As a result, Americans are missing out on a truly comfortable living environment in their own homes or places of business. **Furthermore, the radiant heat systems are much more energy efficient**

Remember we have to account of what materials heat (Large Tubes vs. Capillary tubes) and floor finish source.

You get better heat or cool distribution through the capillary tubes.

And most important the quick recovery time!

On a survey done recently most occupants that have radiant heating on the floors were unhappy due to fact of "The time lag of heat movement through concrete" which can also be a problem. In a very well-insulated house, that lag time can result in overheating, particularly if there are other sources of heat being delivered to the space, such as passive solar. If a concrete slab is "charged" with heat during the early morning hours and the surface is warmed to the point where it cannot readily absorb solar radiation striking it, that solar heat will more directly heat the air, increasing the risk of overheating.. More excerpts on this chapter through this web link: http://www.energy.state.or.us/res/tax/Radiant.htm

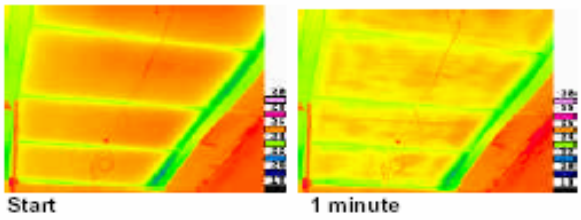
Figure below shows the recovery time on ceiling application.

The capillary tubes velocity is always Laminar that has positive side effect that the loss of pressure grows only linear with the amount of extra water and not quadratic!

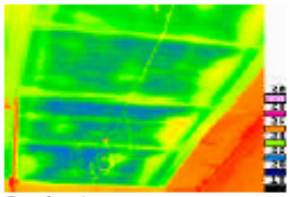
You have more water distribution 98% efficient!

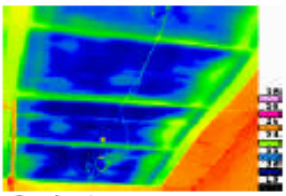
1. NATURALLY AIR CONDITIONING

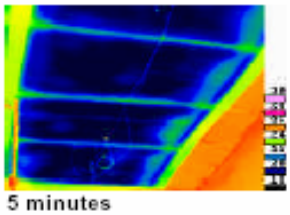
"KaRo cooling can be switched on like a light." This is the feeling you get if you first turn on the KaRo ceiling in the middle of a warm day. After just a few minutes, the KaRo ceiling begins to cool the room effectively. This is brought about by the very small amount of water in the capillary tubes and the positioning of the mats closely to the surface. In addition, the KaRo ceiling is able to regulate itself quite well.

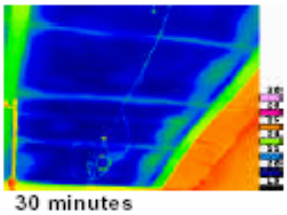

Start

1 minute


2 minutes


3 minutes


5 minutes


30 minutes

Pictures 6 The process after turning on a KaRo metal ceiling
After 2 to 3 minutes the ceiling has reached already a noticeable cooling performance.

Because the capillary tubes are so close together, the heat emission of the KaRo mats remains even, which is a precondition of a high cooling capacity. The capacity is limited by the dew-point temperature, which is the temperature to which air must be cooled for dew to form, and this in turn is limited by the lowest temperature in the ceiling. The level of the cooling capacity is determined, however, by the mean temperature. Higher ripples or oscillations mean then less cooling capacity.

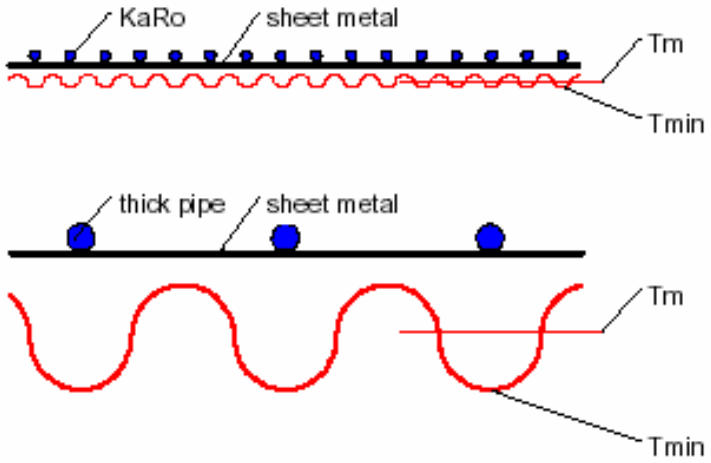


Illustration 4 Ripples with a cooling ceiling
The lowest temperature Tmin of the KaRo ceiling is about the same as the mean ceiling temperature Tm.

Because of the fine apportionment of the capillary tubes in the KaRo mats, they have minute ripples, that is micro-ripples —*Illustration 4* which bring them to the theoretically optimal performance. KaRo mats embedded in plaster have a thermal effectiveness of over 98%. This means that if a layer of water were underneath the plaster instead of the capillary tubes, a construction impossibility, it could only be less than two percent more effective.

2.2 Use of building materials

The use of KaRo mats allow an optimally economical use of building materials, which make them very ecologically sound. For example, even though KaRo mats allow for a much better distribution of heat, in comparison to floor heaters with thick tubes, only about half of the building materials are needed when they are used. Furthermore, according to the laws of physics, the thickness of a wall can be proportionally reduced to the diameter of the tubes, in order to obtain the same amount of stability.

Not only does the more economical use of building materials bring about savings and a better distribution of heat, it helps bring about better ecological conditions by using resources wisely.

2.3 Loss of pressure

Large Tubes vs. capillary tubes?

1. NATURALLY AIR CONDITIONING

Despite their small diameter, KaRo mats experience very little loss of pressure. The water in a KaRo system runs through many parallel capillary tubes, rather than running through just one tube, as in a system with thick tubes. The typical velocity of flow with KaRo averages only 10 to 20 cm/second. The velocity in the capillary tubes is always laminar. That has the positive side effect that the loss of pressure in the KaRo mats grows only linear with the amount of extra water, and not quadratic.

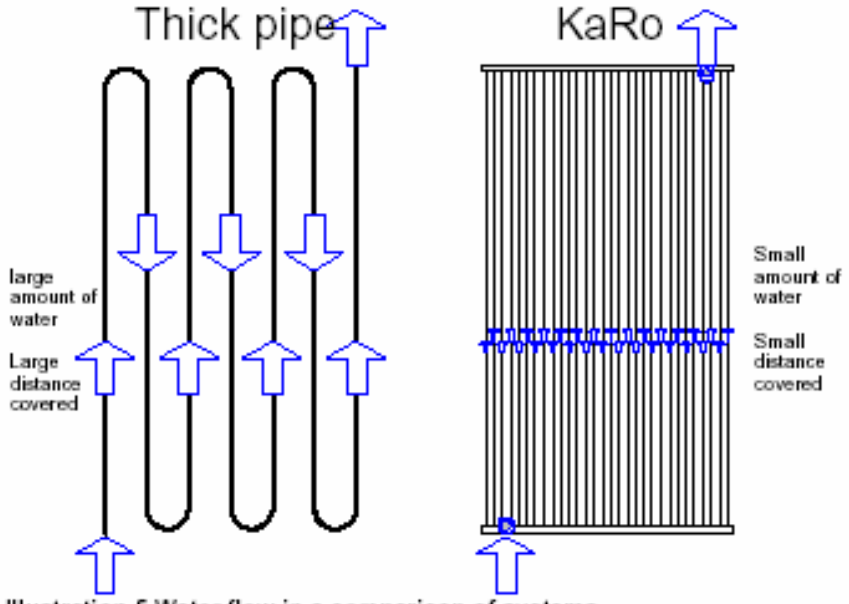


Illustration 5 Water flow in a comparison of systems
With the KaRo system the water runs through many parallel Capillary tubes. The water velocity is only between 10 and 20 cm per second.