DESIGN AND FABRICATION OF RADIANT FLOOR COOLING SYSTEM

N.KamalaKannan[a], C.Janarthanan[b], A.Dinesh Babu[b]

[a]. N.KamalaKannana , *Assistant Professor, Department of Mechanical Engineering*, Knowledge Institute Of Technology, Salem

[b]. C.Janarthananb, A.Dinesh Babub, *Student(s), Department of Mechanical Engineering*, Knowledge Institute Of Technology, Salem.

Abstract— **The use of radiant heating and cooling is not new, the roman have used this type of floor radiant heating and thermal mass heat storage 2000 years ago. In turkey, stream water runs through the channels on walls and floors to cool places in the warm summers. In the 1930s, architect Frank Lloyd Wright piped hot water through the floor of many of his building. Radiant cooling is a gentle temperature conditioning system, exchange thermal energy to the space through convection and radiation. Radiant cooling system can be employed on the ceiling of a room, or in some cases hung from a high ceiling. Cooling water is supplied to the panels at temperature above dew-point temperature of air in the room to avoid condensation of moisture in the air on the panels. Heat is transferred between the space and the cooling panels through a temperature differential. The cooling panels absorb heat through a combination of radiation and convection. Radiant cooling panels are normally used with displacement ventilation where ventilation air is introduced into a room at low level and flows by natural means to replace existing air. In a typical radiantly cooled office building, two to three air exchanges per hour is required. The ventilation air drawn from outdoor should be dehumidified in order to reduce latent load since the cooling panels remove sensible load only. The advantages of hydraulic radiant floor heating include the efficient use of space and that cleaning is not required. Also, the system does not produce noise, cause drafts or use ducts. The system has uniform temperature distribution and is a low-temperature heating system.**

Index Terms—**Radiant heating, Radiant cooling, Cooling water,**

I. INTRODUCTION

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Radiant cooling system Can be employed on the Ceiling of a room, Or in some cases hung from a high Ceiling. Cooling water is supplied to the panels at temperature above dew-point temperature of air in the room to avoid condensation of moisture in the air on the panels. Heat is transferred between the space and the cooling panels through a temperature differential. the cooling panels absorb heat through a radiation and convection. radiative

heat transfer occurs through a net emission of electromagnetic waves from the warm occupants and their surroundings to the cool ceiling. On the other hand, the room airs convicts heat to the cool panels and creates convection current within the space. there are many advantages of radiant cooling system. Comfort levels can be better than those of other conditioning systems because combinations of radiant loads are treated directly and air motion in the space is at normal ventilation levels. Supply air quantities do not exceed those required for ventilation and dehumidification. this provides a draft-free environment. noise associated with fan coil or induction units is eliminated. Draperies and curtains can be installed at the inside wall without interfering with the heating and cooling system. operational costs are reduced for the mechanical chilling system since cooled ceilings operate at relatively high temperatures (average surface temperature of 15°c or above). chillers can operate at higher temperatures resulting in an increase in efficiency and reduction in energy costs. the study are useful for building owners, engineers and users trying to understand the operation, benefits and drawbacks of implementing chilled ceilings in buildings. Normally used with displacement ventilation where ventilation air is introduced into a room at low level and flows by natural means to replace existing air. in a typical radiantly cooled office building, two to three air exchanges per hour is required. the ventilation air drawn from outdoor should be dehumidified in order to reduce latent load since the cooling panels remove sensible load only. the advantages of hydraulic radiant floor heating include the efficient use of space and that cleaning is not required. also, the system does not produce noise, cause drafts or use ducts. the system has uniform temperature distribution and is a low-temperature heating

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Radiant cooling is a gentle temperature conditioning system, exchange thermal energy to the space through convection and radiation.Radiant cooling system can be employed on the ceiling of a room, or in some cases hung from a high ceiling. Cooling water is supplied to the panels at temperature above dew-point temperature of air in the room to avoid condensation of moisture in the air on the panels. Heat is transferred between the space and the cooling panels through a temperature differential. The cooling panels absorb heat through a combination of radiation and convection.

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Noise associated with fan coil or induction units is eliminated. Draperies and curtains can be installed at the inside wall without interfering with the heating and cooling system. Operational costs are reduced for the mechanical chilling system since cooled ceilings operate at relatively high temperatures (average surface temperature of 15°C or above). Chillers can operate at higher temperatures resulting in an increase in efficiency and reduction in energy costs. The study are useful for building owners, engineers and users trying to understand the operation, benefits and drawbacks of implementing chilled ceilings in buildings.

Radiant cooling panels are normally used with displacement ventilation where ventilation air is introduced into a room at low level and flows by natural means to replace existing air. In a typical radiantly cooled office building, two to three air exchanges per hour is required. The ventilation air drawn from outdoor should be dehumidified in order to reduce latent load since the cooling panels remove sensible load only. The advantages of hydraulic radiant floor heating include the efficient use of space and that cleaning is not required. Also, the system does not produce noise, cause drafts or use ducts. The system has uniform temperature distribution and is a low-temperature heating system.

1.1 Heat balance between human body and environment:

Heat emission from the human body occurs through four modes of transfer:

1. Conduction (~5%)
2. Evaporation (~20%)
3. Convection (~30%)
4. Radiation (~45%)

1.2 Methodology:

• With this system surrounding surface temperatures are lowered by absorbing the sensible heat from the conditioned space providing thermal comfort to the occupants in the room and this is made by circulating cooling water in the floors through copper/ aluminum tubes.

• Automatic controls, a subject beyond the scope of this paper, are envisioned to offer the potential to further improve the economic benefits of the lower supply air conditions.

• The majority of air-conditioning devices function on the principle of pulsated air, where the hot air of the room is recycled, cooled and returned into the room.

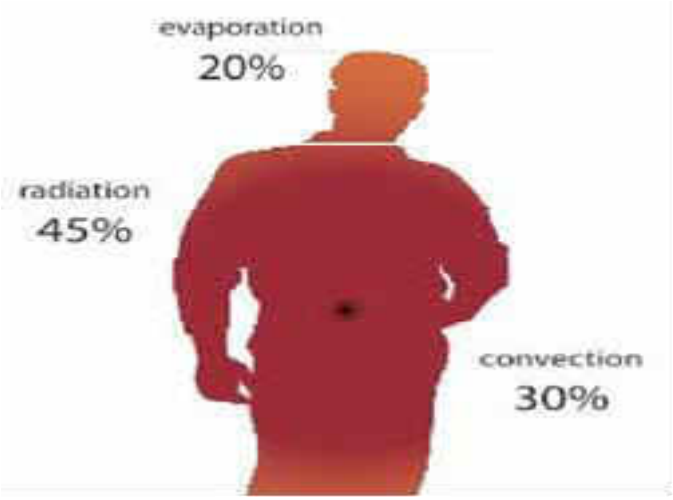

Figure 1.1 Heat Emission from body

• Sensible heat is removed from the space by a combination of convection and radiation.

1.3 Problem Identification:

• Running the air conditioning can make an electricity bill sky rocket, but we use few ways that you can help your air conditioner better and save your money.
• In 24/7 using air conditioner it will turned on full blast at that place.
• Air conditioner creates greenhouse gas emission, one of the causes of global warming.

2. MATERIALS REQUIRED

1. Concrete Slab
2. Copper tubes
3. Exhaust fan
4. Submersible Water Pump
5. Temperature Measuring Device & Indicators

1.2 Objectives:

• To implement Radiant Cooling System in floors with the help of minimum materials and sources.
• To Design a Concrete floor with copper tubes buried beneath it and a water cooling system supported with a natural draft cooling system and a feed pump to circulate the water in the copper tubes.
• To reduce the ambient temperature by removing the sensible heat from the floor surface thereby creating thermal comfort to the room occupants with the help of a Radiant Cooling System.
• Experimental analysis will be done for floors implemented with Radiant Cooling System and normal floors and comparison will be made between the two.
• The process of radiant exchange has a negligible effect on air temperature, but through the process of convection, the air temperature will be lowered when air comes in contact with the cooled surface.

1.3 Working of Radiant Cooling System:

A radiant cooling system is a temperature-controlled surface that cools indoor temperatures by removing sensible heat and where more than half of heat transfer occurs through thermal radiation. Heat will flow from objects, occupants, equipment and lights in a space to a cooled surface as long as their temperatures are warmer than that of the cooled surface and they are within the line of sight of the cooled surface. The process of radiant exchange has a negligible effect on air temperature, but through the process of convection, the air temperature will be lowered when air comes in contact with the cooled surface.

Radiant cooling cools a floor or ceiling by absorbing the heat radiated from the rest of the room. When the floor is cooled, it is often referred to as radiant floor cooling; cooling the ceiling is usually done in homes with radiant panels. Although potentially for arid climates, radiant cooling is problematic for homes in more humid climates.

Most radiant cooling applications have been based on aluminum panels suspended from the ceiling, through which chilled water is circulated. To be effective, the panels must be maintained at a temperature very near the dew point within the house, and the house must be kept dehumidified. In humid climates, simply opening a door could allow enough humidity into the home to allow condensation to occur.

The panels cover most of the ceiling. In all but the most arid locations, an auxiliary air-conditioning system will be required to keep the space's humidity low. Structures built on concrete slabs are prime candidates for radiant cooling systems, and radiant ceiling/floor cooling takes advantage of the same principle using chilled water. Although the costs associated with the supply and installation of a radiant ceiling may be slightly higher than a forced air system, there are other significant savings that should be taken into consideration. The first and foremost saving is that of space. Because the required air volume has been reduced, the need for large amounts of duct work above the ceiling has been greatly reduced.

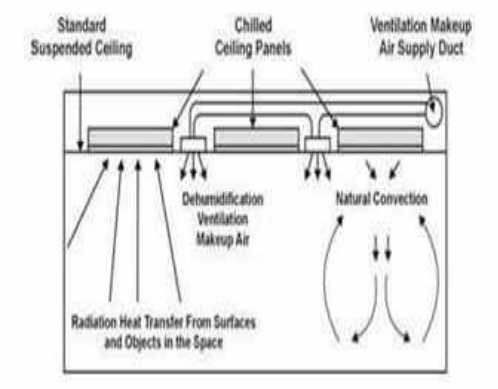

Figure 5.2 Radiant Cooling System Implemented in Ceilings

A radiant cooling system extracts heat differently. Radiant cooling is the reverse of radiant heating: people living in (or sun shining on) the spaces are heat radiators and the floor is the absorber. To cool, a radiant floor system typically circulates water at 55 to 58°F, as contrasted to supply-air conditioning at an uncomfortable 40°. The temperature of a radiant floor is within 2° of the floor temperature of a forced

Air system, yet it has the capacity to remove significantly more heat from direct solar surface heating (rooms and hallways exposed to direct sunlight) than air conditioning alone.

While hot air rises, heat does not. Heat moves from hot objects to cold ones. The indoor climate gains heat from building occupants, electrical appliances, lighting, mechanical systems, and solar radiation. Heat is retained in the thermal mass of the structure, as hot air (sensible heat) and as heat trapped in water vapor (latent heat).

In-floor radiant cooling is most effective at removing direct solar heat gain, followed by sensible heat gain. (It has no inherent capacity to remove latent heat since it does not dehumidify air.)Insulated floor coverings like carpeting limit the capacity to 25 – 30% of the capacity of hardwood or tile floors on top of lightweight concrete.

This means that the plenum height could be reduced by approximately one foot per floor! A reduction in plenum height can be translated into a reduction in overall building height. If this technique were to be applied in the construction of a ten-story office tower, the total height of the building could be reduced by ten feet'. This would translate into significant savings in material and labor in the construction of the building's structure.

1.4 Application

- It can be used to cool a building.
- It can be implemented in factories, classrooms and stores.
- Radiant cooling pipes may be embedded in floors, ceilings,

walls.

1.5 Conclusion

It can be concluded that the system like Radiant cooling panel spreading over a large portion of the ground can be used as an effective way of cooling .By using Radiant cooling system operational costs are reduced. Radiant panels can be used as both heating and cooling panels reducing the amount of equipment and piping required compared to conventional heating and cooling system. By implementing radiant cooling systems in floors and ceilings Zero energy building with zero net energy consumption can be made possible or other exposed surfaces.

References

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