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Infosys M&C Building at Bangalore

Technology Transformation in Cooling Buildings: A Case Study in Radiant Cooling

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Background

Infosys pioneered the radiant cooling technology in India through radiant slab and radiant panel based cooling systems. Infosys building in Hyderabad is the first radiant cooled commercial building in India, and the largest comparison of cooling systems in the world. The building is a live lab split into two symmetric halves, one half with conventional air conditioning and the other with radiant cooling. Data over the last five years show that radiant cooling technology is 30% more efficient than conventional cooling. Energy performance index (EPI) of the radiant cooled building is measured to be about 70 kWh/sq.m./year, among the lowest in the world for a hot and dry climate like Hyderabad. (Guruprakash Sastry, *First Radiant Cooled Commercial Building in India,* Air Conditioning and Refrigeration Journal, July-August 2013.)

However, a constraint with the slab based radiant cooling system is that it cannot be installed in existing buildings.

About the Authors

Sagar N. holds a BE in industrial engineering and MBA in operations. He has an experience of over 8 years in energy efficiency and green buildings, and is responsible for driving energy and water efficiency in existing and new buildings of Infosys.

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Punit Desai is a chemical engineer with post-graduation in marketing management. He heads the smart campus practice and drives green building design projects at Infosys. He has over 14 years of experience in smart buildings, green building design, industrial and comfort cooling systems.

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Depending on the application, there could be concerns around acoustic performance of the building in the absence of additional sound absorbing surfaces. In cases where the owner requires high flexibility with respect to changing space usage, radiant slab could pose limitations.

To overcome the limitations of slab based radiant cooling system, we implemented a radiant panel based cooling system in one of our buildings in Bangalore. These are radiant cooling panels that also serve the purpose of a false ceiling in the space. However, they require large ceiling surface area for cooling due to low cooling capacity of 92 W/m^2 at 10˚C ΔT. These panels also consist of multiple joints and have high pressure drops, making them difficult to install and maintain. We also realized that the available radiant cooling solutions might not be cost effective in India. While radiant cooling offers numerous benefits, the above limitations seem to constraint its adoption.

Two-thirds of the commercial buildings of year 2030 are yet to be built in India. Thus, we have a great opportunity to transform the way cooling is done in buildings. Currently, India has 700 million sq. m. of commercial space, which is projected to grow to about 2000 million sq. m. (Source: *HVAC Market Assessment and Transformation Approach for India by USAID,* 2014). This provided us with the motivation to pursue the development of Radiflux Panels.

Introduction to Radiflux

Radiflux was conceptualized, designed and developed to address the challenges with existing radiant cooling systems, especially in the Indian context. A dedicated team of engineers was formed, which worked for over a year to develop an in-house radiant panel solution. Throughout the development process, the focus was to develop a high efficiency, high quality, reliable, affordable and quick-install solution. Radiflux is a designed, developed and made in India solution for the world, with patents pending in the US, Europe and India.

The first set of Radiflux panels is installed at one of Infosys buildings in Bangalore. These panels deliver about two times more capacity for the same coverage area than other radiant panel solutions available in the market today.

Figure 1: Radiflux panels installed in Infosys building in Bangalore

DesignConcept

Traditional radiant panels (see *Figure 2*) consist of:

1. Ceiling tile (metal or gypsum),
2. Copper or plastic pipe,
3. Water circulation,
4. Heat transfer element (aluminum extrusion or graphite plate) to transfer heat from panel surface to water.

The cooling capacity of radiant panels is dependent on how effectively the pipe is connected to the heat transfer element and also the way heat transfer element is connected to the panel surface. Since air is a bad conductor, any air gap in these connections reduces the heat transfer efficiency. Traditional radiant panels are installed in the form of a suspended ceiling to a space as a uniform ceiling or as an island.

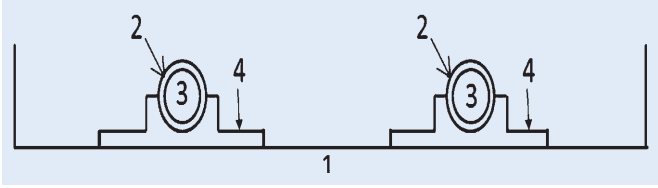

Figure 2: Cross section view of traditional radiant panels

Radiflux is a monolithic panel installed either horizontally or vertically (see *Figure 3*). The panel (5) is made from a single material (aluminum) and acts as a pipe (5a), heat transfer element (5b), and cooling surface (5c). No separate layers are connected together. There are no layers of materials and, hence, there are no air gaps between the layers, thereby enhancing the heat transfer efficiency and allowing maximum possible heat transfer to the panel surface.

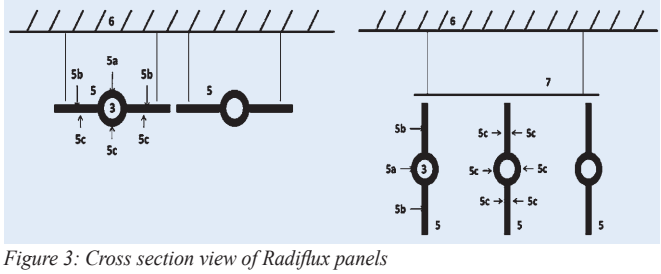

Figure 3: Cross section view of Radiflux panels

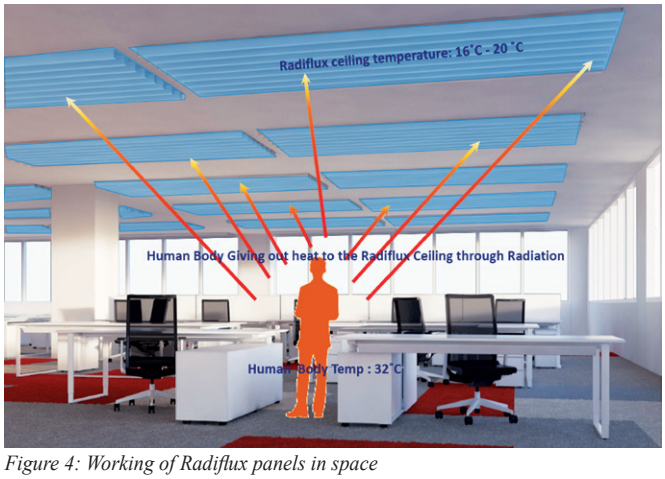

Figure 4: Working of Radiflux panels in space

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In case of traditional panels, resistance to heat transfer can be 0.283˚C/W, assuming a 0.5 mm air gap. On the other hand, Radiflux panels offer lower resistance to heat transfer due to no layers and absence of air gaps. It has a resistance of 0.011˚C/W, equivalent to a reduction of more than 90 per cent as compared to traditional panels. This makes the surface temperature of the panels lower than other panels using the same inlet water temperature, thereby leading to higher cooling capacity. As a result, Radiflux panels requires about 50% less ceiling area compared to traditional panels to cool the space. Rest of the ceiling space can be used for enhancing acoustics and aesthetics as shown in *Figure 4*. Radiflux delivers cooling capacity of 193 W/m^2 of installed area at a temperature difference of 10˚C.

Salient Features of Radiflux Panels

Monolithic and Flexible Design

Radiflux panels have a monolithic design consisting of a single material for carrying chilled water and performing the radiant cooling function. These panels are made of aluminum alloy, have a long life span, and are powder coated for aesthetic considerations. They are available in different sizes and can be installed in varied interior structures.

Highest Capacity in its Class

The vertical arrangement of Radiflux panels with active areas on either side helps in delivering better performance. This type of arrangement increases convection around the panels, thus enhancing their overall cooling capacity.

High Level of Comfort

Typically, many radiant panels are connected in series to form a single water loop. Therefore, the temperature of the panel at the beginning of the loop may be different from the panel towards the end of the loop. To overcome this difference, another overlapping loop is designed in the system in such a way that the coldest panel in the first loop is next to the warmest panel in the second loop. This ensures uniform temperature across a set of panels, and provides high level of comfort to the occupants.

Lesser Connections in the System

Radiflux panels are designed to have lengths as long as seven meters. Further, the system is designed to work without the need for manifolds, leading to less number of chilled water connections in the system. This makes the entire system easy and quick to install and maintain.

Ease of Installation

One of the important design criteria for Radiflux panels was to allow easy and quick installation from the ceiling. They are designed with a simple and quick fix clipping mechanism to meet this design objective.

Testing and Validation

Radiflux has been tested and validated for itsperformance at WSP lab in Germany as per EN14240 standards. The panels have delivered capacity of 197 W/m^2 under test conditions of 10˚C ΔT, almost twice the capacity of traditional radiant panels. Panel capacity at different ΔTs is shown in *Figure 5*.

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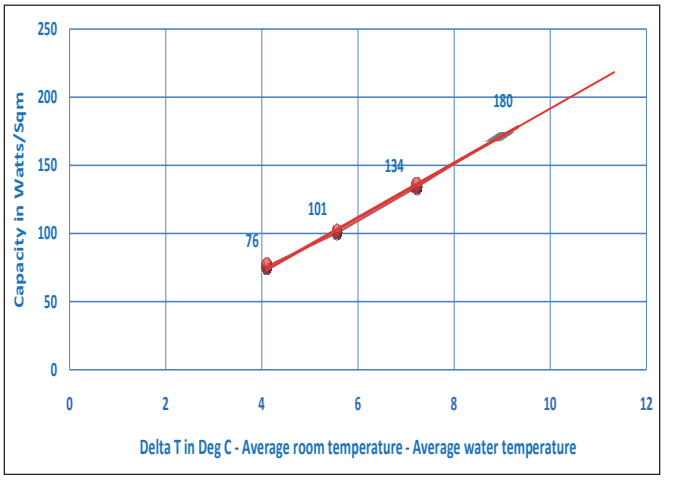

Figure 5: Radiflux capacity (100 mm spacing)

Conclusion

Radiant cooling technology addresses all the challenges of current cooling systems, viz. energy efficiency, thermal comfort and indoor air quality. Radiflux packages all the benefits of radiant cooling technology in one. It has the ability to transform the way cooling is done in commercial buildings. It can be engineered to all air conditioning applications with comfort cooling requirements. In addition to new buildings, this is an effective retrofit solution for existing buildings. ❄