Design considerations of evaporative cooling

Environment, Water

Closed circuit is a cooling process that uses direct evaporative cooling in addition to some type of heat exchanger to transfer the cool energy to the supply air. The cooled moist air from the direct evaporative cooling process never comes in direct contact with the conditioned supply air. The moist air stream is released outside or used to cool other external devices such as solar cells which are more efficient if kept cool. One indirect cooler manufacturer uses the so-called Maisotsenko cycle which employs an iterative (multi-step) heat exchanger that can reduce the temperature to below the wet-bulb temperature. While no moisture is added to the incoming air the relative humidity (RH) does rise a little according to the Temperature-RH formula. Still, the relatively dry air resulting from indirect evaporative cooling allows inhabitants' perspiration to evaporate more easily, increasing the relative effectiveness of this technique. Indirect Cooling is an effective strategy for hot-humid climates that cannot afford to increase the moisture content of the supply air due to indoor air quality and human thermal comfort concerns. The following graphs describe the process of direct and indirect evaporative cooling with the changes in temperature, moisture content and relative humidity of the air.

Indirect evaporative cooling strategies are rare because this strategy involves an architectural element to act as a heat exchanger (for example a roof). This element can be sprayed with water and cooled through the evaporation of the water on this element.

Following are the design consideration while making an indirect evaporating system.

Water use

In arid and semi-arid climates, the scarcity of water will make water consumption a concern for evaporative cooling. From the installed water meters 420938 L (111, 200 gal) of water were consumed during 2002 for the two passive cooling towers at Zion National Park Visitor Center.

Shading

Allow direct solar exposure to the media pads increases the evaporation rate, which reduce water consumption. However, the sun's ultraviolet radiation may increase the degradation of the media as well as heating up other elements of the evaporative cooling design. Therefore, shading is often recommended.

Mechanical systems

Apart from fans used in mechanical evaporative cooling, pumps are the only other piece of mechanical equipment required for the evaporative cooling process in both mechanical and passive applications. Pumps can be used for either recirculating the water to the wet media pad or providing water at very high pressure to a mister system for a passive cooling tower. Pump specifications will vary depending on evaporation rates and media pad area. The Zion National Park Visitor‟s center uses a 250 W (1/3 HP) pump.

Exhaust

Exhaust ducts and/or open windows must be used at all times to allow the cooled humidified air to continually escape the home or air conditioned area. The evaporative system cannot function without exhausting the continuous supply of cooled air to the outside. Depending on the placement of a single ' cooled air' inlet, along with the layout of the house passages, related doors and room windows, the system can be used most effectively to direct the cooled air to the required areas. A well designed layout can very effectively

scavenge and expel the hot air from desired areas without the need for an above ceiling ducted venting system.

Different types of installations

Typically, residential and industrial evaporative coolers use direct evaporation, and can be described as an enclosed metal or plastic box with vented sides. Air is moved by a centrifugal fan or blower, (usually driven by an electric motor with pulleys known as “ sheaves” in HVAC terminology, or a direct-driven axial fan), and a water pump is used to wet the evaporative cooling pads. The cooling units can be mounted on the roof (down draft, or down flow), or exterior walls or windows (side draft, or horizontal flow) of buildings. To cool, the fan draws ambient air through vents on the unit’s sides and through the damp pads. Heat in the air evaporates water from the pads which are constantly re-dampened to continue the cooling process. Then cooled, moist air is delivered into the building via a vent in the roof or wall.

Because the cooling air originates outside the building, one or more large vents must exist to allow air to move from inside to outside. Air should only be allowed to pass once through the system, or the cooling effect will decrease. This is due to the air reaching the saturation point. Often 15 or so air changes per hour (ACHs) occur in spaces served by evaporative coolers, a relatively high rate of air exchange.