CASE STUDY:
Evaporative Cooling

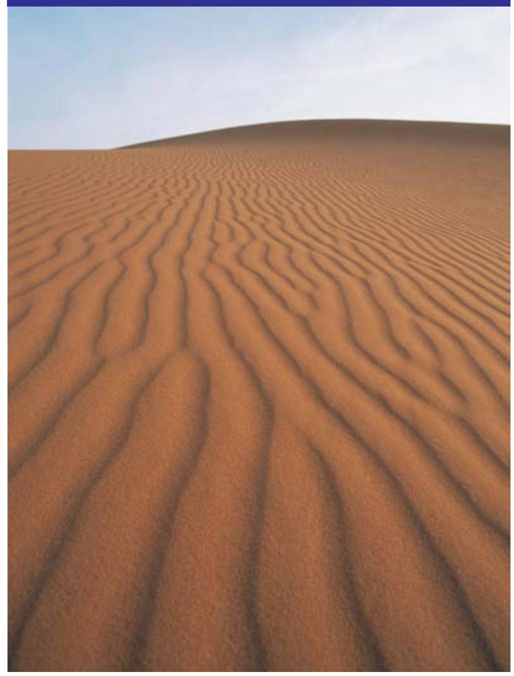
Evaporative Cooling for Badwater, California

Just a few miles from the town of Badwater, in Death Valley California, the personnel at the National Park Service's Cow Creek Maintenance Facility have quite a task maintaining comfortable working conditions at reasonable cost within their various shops. Daytime temperatures routinely hover around 110°F during summer months and can go to 130°F.

Harsh Conditions

In Badwater, CA yearly rainfall averages less than two inches per year. The Wet Bulb (WB) depression is ideal for evaporative cooling. The 2001 California Title 24 Energy Code as well as ASHRAE Standard 62-2001 both called for a minimum outdoor air quantity of 1.5 cfm per square foot of auto shop floor space to meet ventilation requirements. This amounted to a total outdoor air requirement of 18,000 cfm for the two shops to be conditioned. With California's severe energy shortages in 2001, the decision was made to use an Indirect/Direct Evaporative Cooling Unit (IDEC) design rather than refrigeration. On a 121°F design day, the two-stage evaporative cooling systems would deliver 68°F to the conditioned space, allowing the indoor temperature to be maintained at 85°F or lower while introducing the code required outdoor air quantity. This system would consume only 0.2 kilowatt per ton (kw/ton) (1) of electrical energy for sensible cooling of the space.

Harsh conditions surrounding the Cow Creek Facility required an effective yet energy efficient system



BENEFITS

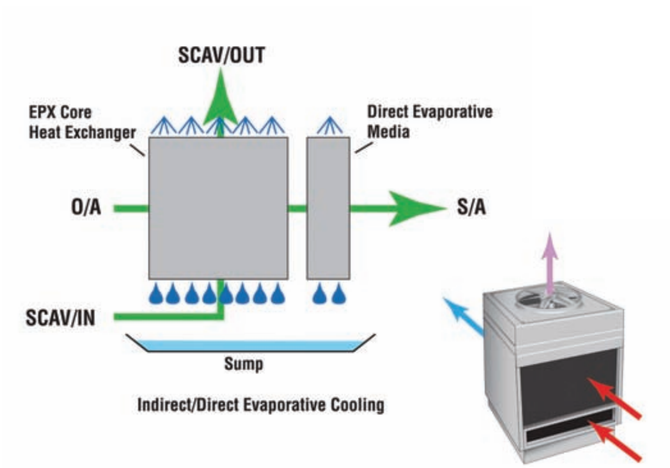
- Meets ASHRAE Standard 62-2001
- HIghly efficient despite harsh conditions
- Uses significantly less energy to air condition than conventional systems
- Reduces peak electrical demand
- Provides winter heat recovery
- Qualifies for utility rebates and/or LEED credits

Munters

A New Heat Exchanger

Hard water and high ambient temperatures require a robust air-to-air heat exchanger which will shed minerals plated out during the Indirect Evaporative Cooling (IEC) process. With a wet-bulb depression at design of 44°F (ambient 121°F dry bulb minus 77°F wet bulb), there would be a significant evaporation rate on the wet side of the heat exchanger surface.

Since heat exchanger effectiveness is a function of surface area, the heat exchanger must present maximum surface yet minimize air-side pressure losses. Early designs of IEC modules used a folded aluminum, cross-flow matrix or round plastic shell and tube type heat transfer surfaces. The limitations of these pioneer products were wet-side fouling and short life expectancy. In addition, the shell and tube design has high static pressure losses and low efficiency.



Improved Conditions

At Cow Creek, where two of the new IEC modules are installed, dry side static pressure losses are in the range of 0.6 to 0.7 inch water gauge (in. w.g.) and wet side losses are 0.8 to 0.9 in. w.g. at design cfm flows with an 80% approach of ambient dry bulb to ambient wet bulb. This approach is often called Wet Bulb Depression Efficiency (WBDE). Water consumption at design temperatures, due to evaporation, is estimated to be 608.5 pounds of water per hour (1.22 gpm) per 10,000 cfm of supply air flow. Since outdoor air is dry cooled from 121°F to 85°F with the IEC heat exchanger, the cooling effect is equal to 33 tons of sensible cooling per 10,000 cfm of supply air. The air is induced vertically up through the inside of the vertical tubes with a propeller fan while water is sprayed down through the wet side matrix or the inside of the tubes. A moisture eliminator on top of the water spray manifold insures no carry-over off the wet side of the heat exchanger.

A concern of many designers is exposed water in the supply air stream. In California, most hospital applications may not use direct evaporative cooling components due to the exposed water that could lead to potential growth of allergenic or pathogenic organisms. The new tube sheet sealing method results in a tighter seal eliminating cross-contamination. Water leakage specifications now call for less than 0.001 gallon per hour leakage between supply and wet side air paths for a 10,000 cfm unit.

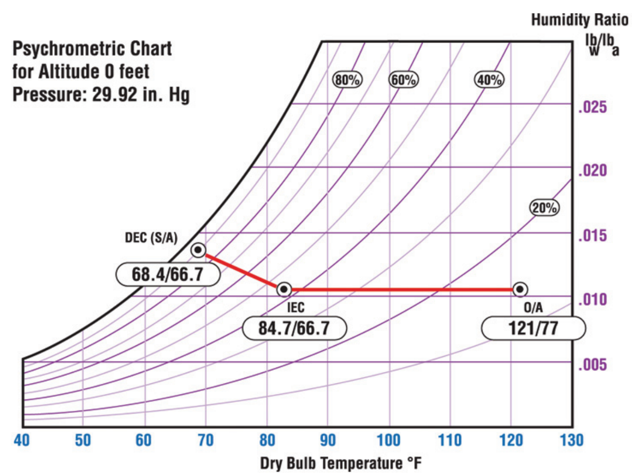
Direct Evaporative Cooling in the Desert

A 12-inch deep wetted media pad, selected for 400 feet/min. face velocity, provided the final stage of cooling for the Cow Creek project. The static pressure loss for the Direct Evaporative Cooler (DEC) section is 0.14 in. w.g. and the evaporation rate is estimated to be 215.6 lb/hr (0.43 gpm) at summer design conditions. The WBDE of the adiabatic cooler is 90.2 %.

A major contribution of the IEC heat exchanger is its ability to generate the lower wet bulb condition of 66.7°F which allows the second stage DEC to deliver 68.4°F to the room. This then increases the overall system sensible cooling tonnage from 33 tons for the IEC alone to a total of 48.2 tons for the total evaporative cooling unit per 10,000 cfm of supply air.

Conclusion

Since 1997 the heat exchangers used in the Cow Creek Maintenance Facility have functioned as intended in numerous applications without maintenance or operational issues. According to Mr. Booth, “the equipment is supplying air that adequately cools the supplied space.” To the authors’ knowledge no other IEC cooling heat exchanger has performed in such a manner.



Two Stage Evaporative Cooling Delivers 48.2 Tons of Sensible Cooling in Death Valley, California.

(1) Scofield, C. Mike and Des Champs, Nicholas H., “Indirect Evaporative Cooing Using Plate Type Heat Exchangers”, ASHRAE Transactions, 1984, V.90, PT.1.
(2) Scofield, Mike, “Indirect Evaporative Cooling Uses Outdoor Air to Reduce Cooling Costs for Surgery Suites”, The Air Conditioning, Heating and Refrigeration News, March 16, 1998.

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