HMX-IDEC cools far better than air washers – the experience of a leading automotive company

Background

This case study is a direct comparison of the simulated and actual cooling performance of an air washer vis-à-vis the HMX-IDEC. The units were installed in dining halls within a manufacturing complex of an Indian multinational automotive company that is a leading manufacturer of passenger cars, trucks, vans, coaches, buses, construction equipment and military vehicles.

Challenges

The new facility of this automotive giant near Ahmedabad, has two dining halls, located at a distance of 1.5 km from each other. Dining hall 1 has a conditioned area of 920 m², while dining hall 2 has an area of 1,533 m². Initially the company was considering air washers to cool both dining halls. Air washers use a single stage i.e. Direct Evaporative Cooling (DEC). When approached, HMX proposed instead the use of superior two stage evaporative cooling technology, i.e., Indirect Direct Evaporative Cooling (IDEC), and emphasized that the HMX's IDEC would be a better option. The company was not sure whether the IDEC systems would perform as per their needs as they were inexperienced with the two stage evaporative cooling technology.

Simulation

ASHRAE (American Society of Heating, Refrigerating and Airconditioning Engineers) has determined the adaptive model to be applicable for naturally ventilated buildings with windows and where air movement is provided by fans – conditions that are valid for the majority of industrial installations in India, and also for these dining halls. Hence, HMX provided a comparison within the framework of adaptive comfort between the expected performance of air washers and the IDEC. These cooling systems were compared in terms of their reliability to deliver comfortable conditions as per ASHRAE standard 55-2010. It was assumed that the conditioned spaces would be maintained at a nominal 27°C, which is within the 90% acceptance band of the comfort zone recommended for Ahmedabad by the adaptive model of comfort (section 5.3, ASHRAE 55-2010). All calculations were performed using eQUEST, a reliable energy simulation software developed by the US DOE (Department of Energy).

The following were the conclusions from the simulations:

1. Though the conditioned space of dining hall 2 is 66% larger than that of dining hall 1, IDEC system with a total capacity of 106,000 CFM could provide far better cooling to this hall than air washers with the same capacity could provide for dining hall 1.
2. For cooling the area of hall 1, an IDEC system with 40% lower capacity as that of air washers would be sufficient.
3. Naturally ventilated spaces in tropical zones such as factory buildings and cafeterias in industries can be effectively cooled using Indirect Direct Evaporative Cooling (IDEC) techniques.

Installation

Intrigued by the simulations, the company decided to make a first hand comparison of the alternative IDEC technology.

HMX supplied and installed two different cooling solutions, i.e., the air washer and the IDEC in early 2011. Two air washers each of 53,000 CFM were installed in dining hall 1, and similarly two IDEC also of 53,000 CFM each were installed in dining hall 2. The basic configurations are summarised in Table 1. Temperatures inside both the conditioned dining halls were maintained in the range of 25-27 °C.

Table 1:

Cooled area	Cooling solution	Conditioned space (m^2)
Dining hall 1	Air washers	920
Dining hall 2	HMX-IDEC	1,533

Dining hall 2

Result

Table 2 below lists the measured ambient temperatures, those at the machine outlet and at multiple locations inside the dining halls on a typical hot and dry October day. Both Dry Bulb Temperature (DBT) and Wet Bulb Temperatures (WBT) were measured hourly using a sling psychrometer. The measurements were conducted in the presence of company personnel.

Table 2:

Date	Cooled area	Comfort cooling solution	Average daily temperature, ºC (measured hourly, 11.00 -16.00 hrs)													
			Ambient		Outlet machine 1		Outlet machine 2		In dining area							
									Location 1		Location 2		Location 3		Location 4	
			DBT, ºC	WBT, ºC	DBT, ºC	WBT, ºC	DBT, ºC	WBT, ºC	DBT, ºC	WBT, ºC	DBT, ºC	WBT, ºC	DBT, ºC	WBT, ºC	DBT, ºC	WBT, ºC
20-Oct-12	Dining hall 1	Air washers	34.2	24.2	24.2	23.0	24.3	23.0	26.2	23.2	25.7	23.2	25.8	23.0	25.8	23.1
	Dining hall 2	IDEC	35.0	24.8	23.5	23.5	22.7	21.8	26.5	23.4	26.7	23.5	26.5	23.4	26.5	23.9
22-Oct-12	Dining hall 1	Air washers	34.5	24.3	24.3	25.5	25.7	23.5	26.9	23.8	26.4	23.8	26.5	24.0	26.5	23.9
	Dining hall 2	IDEC	34.5	24.5	24.5	22.7	22.3	21.3	25.9	22.8	25.9	22.8	26.3	22.8	25.8	22.7

Note: 1. Ambient DBT during the measurement period was in the range 33-35.5 ºC
2. Ambient WBT during the measurement period was in the range 23-26 ºC
3. Accuracy: DBT may be considered to be accurate within ± 0.5 ºC, WBT within ± ºC

The following observations were made:

1. Average ambient temperatures, DBT and WBT, were fairly constant during the measurement period. DBT was mainly in the range 33-35 °C (with only one data point, out of 24, measuring 35.5 °C); WBT was in the range 23-26 °C.
2. The air washers and the IDEC perform within expected limits of respective product specifications. The “wet bulb efficiency” of the air washers varies in the range 80-100% whereas that of the IDEC is in the range 110-130%.
3. Supply air at the exit of the IDEC is consistently cooler than that at the exit of the air washers; average DBT is 1.5-3 °C lower and the average WBT is 0.5-2 °C lower.
4. The average DBT in both the dining halls are substantially equal despite the conditioned space of dining hall 2 being 66% larger than dining hall 1.

It is fairly clear from these results that the HMX's IDEC systems provide equivalent cooling for a much larger floor space (by about 66% larger) as an air washer of the same airflow capacity. In other words, in order to cool the same space, the capacity of the IDEC can be 40% lower than that of an equivalent air washer. Also, the space conditioned by the IDEC will have much lower levels of humidity. Hence the inside space conditions will be more comfortable.

> “We are very satisfied with the performance of the HMX-IDEC, particularly with respect to the air washer. This is also confirmed by the fact that many workers prefer to dine at dining hall 2 where the HMX-IDEC is installed rather than dining hall 1, where the air washer is working, even though dining hall 2 is further down by at least 1.5 km.”