HUMIDIFIERS ARE COOL IN AHUS

Damien Power, Ireland Sales Manager at Condair, explains how to use adiabatic humidifiers for evaporative cooling in AHUs.

The physics of evaporative, or adiabatic cooling, as it is sometimes referred to, is based around a transfer of energy. As water transforms from its liquid state into a gaseous state, it consumes energy.

This energy is taken from the air, in the form of heat or thermal energy.

In order to evaporate one kilo of water at 15°C, around 680W of thermal energy is used. Which means that for every kilo of water evaporated into an atmosphere, 680W of evaporative cooling is achieved.

Now for a mechanical cooler to deliver 680W of cooling, it would consume about 226W of electrical energy. However, it's possible for a single evaporative humidifier to deliver over 1,000kg of moisture and a resulting 680kW of cooling, while still operating on less than half a kW of electrical energy. Amazingly that's over 500 times the cooling delivered from a mechanical cooling system, from a very similar amount of electrical energy.

But, the potential to use evaporative cooling is limited by how much moisture the air can absorb – and this comes down to its relative humidity. If the air is already very humid, evaporative cooling's effect is limited. But not necessarily eliminated, as some AHU strategies will still greatly benefit from evaporative cooling even in very humid climates.

There are three main AHU strategies; direct evaporative cooling, in-direct evaporative cooling and another form of In-direct, which we call exhaust air in-direct.
Direct evaporative cooling sees the AHU bringing in fresh outside air, passing it through an adiabatic humidifier, where it absorbs moisture and is cooled.

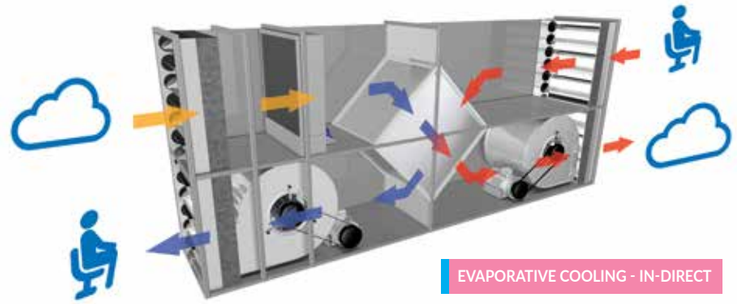
Then this cooled air is supplied to the indoor environment. A percentage of indoor air is continually vented outside, thus allowing more cooled, fresh air in.

This strategy is ideal for warm dry climates and buildings that can have high levels of ventilation. However, it isn't so useful in very humid environments, as the evaporation of the water from the humidifier depends greatly on the incoming air being able to absorb it.

The second strategy is in-direct. The air handling unit in this strategy is operating with two airstreams. One that draws cool outside air into the AHU, then passes it through a heat exchanger before venting it outside. Whilst the other air stream extracts warm air from the building, passes it through the same heat exchanger and then reintroduces it to the building. Neither airstream physically mixes, but the colder outside airstream is used to cool the warmer internal airstream via the heat exchanger.

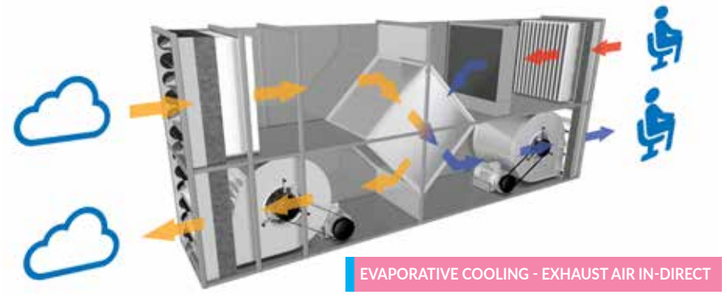
Now this can cool a building even without any evaporative cooling, but if you apply a humidifier to the external airstream prior to the heat exchanger, you reduce the temperature of that external airstream and get even more cooling from the system. It does, however, rely on the outside air being colder than the inside air, either before or after humidification. So again, in very hot and humid climates, this may not be the most effective strategy.

However, in temperate climates such as Ireland, this strategy is ideal for data centres or other secure buildings, as it reduces the risk of introducing pollutants to building from outside. It should be noted however, that this isn't a ventilation system, so fresh air still needs to be introduced by some other method.



EVAPORATIVE COOLING - IN-DIRECT

The third strategy is exhaust air in-direct. This method also uses a heat exchanger. Warm air is extracted from the room and passed through a humidifier, where is it saturated as close to 100%RH as possible. This cools the air as much as possible before it's passed through the heat exchanger and subsequently vented outside. Another airstream draws fresh air in from outside and passes it through the heat exchanger, where it is cooled by the humidified and exhausted room air.

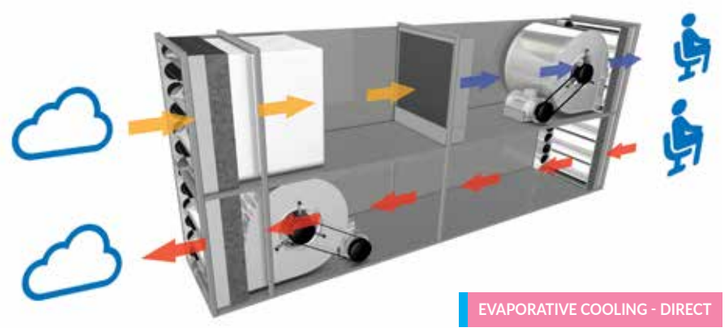


EVAPORATIVE COOLING - EXHAUST AIR IN-DIRECT

The heat exchange can reduce the temperature of the incoming air by a few degrees, which doesn't replace the need for mechanical cooling but can significantly reduce the requirement for it. This strategy can also be used in hot and humid regions, as the room air that the humidifier is cooling is always dry enough to be able to absorb moisture.

To illustrate the potential of using humidifiers for evaporative cooling in AHUs, one client we work with in the telecommunication sector managed to reduce AHU energy consumption by 80% when using a direct evaporative cooling strategy. They were needing to replace mechanical cooling systems in rooms that suffered high heat gain from electronic equipment.

They developed an air handling unit that used a direct evaporative cooling strategy. Rather than using mechanical chillers to cool the room, they brought in outside air and vented the internal air. During the winter, it can run in free cooling mode without any need for evaporative cooling, but when the outside temperature rises to around 20°C, the evaporative cooler switches on and increases the cooling capacity. This allows the AHU to successfully achieve the indoor target condition without ever needing mechanical cooling.



EVAPORATIVE COOLING - DIRECT