Exploiting free cooling

Free cooling can contribute to the cooling requirement of data centres for much of the year — either totally or partly. The energy thus saved is only part of the story. Higher chilled water temperatures off a chiller and the potential to operate them at part load, where they are more efficient, add to the savings. David Wilks of Airedale International takes up the story.

In the northern hemisphere, free-cooling opportunities are relatively abundant. A London data centre with a typical supply-air temperature of 24°C and supply and return water temperatures of 17°C and 22°C, respectively, is capable of operating in full or partial free-cooling mode for up to 95% of the year.

Under these conditions, a free-cooling chiller such as the TurboChill or DeltaChill could generate energy savings of up to 50% compared with a conventional chiller. Since energy accounts for such a large proportion of budget, free-cooling units can return the initial investment within a very rapid timeframe.

Concurrent free cooling provides significant energy-saving opportunities by delivering free cooling at the same time as mechanical direct-expansion (DX) cooling when free-cooling alone cannot meet the demand. The energy savings are primarily achieved as a result of the reduced demand for mechanical cooling while in concurrent free-cooling mode. A further contribution is made by maximising the part-load efficiencies of components such as inverter-driven pumps and compressors.

Raising the supply temperature from a chiller to 18°C and also raising the return temperature to 24°C will further increase the free-cooling opportunity and achievable savings — while still being well within the ASHRAE (Class 1 & 2) recommended data-centre upper operating temperature of 27°C.

Where there is sufficient space outdoors, air free-cooling can be applied, which can be enhanced using adiabatic cooling to further increase free-cooling potential.

Adiabatic cooling is a heat-free method of transferring energy that can significantly reduce the air temperature, especially in warm, dry conditions. The method used may be a fine water spray or a wetted media. The latter, which is applied in our AireFlow indirect adiabatic air-handling unit (AHU), offers the benefits of higher saturation efficiency and lower maintenance. This lower air temperature is then used as a cooling medium and, based on London ambient temperatures, can easily achieve ASHRAE recommended conditions using 100% free-cooling.

As the ambient temperature rises, high-efficiency EC (electronically commutated) fans will modulate to increase airflow with exact capacity match. In more challenging environments, an optional mechanical cooling module will top-up the cooling capacity with a partial DX supplementary cooling section. A further advantage for data-centre operators is that there is no need for precision air-conditioning (PAC) units, freeing space within the data centre for IT equipment.

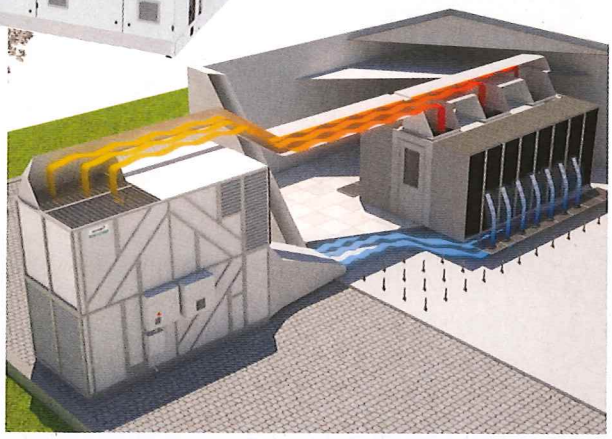
For data centres, indirect heat exchange AHUs provide essential water and air filtration to prevent ingress of pollutants and, with their substantial energy-saving potential, can significantly reduce energy costs compared with DX and chilled-water systems over the course of their lifetime.

Our in-house analysis indicates that an AireFlow AHU will achieve annualised running costs up to 22% lower than a typical free-cooling chiller, with an achievable PUE (power usage effectiveness) below 1.1. In comparison with a typical DX precision air conditioning (PAC) system, indications are that the savings are even greater, with the potential to cut annualised running costs by up to 70%. The 100 kW AireFlow can achieve a pPUE (partial PUE) of 1.035.

To optimise system performance and maximise free-cooling opportunities intelligent controls strategy will also be used.

By applying modulation and sequencing strategies, the part-load efficiencies of components can be maximised to ensure that each element of the system works as part of the whole — balancing cooling duty, temperature, humidity, air flow and pressure to exactly match the load and ambient conditions. Through the use of temperature sensors and sequencer chiller controls, for example, cooling can be staged to ensure a smooth transition from DX cooling to free-cooling. On sites with combination of chillers with and without free-cooling capabilities, the sequencer ensures that when the ambient temperature is low, the free-cooling chiller is the first to start.

On the AireFlow AHU, the activation point for the adiabatic system is optimised via the flexible controls strategy — allowing the user to balance water consumption with power draw. By activating the adiabatic system earlier, the ambient fans can be run at a lower speed; conversely, activation of the adiabatic system can be deferred in favour of running the ambient fans at a higher speed to satisfy demand.



Exploiting the benefits of free cooling. Chillers such as Airedale's TurboChill (left) can utilise free cooling to generate energy savings of up to 50% compared with a conventional chiller. Indirect adiabatic air-handing units (below) provide a highly efficient external solution for data centres, freeing internal space as internal PAC units are not needed.

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David Wilks is research and test manager with Airedale International.