Cooling at Scale: Free Air Cooling at Facebook

Facebook's Prineville Data Center employs an innovative evaporative cooling method that offers key advantages over the Computer Room Air Conditioning (CRAC) units in the majority of data centers. The free-air cooling system is space-saving, ultra-efficient, and quieter than other large-scale cooling solutions.

The heart of the system is a two-story penthouse that draws outside air in, filters it, conditions it (when needed) and sends it to the data hall.

Here's how it works.

Outside air is pulled in through a grille via a sophisticated fan wall system that constantly measures the air pressure of the data center and adjusts fan speeds accordingly. A series of intake dampers that run the length of the building control the amount of that air that enters the filtering area.

A second set of dampers that run below the intake dampers enable hot air to return from the data center floor and mix with the outside air. When the outside air is warmer than the desired temperature, the return air dampers remain closed. When the outside air is cooler than the desired temperature, temperature sensors automatically open the dampers. This dual damper system enables Facebook to mix the air so it is close to an optimal temperature (65°F-80°F) prior to filtration.

The mixture of outside and server-return air is then drawn through a series of filters. This filtering system removes all particulate matter from the air before it encounters the misting wall.

The misting wall uses thousands of jets with microscopic holes to blast water filtered using reverse osmosis into the air. The water is drawn from an onsite well, filtered, and then stored (48 hour capacity in case of well pump failure). The system automatically assesses the temperature and humidity of the filtered air and engages the precise number of jets to ensure that the air that flows to the data hall is

within 70°F-76°F and 35-65% humidity. Spillage runs through a drainage system back to the reverse osmosis system, eliminating water waste.

To eliminate any remaining moisture from the newly cooled and humidified air, a mist eliminator removes any lingering water particles. The air is pulled through the eliminator using the same fan wall that draws in outside air. The air then enters into a plenum system and is distributed throughout the data hall.

Hot air generated by the equipment in the data hall rises naturally into ducting positioned over every hot aisle. This air rises to the penthouse where it is mixed with outside air, redirected to heat the data center offices (if needed), or exhausted outside. This cycle repeats throughout the day.

Because the cooling infrastructure is contained in the penthouse and overhead ductwork, it enables Facebook to devote nearly all of its data hall floor space to housing racked equipment. Prineville alone supports more than 100,000 servers via evaporative cooling, as well as thousands of switches, routers, and other equipment.

By the Numbers

Avg. Temp: ~70°F
Avg. Humidity: ~50%
Servers: >150,000
PUE: 1.08 (2014)
WUE: 0.27 L/kWh (2014)

With an industry leading PUE (power usage effectiveness) of 1.08 and a WUE (water usage effectiveness) of 0.27 L/kWh over the last 12 months (https://www.facebook.com/PrinevilleDataCenter/app_399244020173259), while serving an average user base of well over one billion people. Facebook's Prineville data center is leading the way.