Reclaiming Air Handler Condensate Water

Conserving water makes good business sense in today's economic climate, so why are so many properties in the United States discarding hundreds of millions of gallons of free, usable water every year?

When facility owners search for ways to conserve water, they need only to look as far as the building's air-conditioning system. The condensation water that collects in the drip pans of air-conditioning air handlers is a perfect source of high-quality and free water. Since most commercial and institutional properties in the United States use air conditioning, this water source is an easy-access and excellent candidate for reclamation and reuse.

When a modern air-conditioning system "conditions" the air, it not only cools the air, it also dehumidifies it. The moisture removed from the air collects on the fin coils of the air handler and eventually drips down and collects in the drip pan where, most often, it is piped to the drain and discarded.

Air handler condensate (AHC), also referred to as fijn water, is basically pure distilled water. It is free of scale-forming minerals and salts. This high-quality water is particularly useful as cooling tower makeup water.

Every air-conditioned building in the world generates condensate water. How much water is that? The amount depends on several key factors:

- Size of the cooling system
- Local temperature and humidity conditions
- Amount of outside air used
- Target indoor temperature and humidity

Some of these elements are obvious. The larger the system, the more air conditioned, therefore the more condensate generated. Likewise, with long, hot, humid summers, more condensation is generated than with a cooler or drier climate. For example, buildings in Miami, Fla., and Birmingham, Ala., generate more condensate water per ton of air conditioning than buildings in Dallas and Phoenix simply due to the higher humidity in those areas. An often overlooked variable is the amount of outside air blended into the system. Buildings with large, open public spaces; hospitals, classroom buildings, or any buildings with a high number of air turns are huge generators of air handler condensate.

Never too HOT, Never too COLD

Ceiling Air Diffusers With an Innovative Design

- They're quiet and SAVE on energy bills (tests reveal a savings of 28%)
- Eliminates HOT or COLD drafts blowing on people
- Mixes supply air with room air quickly for uniform temperatures

Image courtesy of Chem-Aqua
So, how much water is that? The average for all buildings across North America is 0.5 gallons of condensate per hour for every ton of air-conditioning operation. This works out to 6,000 gallons per day (1.2 million gallons per year) for a building with an average cooling load of 500 tons and a 200-day cooling season.

You can determine the amount available for your building by doing a few simple calculations. Basically, the amount of moisture removed by the coil (at these operating conditions) is found by multiplying the mass flow rate of air through the coil by the difference between the humidity ratio entering and leaving the coil.

The humidity difference between entering air and leaving air must be looked at and calculated.

Sample conditions would be: 0.0112 - 0.0087 = 0.0025 lb of water/lb of dry air.

Therefore the moisture removed by the coil would be calculated as follows:

\[(6,100 \text{ ft}^3/\text{min} \times 0.075 \text{ lbs/ft}^3) \times 0.0025 \text{ lb of water/lb of dry air} = (1.14 \text{ lbs of water/ min}) / (8.33 \text{ lbs/gallon}) = 0.14 \text{ gpm or 8.24 gallons/hour.}\]

Once you've decided you have enough of this high-quality water to make reclaiming it worthwhile, how do you do it? In most cases, it is a fairly straightforward process. The AHC is collected in a small collection tank equipped with a float-activated submersible pump. The collected condensate is then pumped directly to the cooling tower. Or it can be pumped into the cooling tower water supply line. (See example in image.)
This type of recovery system can benefit your operation in five ways:
1. Reduces sewer costs associated with dumping the AHC.
2. Reduces the amount of fresh water purchased.
3. Increases cooling tower operating cycles, which further reduces sewer and city water charges.
4. Reduces the possibility of energy-robbing scale formation (due to the absence of minerals and salts in the AHC).
5. Reduces energy consumption by lowering condenser pressure on the chiller compressor(s).

What if you have a distributed chilled water system and your cooling tower water return lines do not run near the air handlers? The AHC can still be recovered using a slightly more complex system.

The AHC would be captured the same way, but instead of pumping it into the cooling tower water supply line it would be pumped into the chilled water return line. This overpressurizes the chilled water line. By adding a pressure relief valve in the main chiller room, the excess water can easily be bled into the cooling towers for use as makeup water. (See example in diagram one.)

When using the chilled water system to return AHC to the main chiller room where it can be bled off for use as makeup, a few extra steps must be followed:

1. Since buildings or campuses with distributed chilled water systems tend to be bigger, it is often helpful to collect the AHC in several small tanks at each air handler and then combine the collected AHC into a single large tank. This can help control costs by reducing the number of high-pressure pumps needed to pump the AHC into the chilled water line.
2. The AHC may be contaminated with airborne dirt and debris so the water should be filtered before it is added to the chilled water line.
3. Since you are now making up the chilled water with essentially pure, distilled water, the chilled water chemistry will need to be changed to provide a higher level of corrosion protection.
4. A biocide will need to be added to the chilled water treatment program. In extremely large systems, like the ones found on university campuses, chlorine dioxide has emerged as the treatment of choice.
5. Since the chilled water treatment will be bled into the cooling tower along with the excess water, you should profile the cooling tower treatment program to make sure it is compatible with the new chilled water treatment program.

While somewhat more complex than direct feed to the cooling tower water supply line, using the chilled water system to transport AHC to the point of use has some additional benefits. The first four benefits are the same as outlined above, but numbers five and six provide a secondary category for savings:
1. Reduces sewer costs associated with dumping the AHC.
2. Reduces the amount of fresh water purchased.
3. Increases cooling tower operating cycles, which further reduces sewer and city water charges.
4. Reduces the possibility of energy-robbing scale formation (due to the absence of minerals and salts in the AHC).
5. Replaces any chilled water losses with water at 42-48°F instead of ambient temperature. This saves approximately 170 BTUs per gallon of water replaced.
6. On the hottest, most humid days of the year, when electrical demand charges are typically the highest, the most AHC is available. That means makeup water for the cooling tower is coming in at 42-48°F instead of the typical 85°F water. This reduces energy consumption by lowering the condensing pressure on the chiller compressor(s).

Air handler condensate offers a wealth of value. In the past this has been an untapped wealth; however, as water restrictions become more prevalent, water shortages more frequent, and increased city water and sewer charges more common, alternative water sources like AHCs are gaining attention and becoming increasingly attractive to building owners and operators searching for ways to conserve water without going (financially) overboard.

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