

Humidity

Dr Peadar Grant

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1 Humidity

Humidity is a measure of the amount of water vapour contained in the air.

We can specify the humidity in a number of ways. Humidity is linked to temperature, which makes understanding its measurement a bit harder.

1.1 Relative humidity

Relative humidity quantifies the amount of water vapour in the air as a percentage 0 % to 100 % of the maximum amount of water vapour the air can hold at a given temperature.

1.2 Dew point

The dew point is the temperature at which water vapour liquifies.

When air is at 100 % relative humidity, the dew point is equal to its temperature. It is said to be saturated.

1.3 Calculation

Magnus formula:

$$y(T, RH) = \ln \left(\frac{RH}{100} \right) + \frac{bT}{c + T} \quad (1)$$

$$T_{dp} = \frac{c \cdot y(T, RH)}{b - y(T, RH)} \quad (2)$$

where $b = 18.678$ and $c = 257.14$ C.

Simplified approximation:

$$T_{dp} \approx T - \frac{100 - RH}{5} \quad (3)$$

$$\Rightarrow RH = 100 - 5(T - T_{dp}) \quad (4)$$

2 Humidity envelope

2.1 Environmental classes

The ASHRAE environmental classes require humidity to be controlled.

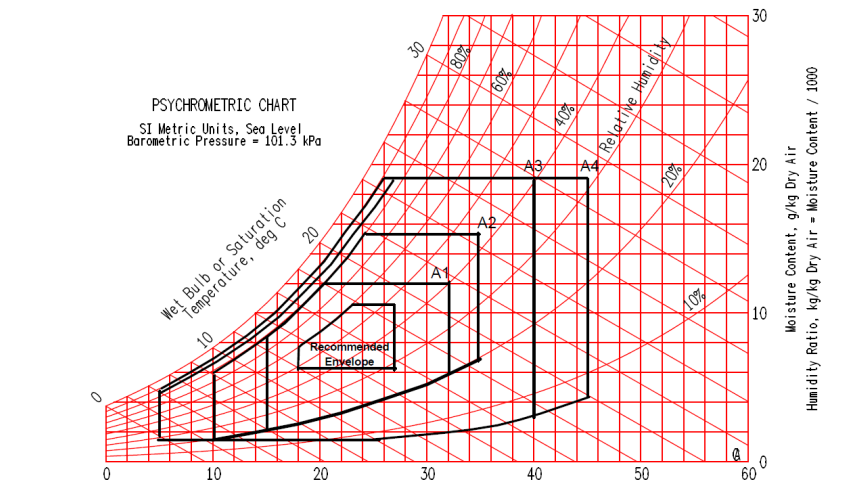


Figure 1: ASHRAE environmental classes

2.2 Humidity control

Precision air conditioning systems manage humidity along with temperature.

For the purposes of humidity control we will assume a DX CRAC and Chilled-Water CRAH to be identical.

3 Dehumidification

3.1 Dehumidification during cooling

Dehumidification will occur naturally as a byproduct of cooling. When air is cooled below its dew point as it passes through the evaporator, some of the moisture will condense. The condensate drains or is pumped away to waste.

The degree of dehumidification can be controlled somewhat by varying the evaporator fan speed and the temperature of the evaporator coil:

- The longer the air spends in contact with the coil, the more dehumidification will occur. Dehumidification performance should be better at lower fan speeds (with all other variables being equal.)
- The colder the evaporator coil, the more dehumidification will occur. Some systems with an electronically controlled expansion valve can vary this to modulate the dehumidification performance.

3.2 Dehumidification with reheat

Sometimes we will have a demand for dehumidification when cooling is not also required. We can often tolerate a small degree of overcooling. Other times we will need to re-heat the air:

- Electric re-heat where electric heaters warm the air after it passes over the evaporator. These are sometimes modulated using a device called a Silicon Controlled Rectifier to give precision control of the air temperature.
- Hot water or steam re-heat where an additional reheat coil is situated downstream of the evaporator. Controlled by a motorised valve that can modulate the hot water/steam flow on/off to maintain the air temperature. Requires source of hot water such as a central boiler, often shared with other services like space or water heating.

- Hot gas reheat where the refrigeration system itself releases heat back into the airstream downstream of the evaporator. Requires less energy than the electric or hot water re-heat options.

3.3 Independent dehumidifier

Independent dehumidifiers are like a CRAC except that both the evaporator and condenser coil are in the indoor airstream. They are used in situations where dehumidification is required without cooling, and are not normally seen in data centre environments.

The evaporator cools air below its dew point and the condenser coil re-heats it.

4 Humidification

Humidification involves adding moisture to the air, increasing its relative humidity. Humidifiers can be separate independent devices but are commonly incorporated with a CRAC.

4.1 Infrared humidifier

The infrared humidifier uses quartz lamps to boil water in a pan, Figure 2.



Figure 2: Photo of CRAC with infrared humidifier

Unwanted heat will be introduced to the controlled space by an infrared humidifier. This is limited if only a small amount of humidification is required (to offset dehumidification caused by cooling).

4.2 Steam canister humidifier

Steam canister humidifiers use electrodes to pass a current through water, heating it in the process, Figure 3. The steam boiled off is released into the air.

Similar to the infrared humidifier, the steam humidifier will introduce unwanted heat into the controlled space. This can be kept relatively low if the humidifier's duty cycle is low.

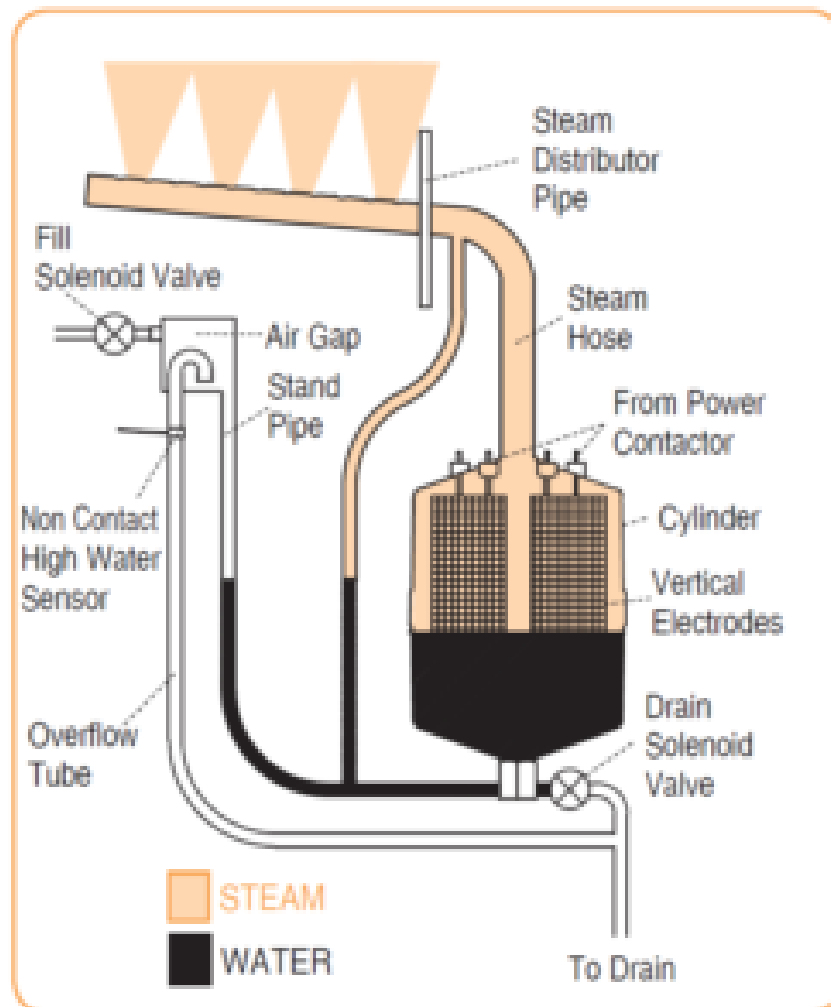


Figure 3: Schematic diagram of steam canister humidifier

4.3 Ultrasonic humidifier

Ultrasonic humidifiers atomise water into tiny droplets, releasing it into the air.

Ultrasonic humidifiers are much cheaper to run than infrared and steam humidifiers and do not introduce unwanted heat into the controlled space. They are available as retrofit kits for many CRACs, with a similar form factor to infrared units, Figure 4.



Figure 4: Photo of an ultrasonic humidifier designed for retrofit applications

Ultrasonic humidifiers need a very clean water supply which adds to their overall cost, but is economic in multiple unit installations.