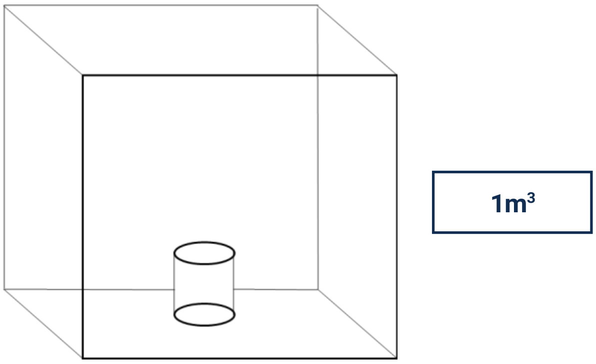
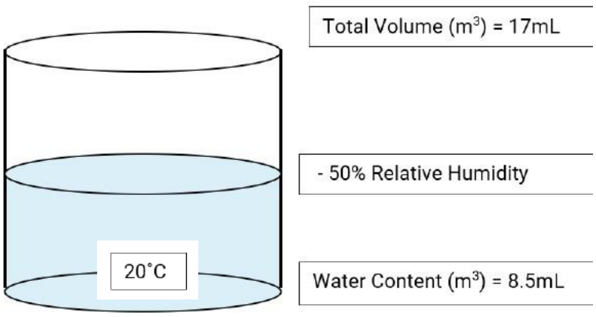
Relative humidity is the most common method of humidity measurements, yet it is also the most perplexing. Relative humidity is expressed as the percentage of water vapour in the air RELATIVE to the total amount of water the air can hold at a given temperature.



When the temperature of air increases the total amount of water vapour that can be contained in the air increases. As the temperature of air decreases the total amount of water vapour that can be contained in the air decreases. Therefore, relative humidity is not the ideal metric for evaluating the water content within air as the ratio of vapour content to total possible vapour content changes with temperature

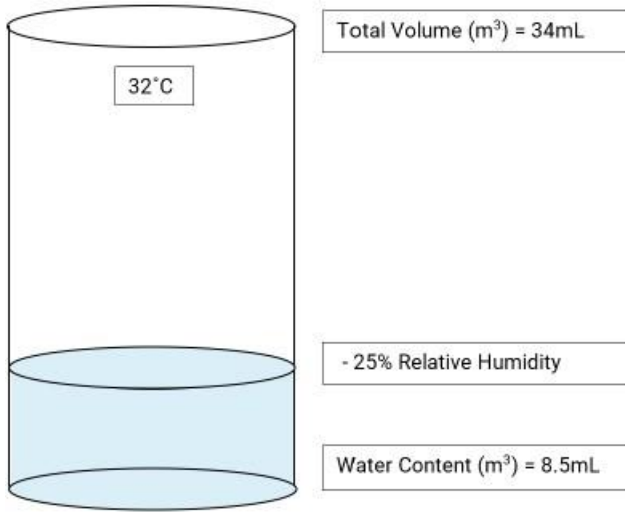
For simplicity to help understanding, consider a scenario in which a jug was to represent the total amount of volume available to absorb moisture within 1m^3 of air at a given temperature



If the temperature of the air is 20˚C the total volume of water the jug can hold is 17g (17mL) of water per cubic meter of air. 50% relative humidity would mean that the jug will hold 8.5 g/m^3.

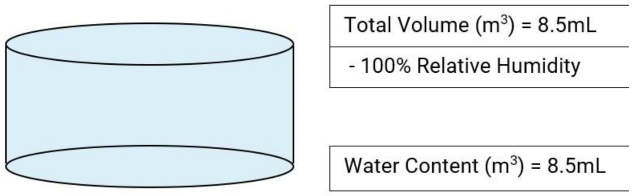
As air increases in temperature the amount of water that it can absorb increases. In other words, the size of the jug grows.

If the temperature of the air rises to 32˚C, the total volume of water it can absorb increases to 34 grams of water per cubic meter. The volume of water in the air remains the same, but the relative humidity has changed.



Conversely if the air were to decrease in temperature the amount of water it can absorb will also decrease. In other words, the size of the jug is reduced.

If the temperature of the air decreases to 8˚C the total volume of water it can absorb is reduced to 8.5 grams of water per cubic meter. The volume of water in the air remains the same but the relative humidity has changed.



When relative humidity reaches 100% the air cannot hold any more water vapour. This is called saturation point. This is the point when clouds can produce rain, windows condense, and cool objects sweat.

As you can see relative humidity can be deceiving when measuring humidity. A more accurate method is to use absolute humidity (the amount of grams of water in a cubic meter of air) or specific humidity (the amount of grams of water in one kilogram of dry air). By using one of these two methods the water content within the air will remain constant regardless of the temperature of the air.

Humans' bio-cooling system is based upon the perspiration and then evaporation of sweat from our pores. It is this cooling system that makes humans particularly susceptible to fluctuations in humidity. If the water content in the surrounding air is high the evaporation of our perspiration is inhibited, making us feel uncomfortable at a given temperature, vice versa if the water content in the surrounding air is particularly low perspiration is free to evaporate effortlessly making us feel more comfortable at a given temperature. Therefore, an understanding of the impacts of humidity on the effectiveness of an air conditioner is important in the initial design, control methodology and system diagnosis is essential.

Under Sized Systems

Undersized systems are ineffective at removing the moisture content from the air. Much of the available capacity is utilised by removing moisture rather than reducing supply air temperature. Undersized systems often display symptoms such as:

- High space temperatures
- High space RH% and wet bulb temperatures
- Mould and contaminants within split system casing and supply fan and duct
- High power consumption
- Long cooling hours
- Low air on/off temperature difference

Oversized Systems

Commonly systems can be overdesigned in capacity requirements due to improper heat load estimation. An oversized system will cycle onto cooling mode and the indoor coil will become damp with condensed moisture. The unit will then reach set point temperature and cycle off before the water condensed on the coil has had adequate time to accumulate in droplets and run off the coil and released out of the drain line. In the proceeding off cycle this moisture is evaporated back into the supply air stream along with additional moisture added from the fresh air intake and other fresh air ingress points. Oversized systems often display symptoms of:

- Stuffiness and discomfort within the space at set point. Especially noticeable on low ambient high humidity days (rainy / overcast).
- High RH% and wet bulb temperatures at set point
- Higher moisture content in the space than in ambient conditions

Economy Cycle

Systems using economy cycle controlled of a dry bulb ambient temperature reading can increase the capacity requirements of the air-conditioning system if additional moisture is added to the space. An increase in moisture content will require an increase in cooling capacity required to remove additional latent heat resulting in a decrease in energy efficiency rather than an increase. Economy cycle should only be operated when the total heat energy of the air (sensible heat + latent heat) of the conditioned space is higher than the total heat energy of the ambient conditions. In other words, the wet bulb temperature of the outdoor condition should not be higher than that of the conditioned space wet bulb temperature.