Basic Principles of Hygrometry

Relative Humidity

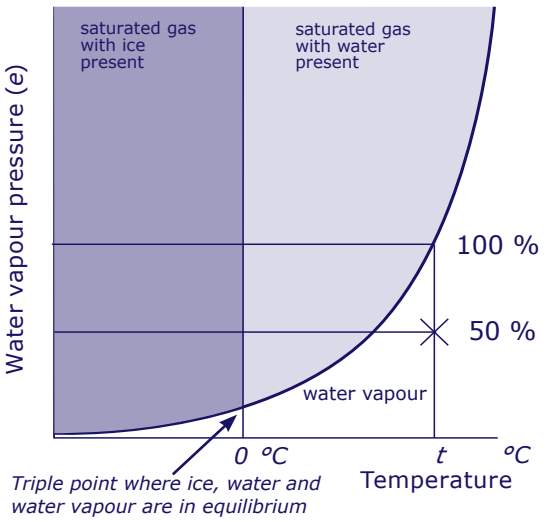
What is Relative Humidity?

Relative Humidity is one of the most common and useful humidity scales, yet it is easy to misunderstand what is meant when a relative humidity (rh) is being quoted. It is an indication in percentage terms of how close a gas is to its saturation point at a particular temperature.

Air contains a mixture of gases, mainly nitrogen, oxygen and varying amounts of water vapour. The amount of a particular gas present may be expressed in terms of a partial pressure. The sum of the partial pressures exerted by each of the gas mixture components equals the total pressure. For air:

Nitrogen + Oxygen + Water Vapour + Other Gases = Total Pressure

The wetter the air, the higher the partial pressure water vapour exerts.



Warm air (or any other gas) is able to hold more water vapour than cool air, and can be likened to a sponge - the warmer the gas the larger the sponge. A saturation curve of water vapour versus temperature shows that as temperature increases more water is able to be held in the vapour phase. Relative humidity is calculated by dividing the actual water vapour pressure by the maximum water vapour pressure possible at that temperature and expressed as a percentage:

$$rh = \frac{e}{e''} \times 100$$

Where
e = actual water vapour pressure
e'' = maximum water vapour pressure at that temperature

If air is cooled the rh will increase until it reaches the dewpoint (see technical bulletin 1) where the gas is saturated at 100% rh. With further cooling more water will condense and the relative humidity remains at 100%.

Note there is no input or reference to pressure in the formula. If a relative humidity measurement is made at an elevated pressure, it is correct, at that pressure. If the same air is expanded to atmospheric pressure, the actual water vapour pressure will drop and the rh will be lower than at the elevated pressure. Conversely if air at atmospheric pressure is compressed it will approach its saturation point and therefore the rh will increase (see technical bulletin 1 and 3 for dewpoint and pressure dewpoint).

Drying Rates and HVAC Applications

Relative humidity is a good indication of drying rates. At low relative humidities water will evaporate very readily and drying occurs quite rapidly. A high rh indicates that the gas is closer to saturation and water will evaporate more slowly. It is because of these changes that heating, ventilation and air conditioning engineers use rh measurements and may define a "comfort zone" in terms of temperature and rh limits.

In commercial dryers, products pass through zones with decreasing relative humidities in order to achieve an efficient and consistent dried product. The chart overleaf allows a conversion between dewpoint and rh at various temperatures.

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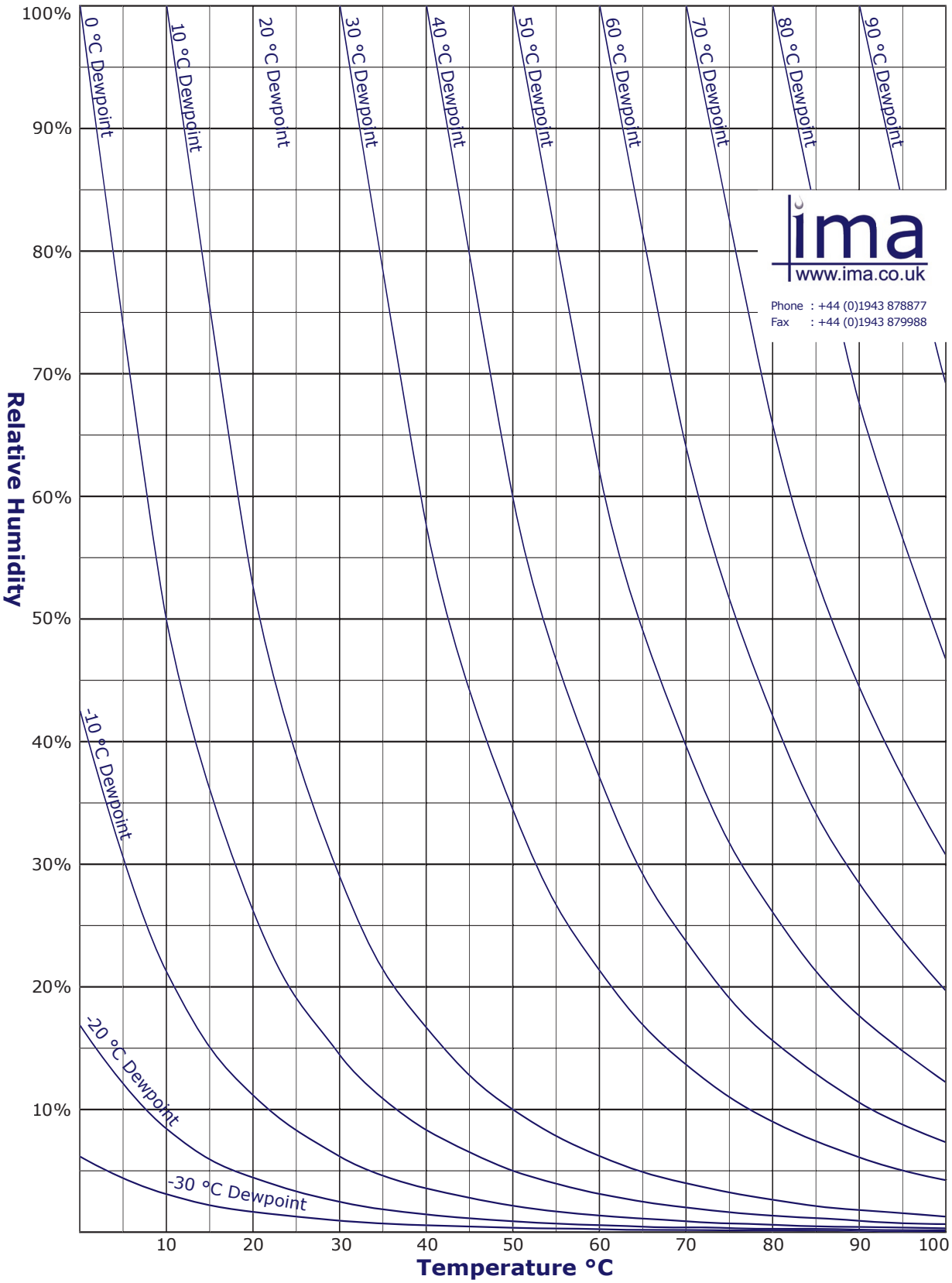
Relative Humidity Conversion Chart



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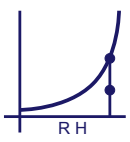

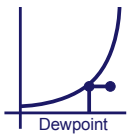

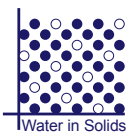

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