Principles of Hygrometry

What is Dew Point?

Humidity is a subject that few engineers deal with on a continuous basis, and it is easy to misunderstand the various humidity scales. Dew point is a well used and useful scale of humidity. It is defined as the temperature below which water vapour will condense into liquid water. It is a consequence of the absolute humidity, and independent of the temperature of a gas. The dew point temperature of a gas can therefore be used to indicate the absolute humidity of a gas.

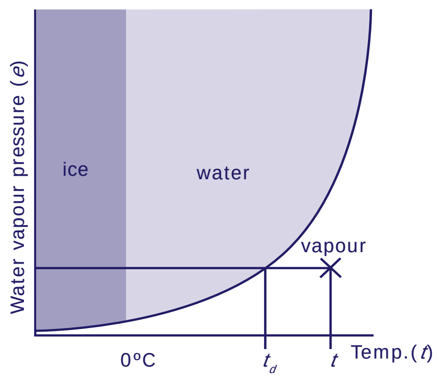
Air contains a mixture of gases, mainly nitrogen, oxygen, and varying amounts of water vapour. The amount of a particular gas present may be expressed in terms of a partial pressure. The sum of the partial pressures exerted by each of the gas mixture components equals the total pressure. For air:

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. This can be likened to a sponge - the warmer the gas, the larger the sponge. *Fig. 1* illustrates the saturation curve of water vapour versus temperature. This shows that as temperature increases, more water is able to be held in the vapour phase. Dew point (t_d) is defined as the temperature to which the gas would need to be cooled in order for condensation to begin. If the gas is cooled further, more water will condense - the temperature and the dew point are the same, and the gas is still saturated.

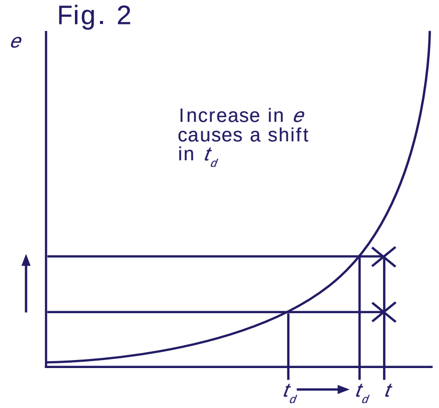
Fig. 1



Why Does Dew Point Change with Pressure?

It is important to know that dew point also changes with pressure. With an increase in total pressure, each partial pressure is also increased: an increase in total pressure causes a shift in dew point. This increase is like squeezing a sponge - air is unable to hold as much water vapour under pressure. In *Fig. 2*, the total pressure is doubled and therefore, the vapour pressure due to water vapour is doubled. The result is that the dew point shifts. In most compressed air systems, where air at atmospheric pressure is compressed to 7 Bar or more, the vapour pressure rises a long way above the saturation curve, and the drain traps are continually running with liquid water as the air cools at the exit of the compressor: it is saturated with water and the temperature and the dewpoint are the same.

Fig. 2



Frost Point and Dew Point

When referring to dew points warmer than the freezing point of water, it is clear that the water is condensing. At temperatures colder than 0 °C, ice will be the condensate. There is a small region just below 0 °C where it is possible for super-cooled water to form, and there is a small difference between the vapour pressure over water, and the vapour pressure over ice, as can be seen by comparing the two °F dew point scales on the conversion scale overleaf. For most applications, the terms dew point and frost point are interchangeable, and it is acceptable to talk in terms of dew point, even though it is really a frost point below 0 °C. The exception to this is the natural gas industry, where the standards have been written around water dew points down as far as -40 °C.

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TECHNICAL BULLETIN 1

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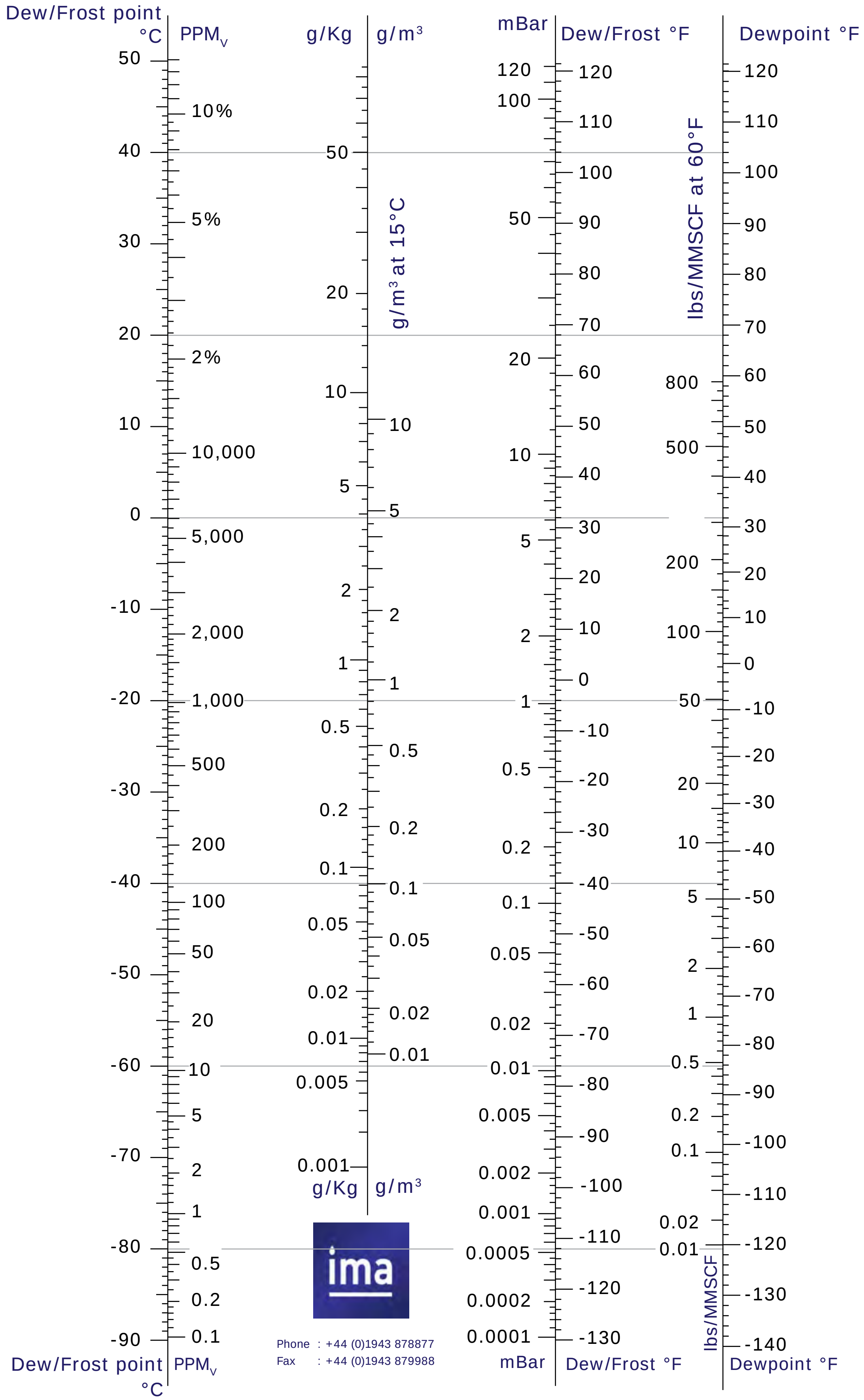
Moisture Conversion Chart

Correct at standard atmospheric pressure



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