



Air-Conditioning & Refrigeration

BSc

Lecture 4

Course weekly Outline &

Ch.1 (Introduction to Air conditioning & Refrigeration)

P. Dr. Maki Haj Zaidan

Tikrit university\ engineering college\ mechanical dept.

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1. PSYCHROMETRIC CHART



Based on a barometric pressure of 101.325 kPa

Sensible/total heat

ratio for water added at 30°C

Specific enthalpy (kJ/kg)

Wet bulb temperature (°C)

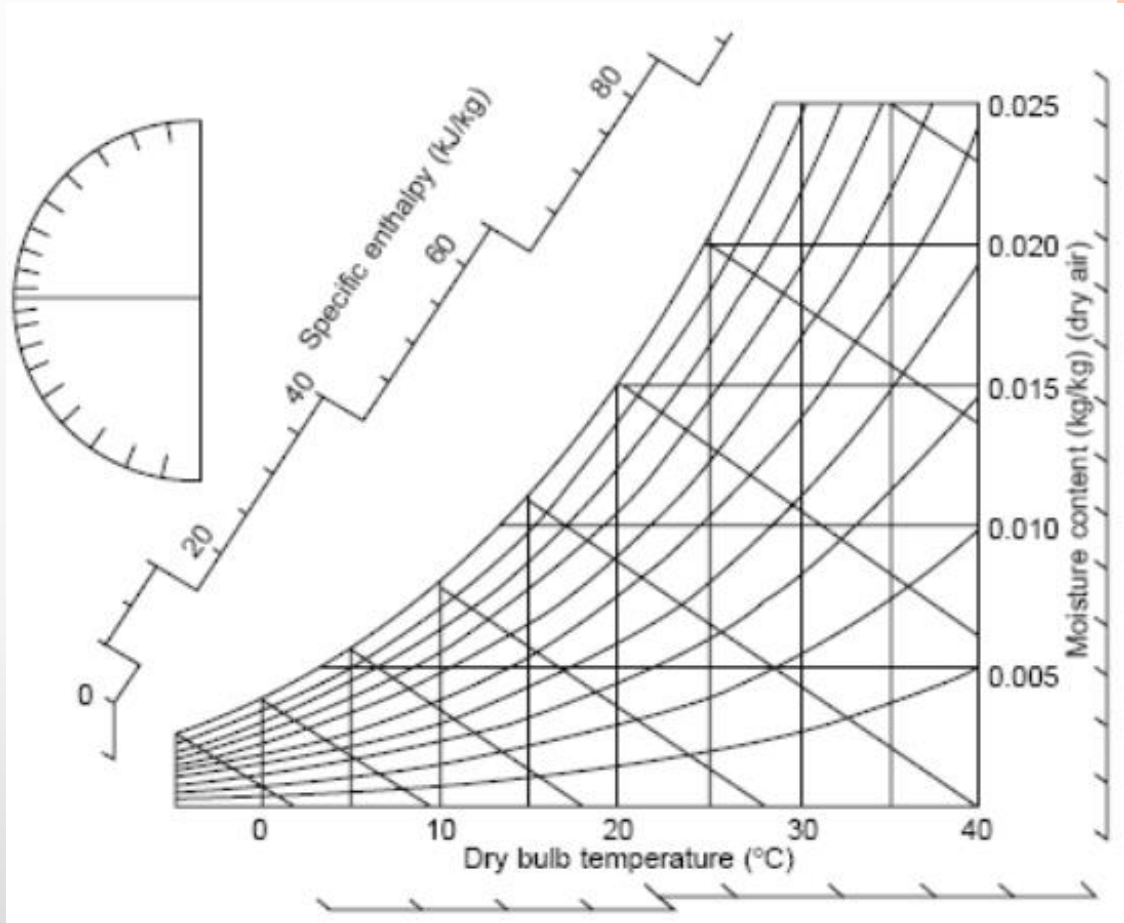
Specific volume (m³/kg)

Percentage saturation

Dry bulb temperature (°C)

Specific enthalpy (kJ/kg) dry air

Moisture content (kg/kg) dry air





The chart which is most commonly used is the g vs. t_d i.e. a chart which has specific humidity or water vapor pressure along the ordinate and the dry bulb temperature along the abscissa. The chart is normally constructed for a standard atmospheric pressure of 101.325 kPa corresponding to the pressure at the mean sea level. A typical layout is shown in the figure. The procedure of drawing various constant properties is now considered.

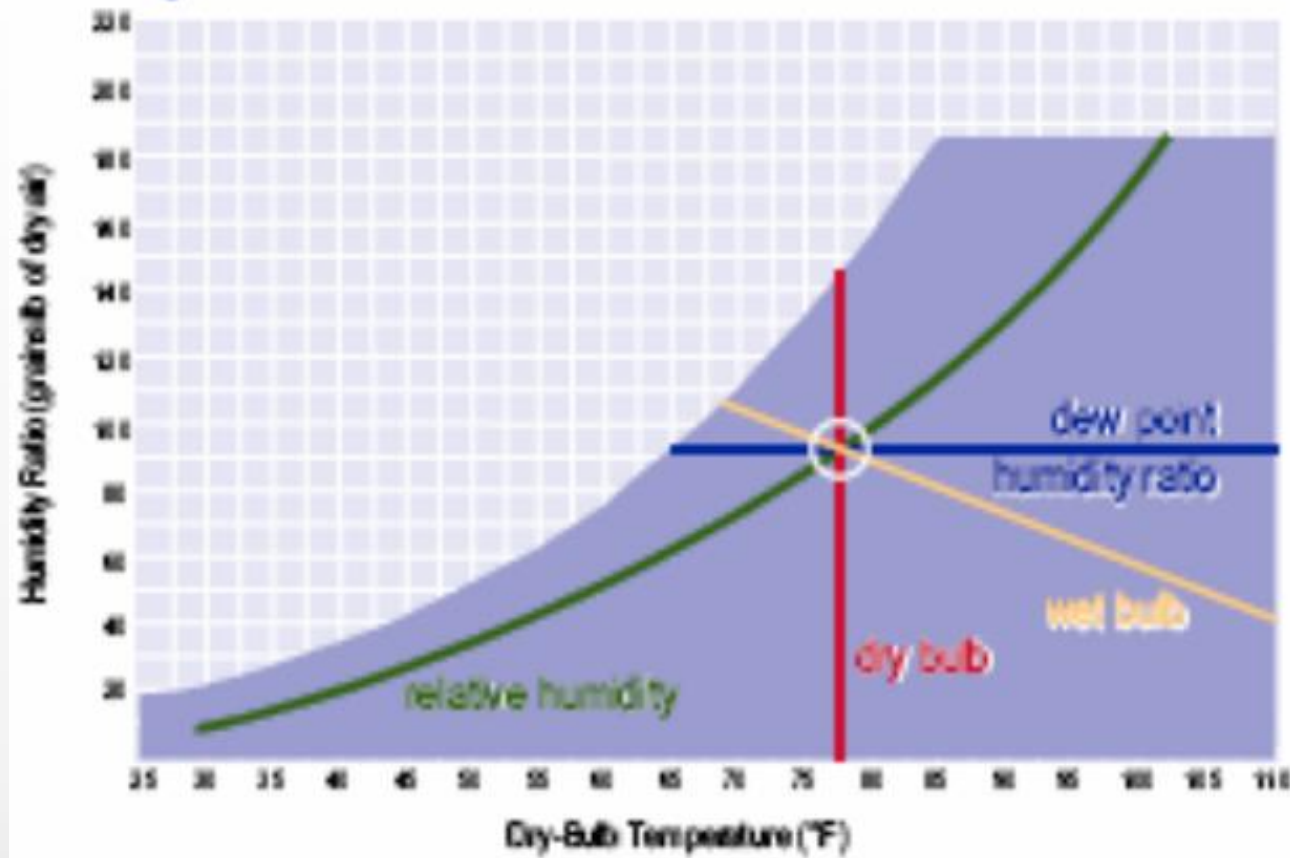
The saturation line represents the states of saturated air at different temperatures. The saturation line on the chart is, therefore, the line of 100% RH since for all points on this line $P_v = P_s = P_{ss}$.

Similarly, one can show the lines of constant thermodynamic Wet bulb temperature, constant specific enthalpy and constant specific volume.

The particular psychrometric chart given in the figure is for normal DBT range of 0 °C to 50 °C and humidity ratios of 0.0 to 0.03 kg/kg_{d.a.}

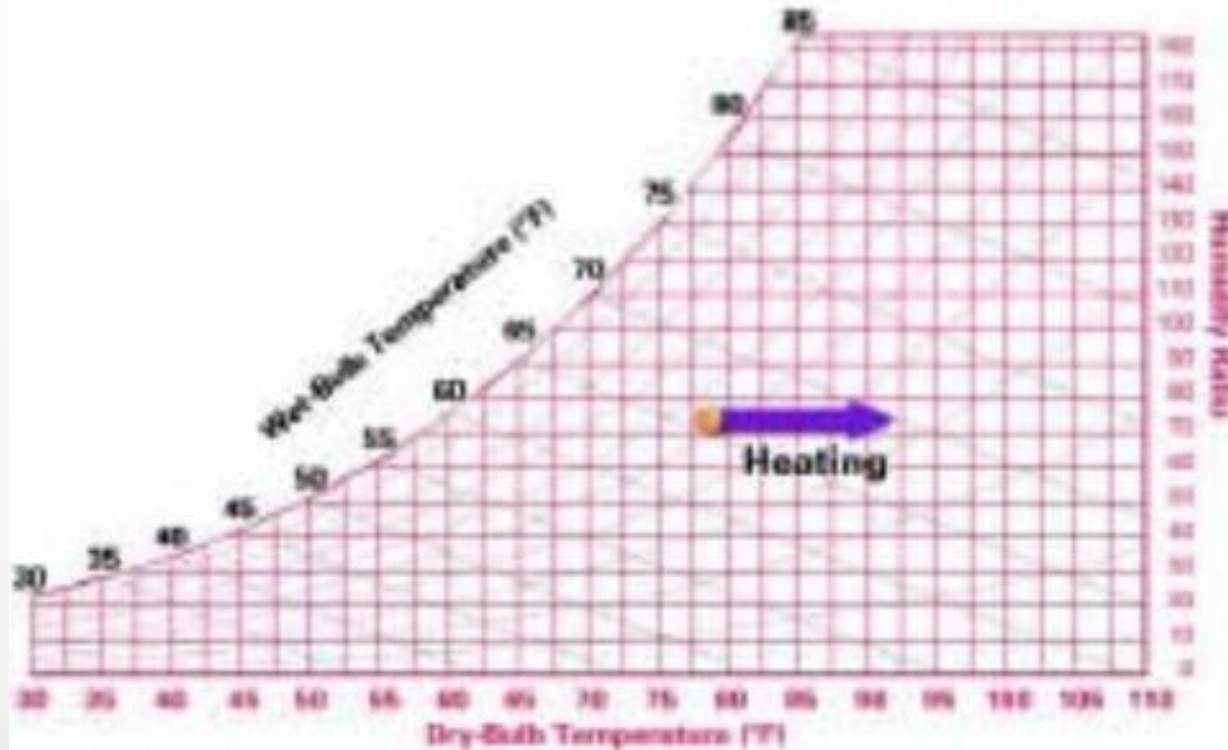
Psychrometric charts for other conditions such as subzero or high temperature can also be prepared.

Properties of Air



The lines of the psychrometric chart represent five physical properties of air: **dry bulb**, **wet bulb**, **dew point**, **humidity ratio**, and **relative humidity**. If any two of these properties are known, the remaining properties can be determined from the chart.

Effect of Adding Sensible Heat

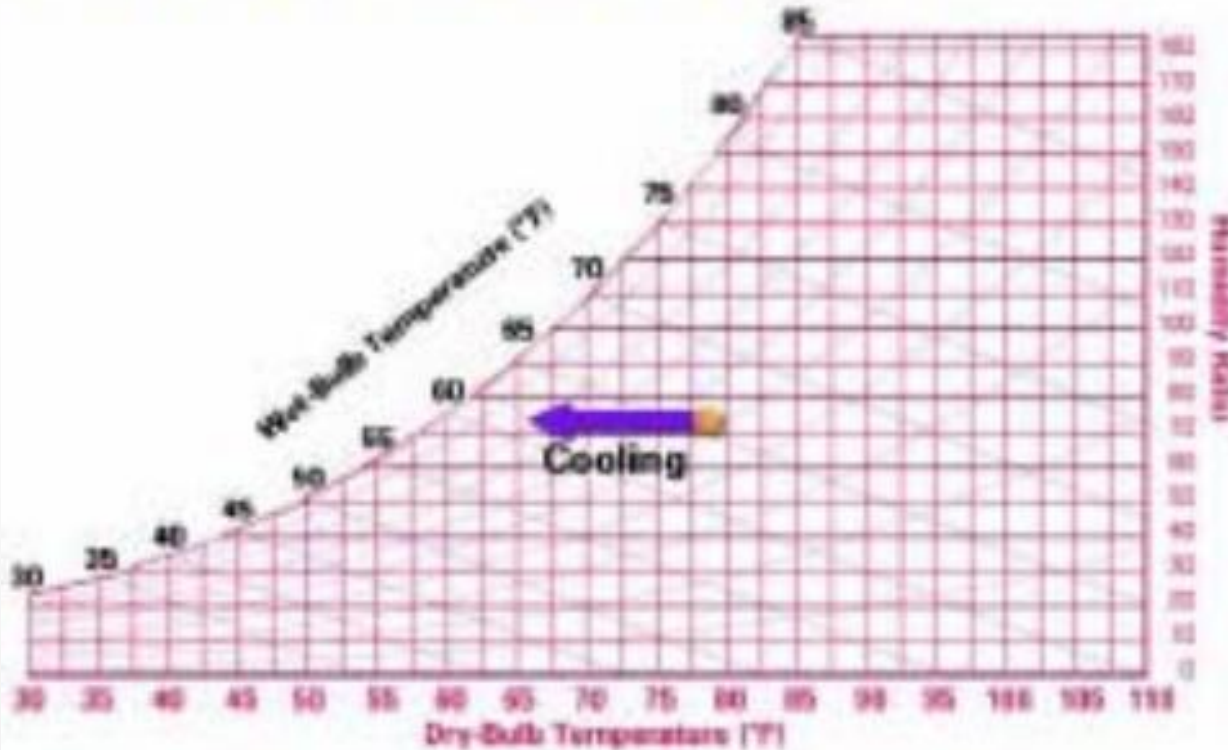


Effect of Sensible Heat and Moisture Changes

When either the sensible heat content or the moisture content of air changes, the point on the psychrometric chart that represents the original air condition moves to a position that represents the new condition of temperature and/or humidity.

For example, if sensible heat is added to air, the air condition moves horizontally to the right.

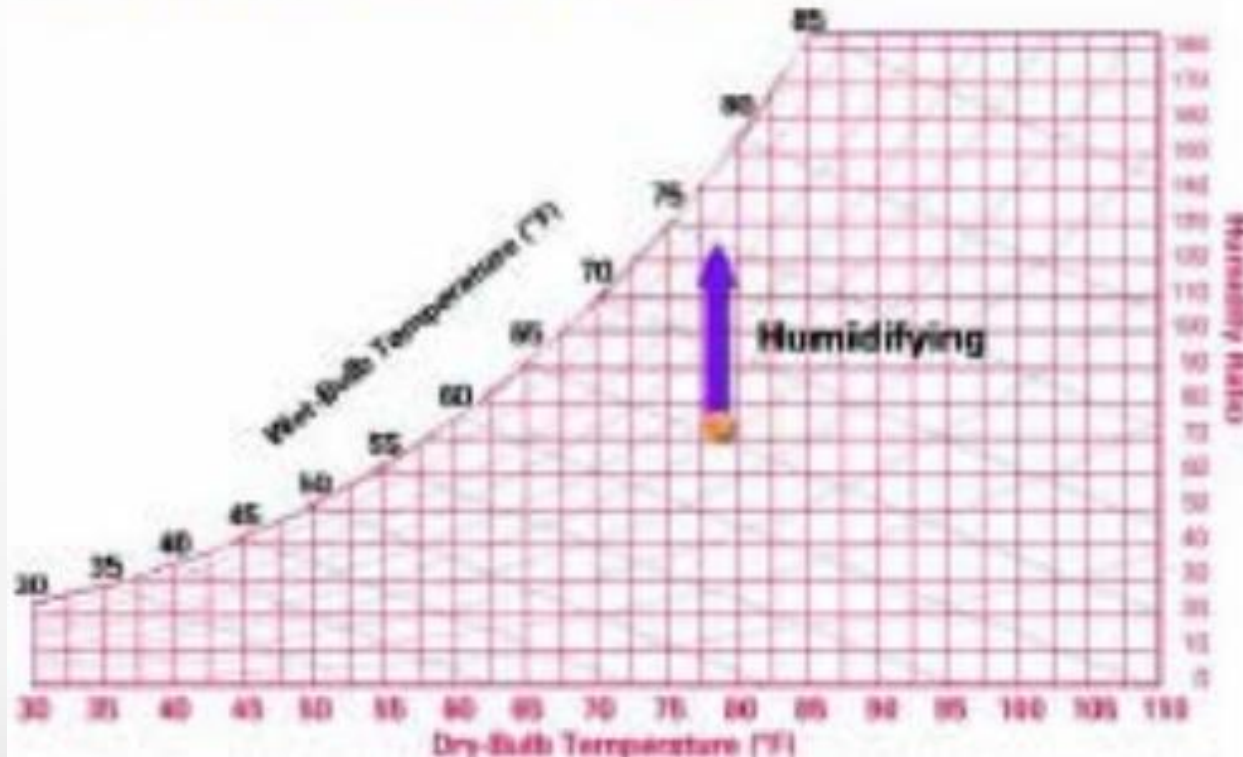
Effect of Removing Sensible Heat



Conversely, if sensible heat is removed from air, the air condition moves horizontally to the left. As long as the moisture content of the air remains unchanged, the humidity ratio remains the same. Therefore, this movement follows the horizontal humidity-ratio lines.

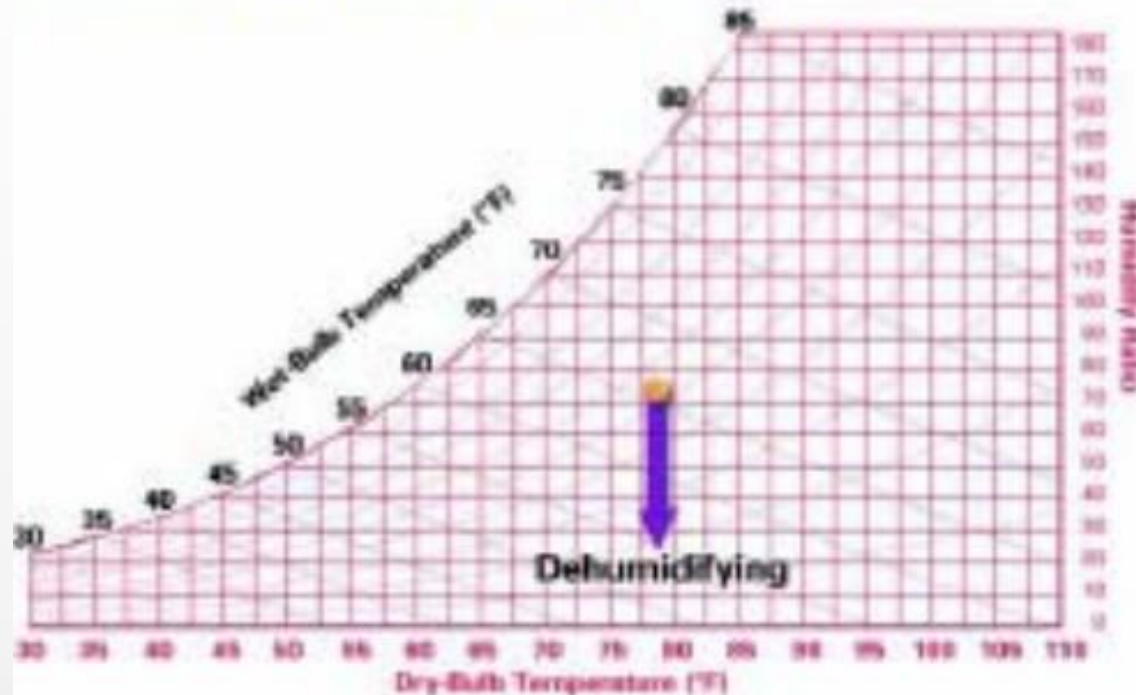
2. Humidification, dehumidification:

Effect of Adding Moisture



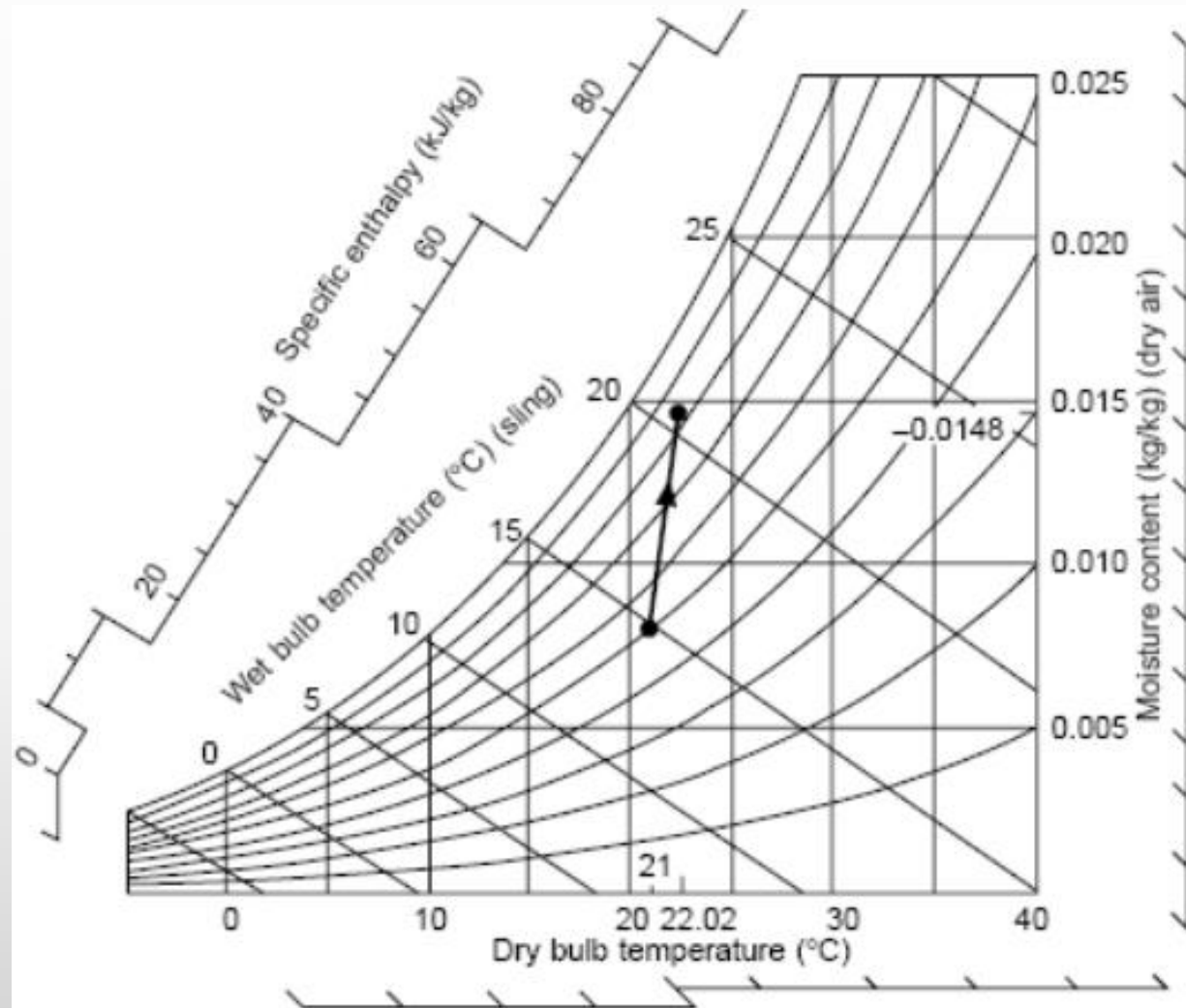
On the other hand, if moisture is added to air without changing the dry-bulb temperature, the air condition moves upward along a dry-bulb temperature line.

Effect of Removing Moisture



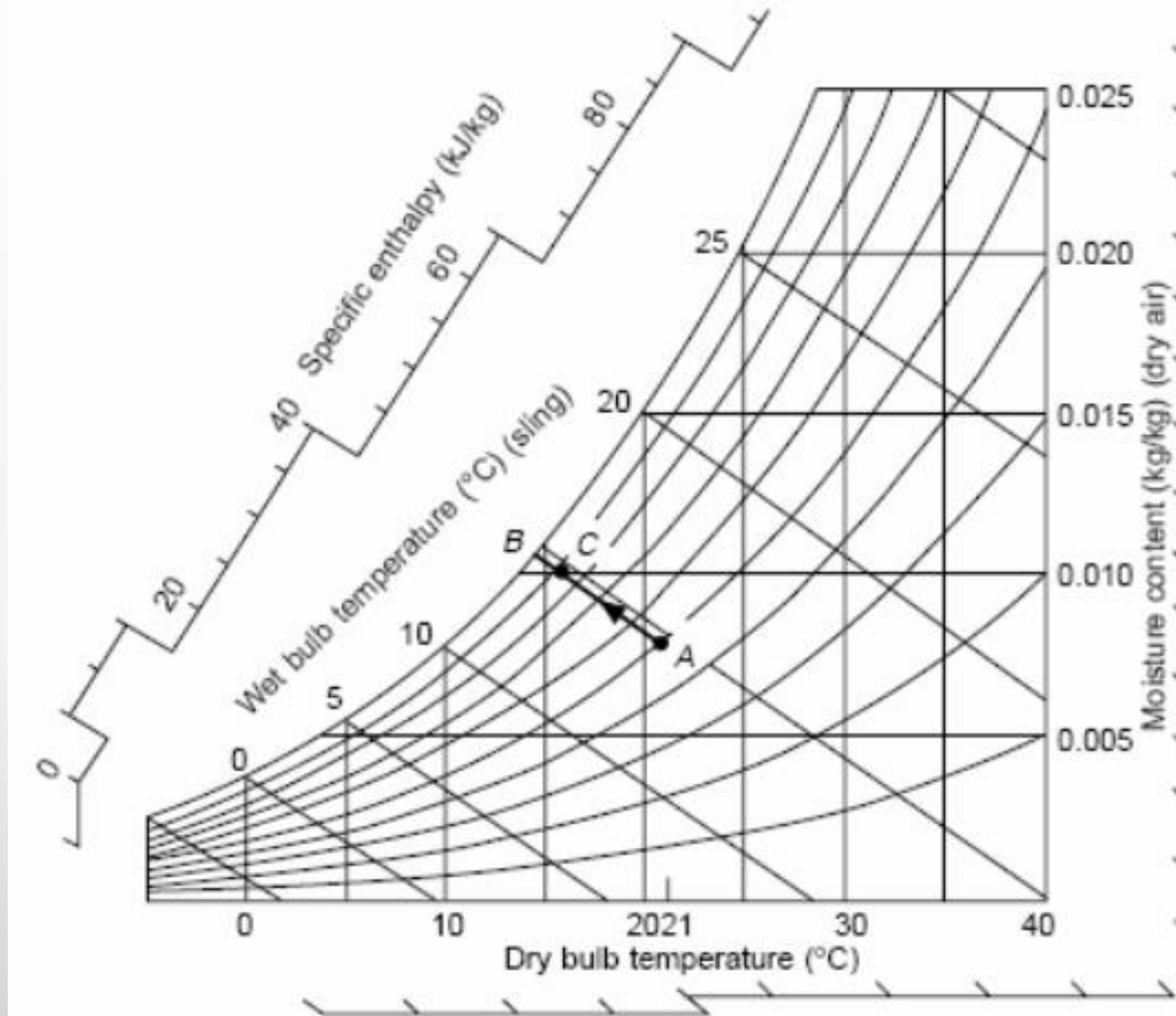
Finally, if moisture is removed from the air without changing its dry-bulb temperature, the air condition moves downward along a dry-bulb temperature line.

4. Heating and humidification:



5. Adiabatic cooling :

The process of adding latent heat and removing sensible heat at constant enthalpy as in the air cooler .



Exercises:

1- Air at a state of DBT = 14 °C, RH= 50% is passed through a heating coil. The DBT is increased up to 42 °C. The moisture content remains constant in this process. Find: a) WBT of the exit air. b) The dew point temperature. c) The sensible heat added by the heating coil for 1.0 kg/s of air.
{Answers a) 19.5 °C, b) 3.9 °C, c) 28.6 kW}

2-Air at condition of DBT = 45 °C, RH= 20 % enter to an air cooler and exit at RH= 60 %. Find: a) DBT of exit air. b) The moisture content (g) at exit. c) plot the psychrometric process. { Answers a- 31.5 °C, b- 5.5 g /kg }

3- Moist air at DBT =30 °C and WBT = 25 °C enter a cooling coil and exit from it at saturation state with DBT = 15 °C. IF the air is supplied to the coil at 3 m³ /s. Find: a) All the properties of air at inlet and outlet. b) The sensible heat that has been removed by the cooling coil. c) A mount of moisture that has been removed from the air by the cooling coil.

{ Answers a- $h_1 = 76$ kJ/kg , $g_1 = 0.081$ (kg/kg)_{dry air} , $v_1 = 0.882$ m³/s , $RH_1 = 66\%$, $T_{dp} = 23.2$ °C , $h_2 = 42$ kJ/kg , $g_2 = 0.0107$ (kg/kg)_{dry air} , $v_2 = 0.831$ m³/s , $RH_2 = 100\%$ b- 115.6 kW c- 0.0248 (kg/kg)_{dry air} }