

Palestine Polytechnic University



College of Engineering & Technology

Mechanical Engineering Department

PROJECT NAME

**Developing psychrometric chart for Palestine main locations
using matlab soft ware computer program**

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According to the project supervisor and according to the agreement of the Testing committee members, this project is submitted to the Department of Mechanical Engineering at college of engineering and technology in partial fulfillment of the requirements of (B.SC) degree.

Supervisor Signature

.....

Examine community Signature

.....

Department Head Signature

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Dedication

I gift this graduation project
To my parents who raised us
To who carry candle of science
To light his avenue
Of live

To all students & who
Wish to look for
The future

To who love the knowledge &
Looking for all is new
In this world

Acknowledgement

My thanks go first to my advisor Eng. Mohammad Awad. His guidance and support made this work possible. His constant encouragement, intuitive wisdom, and resolute Leadership were instrumental in completing this work.

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I also thank everyone helped me and encouraged me.

And finally, my ultimate thanks go to all lecturers, doctors, engineers, and to the great edifice of science, (Palestine Polytechnic University), for their effort and guidance which helped building our characters to become successful engineers.

ABSTRACT

Air conditioning is very important in our life now. It basically depend on the psychrometric processes and psychrometric chart, this project idea is to developing anew psychrometric chart for different metrological location in Palestine instead of the atmospheric psychrometric chart. In this project, a computer soft ware will use to analyzing and calculating the properties of air and plotting the psychrometric chart for different meteorological locations in palestine. These locations are Hebron, Jerusalem, Jericho, and Gaza.

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11. matlab, soft ware computer program

Chapter One

General Introduction

- Project Background.
- Project Scope.
- Project Goals and Objectives.
- Project Implementation Plan.

1.1 Project Background

Human still thinking how to improve his life to be easy so as to be better, this is the reason of spread industry and technology, and life became easier than previous mode.

So HVAC engineers developing the psychrometric chart which is a plot of psychrometric properties of moist air. It's considered as one of the major tool used in air conditioning practice. It reduced the tedious and time consuming computation to simple plotting of moist air process on such a chart and then estimating the desired properties.

Psychrometric chart is a thermodynamic chart. However, it is normally presented at atmospheric pressure only, as most applications are at this pressure. Thus, we need only 2 more properties to determine the thermodynamic state – the pressure is already given. Thus, if we have a psychrometric problem at non-atmospheric pressure, the atmospheric psychrometric cannot be used. Any more, instead one has to use the tedious and time consuming relations for determining the properties for each state of the air.

In this project, a computer soft ware computer program for analyzing and calculating the properties of air and plotting the psychrometric chart for different metrological locations in Palestine will be performed and developed. These locations are Hebron, Jerusalem, Nablus, Jericho, and Gaza.

1.2 Project Scope

The scope of the project is to develop new psychrometric charts for different metrological location in Palestine. This includes the following main topics:

- Analysis of the thermodynamic properties of moist air.
- Studying the psychrometric processes and how it happens.

- Studying different metrological location in Palestine and their barometrical climate and main pressure.
- Discussing and defining the metrology used for the measurements of psychrometric in the metrological locations.
- Develop new psychrometric chart for Palestine different locations simulation using soft ware computer program to plot the charts

1.3 Project Goals and Objectives

The overall aim of the project is to develop a computer program for plotting the psychrometric chart for different pressure locations by the aid of suitable software.

1.3.1 The main objective

- Applying the HVAC engineering principles on the various process components and systems.
- Creating bridges between engineering education and the society.
- Providing the HVAC engineers with suitable psychrometric chart corresponding to each location.
- Studying the psychrometric properties and how are they measured.
- Studying the measuring tools of practical psychrometric properties.
- Learning a new computer program (matlab) that can be used for this purpose.
- Such a project provides the opportunity to apply what have been studied in five years in the engineering collage.
- The availability of obtaining funds from computer soft ware pushing the required project component.
- Put the data collection about Palestine psychrometric properties in the psychrometric building equation.
- Using matlab software program to programming the equations.
- Developing five psychrometric charts for Hebron, Jerusalem , Nablus ,Jericho and Gaza.

Chapter Two

psychrometry

- Introduction.
- Dry and atmospheric air.
- Specific and relative humidity.
- Dew point temperature.
- Adiabatic saturation process.
- Psychrometric chart

2.1 Introduction

If HVAC problems and challenges are to be properly diagnosed and designed, it is essential that the Psychrometric chart and psychometrics, in general be clearly Understood. This course will review the essential elements of psychrometric and the behavior of mixture of air and water vapor under varying conditions, and plotting the state and processes on the psychrometric chart. With this knowledge, one will be able to understand many of the HVAC challenges that are certain to arise, as well as anticipate problems before they Occur and incorporate in his design.

2.2 Dry and atmospheric air

Air is mixture of nitrogen, oxygen, and small amount of some other gases. Air in atmosphere normally contain some water vapor and is referred to as atmospheric air. Air that contains no water vapor is called dry air. The amount of water vapor changes as result of condensation and evaporation from oceans, lakes, rivers, showers, and even the human body. Although the amount of water vapor in the air is small, it plays major role in human comfort . Therefore, it's an important consideration in air-conditioning applications.

The temperature of air in air conditioning aplication range from -10 to about 50 C. In this range, dry air can be treated as an ideal gas with a constant C_p value of 1.005kJ/kg.K, taking 0 C as the reference temperature, we find it convenient to sketch our processes for the water-vapor component on a $T-v$ diagram follow:

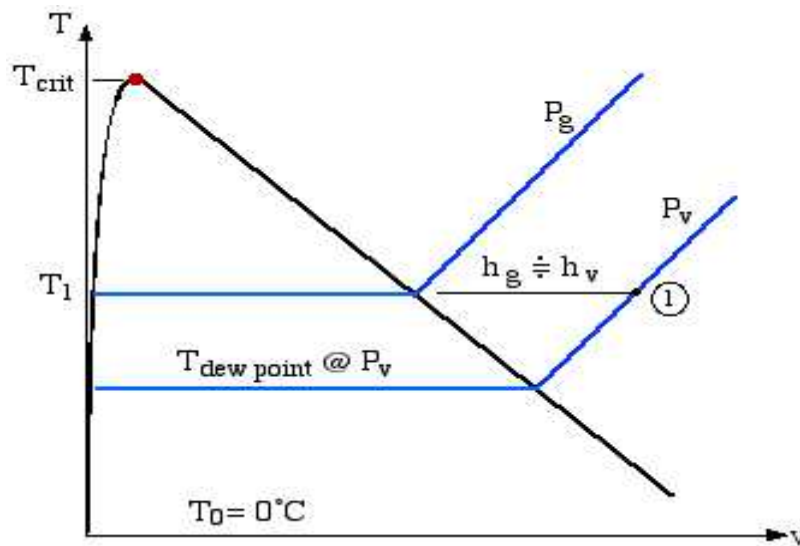


Figure [2.1] T-v diagram for water vapor

Consider the water vapor shown at state (1) on the diagram. We will find it convenient throughout this section to evaluate enthalpy with respect to $T_0 = 0^\circ\text{C}$, since ultimately we only consider differences in enthalpy. From the above diagram:

$$h_{\text{dry air}} = C_p T = (1.005 \text{ kJ/kg} \cdot \text{C}) * T \quad (2.1)$$

$$h_{\text{dry air}} = C_p \Delta T = (1.005 \text{ kJ/kg} \cdot \text{C}) * \Delta T \quad (2.2)$$

Where T is the temperature in $^\circ\text{C}$ and ΔT is the change in temperature. In air-Conditioning processes we are concerned with the change in enthalpy h , which is independent of the reference point selected. Water vapor in air behaves as if it exists alone and obeys the ideal gas relation $PV=RT$

An ideal gas is defined as a gas whose molecules are spaced far apart so that the behavior of a molecule is not influenced by the presence of other molecules—a situation encountered at low densities. When two or more ideal gases are mixed, the behavior of a molecule normally is not influenced by the presence of other similar or dissimilar molecules, and therefore a non reacting mixture of ideal gases also behaves as an ideal gas. Air, for example, is conveniently treated as an ideal gas in the range where nitrogen and oxygen behave as ideal gases. When a gas mixture consists of real (nonideal) gases, however, the prediction of the P-v-T

Behavior of the mixture becomes rather involved. The prediction of the P-v-T behavior of gas mixtures is usually based on two models: Dalton's law of additive pressures and Amagat's law of additive volumes. Both models are described and discussed below.

Dalton's law of additive pressures: The pressure of a gas mixture is equal to the sum of the pressures each gas would exert if it existed alone at the mixture temperature and volume

Amagat's law of additive volumes: The volume of a gas mixture is equal to the sum of the volumes each gas would occupy if it existed alone at the mixture temperature and pressure.

Then the atmospheric air can be treated as an ideal gas mixture whose pressure is the Sum of the partial pressure of dry air P_a and that of water vapor P_v .

$$P = P_a + P_v \text{ (Kpa)} \quad (2.3)$$

Since water vapor is an ideal gas, the enthalpy of water vapor is function of temperature only, that is, $h = h(T)$. This can also be observed from T-s diagram of Water T-s diagram where the constant enthalpy lines coincide with constant temperature lines at temperature below 50 C. therefore, the enthalpy of water vapor In air can be taken to be equal to the enthalpy of saturated vapor at the same Temperature. That is,

$$h_v(T, \text{low}P) = h_g(T) \quad (2.4)$$

The enthalpy of water vapor at 0 C is 2500.9 kJ / kg . the average C_p value of water vapor in the temperature range -10 to 50 C can be 1.82 kJ / kg . C then the enthalpy of water vapor is.

$$h_g(T) = 2500.9 + 1.82T \text{ (kJ/kg)} \quad T \text{ in } C \quad (2.5)$$

2.3 Specific and relative humidity of air

The amount of water vapor in the air can be specified in various ways probably the most logical way is to specify directly the mass of water vapor present in the unit of mass of dry air. This is called specific humidity and denoted by ω .

$$\omega = 0.622 \left(\frac{P_v}{P_a} \right) = 0.622 \left(\frac{\phi \cdot P_g}{P_a} \right) = 0.622 \left(\frac{\phi \cdot P_g}{P - \phi \cdot P_g} \right) \quad (2.6)$$

Note that other terms in common usage are *humidity ratio* or *absolute humidity* to denote specific humidity. The specific humidity can be conveniently determined in terms of the partial pressures P_a and P_v as follows:

$$\omega = \left(\frac{\dot{m}_v}{\dot{m}_a} \right) = \left(\frac{m_v}{m_a} \right) = \left(\frac{P_v V / (R_v T)}{P_a V / (R_a T)} \right) = \left(\frac{P_v / (0.4615 [\text{kJ/kg.K}])}{P_a / (0.287 [\text{kJ/kg.K}])} \right)$$

$$\omega = 0.622 \left(\frac{P_v}{P_a} \right) = 0.622 \left(\frac{P_v}{P - P_v} \right) \left[\frac{\text{kg vapor}}{\text{kg dry air}} \right] \quad (2.7)$$

the '*relative humidity*'s: is the ratio of the mole fraction of water vapors in a given sample of moist air to the mole fraction of water vapors in air saturated at the same temperature and pressure. It is also the ratio of the partial pressure of water vapor to the partial pressure of water vapor in air saturated at the same

temperature and pressure. The relative humidity is the colloquial way of expressing moisture content.

$$\text{Relative humidity} \Rightarrow \phi = \left(\frac{m_v}{m_g} \right) = \left(\frac{P_v \cdot V / (R_v \cdot T)}{P_g \cdot V / (R_v \cdot T)} \right) = \frac{P_v}{P_g} \text{ at temperature } T \quad (2.8)$$

Furthermore, we can determine the specific humidity in terms of the Relative humidity, and vice versa, as follow.

$$\omega = 0.622 \left(\frac{P_v}{P_a} \right) = 0.622 \left(\frac{\phi \cdot P_g}{P_a} \right) = 0.622 \left(\frac{\phi \cdot P_g}{P - \phi \cdot P_g} \right) \quad (2.9)$$

$$\phi = \left(\frac{\omega \cdot P_a}{0.622 P_g} \right) = \left(\frac{\omega \cdot P}{(0.622 + \omega) P_g} \right) \quad (2.10)$$

The relative humidity range from 0 for dry air to one for saturated air. Note that the Amount of moist air can hold depend on its temperature .

2.4 Dew point temperature

The **dew-point temperature** T_{dp} is defined as *the temperature at which condensation begins when the air is cooled at constant pressure*. In other words, T_{dp} is the saturation temperature of water corresponding to the vapor pressure:

$$T_{dp} = T_{sat}@p_v \quad (2.11)$$

As the air cools at constant pressure, the vapor pressure P_v remains constant. Therefore, the vapor in the air undergoes a constant-pressure cooling process until it

strikes the saturated vapor line. The temperature at this point is T_{dp} , and if the temperature drops any further, some vapor condenses out. As a result, the amount of vapor in the air decreases, which results in a decrease in P_v . The air remains saturated during the condensation process and thus follows a path of 100 percent relative humidity (the saturated vapor line). The ordinary temperature and the dew-point temperature of saturated air are identical. You have probably noticed that when you buy a cold canned drink from a vending machine on a hot and humid day, dew forms on the can. The formation of dew on the can indicates that the temperature of the drink is below the dew-point temperature of the surrounding air. The dew-point temperature of room air can be determined easily by cooling some water in a metal cup by adding small amounts of ice and stirring. The temperature of the outer surface of the cup when dew starts to form on

2.5 The Adiabatic Saturation Process

There is *no* direct method of measuring specific humidity ω or relative humidity ϕ thus in this section we develop the Adiabatic Saturation Process leading to the practical Wet & Dry Bulb Thermometer, or Sling Psychrometer. Consider the channel below in which air of unknown humidity enters at station (1) and after absorbing moisture from the liquid pool, exits at 100% relative humidity at station (2). This process is shown on the $T-v$ diagram below.

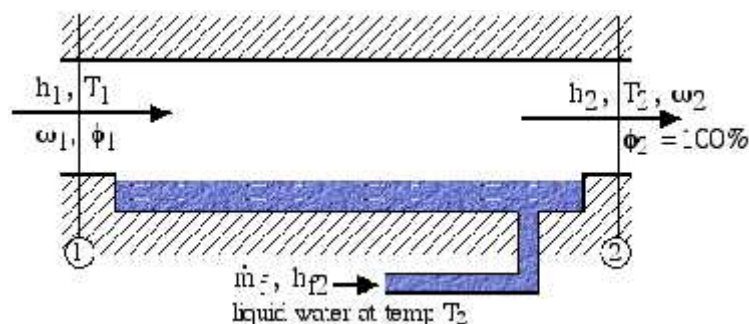


Figure [2.2] adiabatic mixing

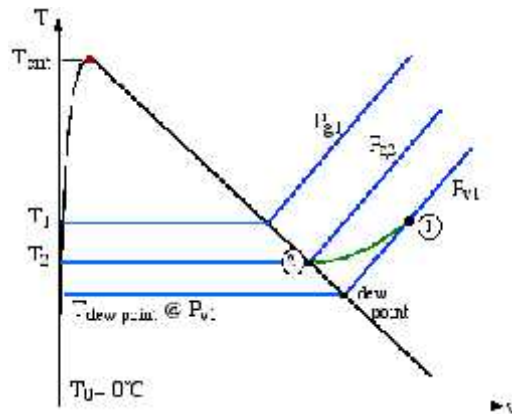


Figure [2.3] T - v diagram for adiabatic process

the adiabatic saturation process described above can be analyzed as a steady-flow process. The process involves no heat or work interactions, and the kinetic and potential energy changes can be neglected. Then the conservation of mass and conservation of energy relations for this two inlet, One-exit steady-flow system reduces to the following:

mass flow:

$$\begin{aligned} \dot{m}_{v1} + \dot{m}_f &= \dot{m}_{v2} \quad \dot{m}_a \text{ (dry air)} \\ \dot{m}_a \omega_1 + \dot{m}_f &= \dot{m}_a \omega_2 \Rightarrow \dot{m}_f = \dot{m}_a (\omega_2 - \omega_1) \end{aligned} \quad (2.12)$$

energy:

$$\begin{aligned} \dot{m}_a h_1 + \dot{m}_f h_{f2} &= \dot{m}_a h_2 \\ \dot{m}_a h_1 + \dot{m}_a (\omega_2 - \omega_1) h_{f2} &= \dot{m}_a h_2 \\ \Rightarrow h_1 + (\omega_2 - \omega_1) h_{f2} &= h_2 \\ h_1 = C_p T_1 + \omega_1 h_{g1}, \quad h_2 = C_p T_2 + \omega_2 h_{g2} \\ \omega_1 (h_{g1} - h_{f2}) &= C_p (T_2 - T_1) + \omega_2 (h_{g2} - h_{f2}) \\ \omega_1 = \frac{C_p (T_2 - T_1) + \omega_2 h_{fg2}}{(h_{g1} - h_{f2})} &\leftarrow \text{how to determine } T_2? \omega_2? \end{aligned} \quad (2.13)$$

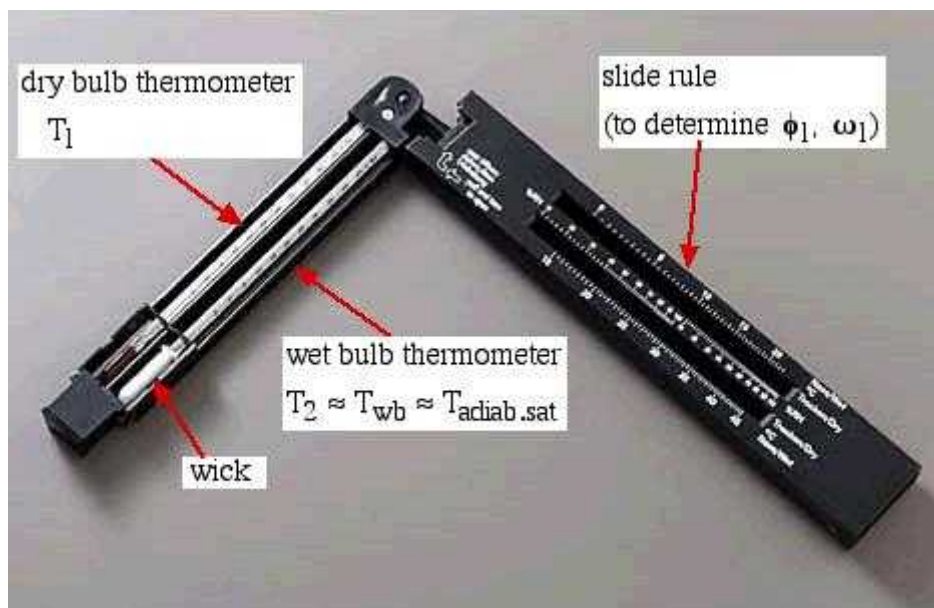
Referring to the T - v diagram above, since $\phi=100\%$, $P_{v2}=P_{g2}$, thus:

$$\omega_2 = 0.622 \left(\frac{P_{g2 @ T_2}}{P_2 - P_{g2 @ T_2}} \right)$$

$$P_2 \approx P_1 \approx P$$

(2.14)

In order to determine T_2 and T_1 we use a *wet & dry bulb thermometer* (or *sling psychrometer*), typically as in the following figure. The wet bulb is wrapped in a cotton wick saturated with water, and one swings the thermometer in the air until a steady temperature is attained. The wet bulb temperature T_{wb} is then very closely equal to the adiabatic saturation temperature T_2 .



Figure[2.4] *sling* psychrometer

2.6 Psychrometric Chart and Air Characteristics

A psychrometric chart presents physical and thermal properties of moist air in a graphical form. It can be very helpful in troubleshooting greenhouse or livestock building environmental problems and in determining solutions. Understanding psychrometric charts helps visualization of environmental control concepts such as

why heated air can hold more moisture, and conversely, how allowing moist air to cool will result in condensation. The objective of this fact sheet is to explain characteristics of moist air and how they are used in a psychrometric chart.

A psychrometric chart contains a lot of information packed into an odd-shaped graph. If we dissect the components piece by piece, the usefulness of the chart will be clearer. Boundaries of the psychrometric chart are a dry-bulb temperature scale on the horizontal axis, a humidity ratio (moisture content) scale on the vertical axis, and an upper curved boundary which represents saturated air or 100 percent moisture holding capacity. The chart shows other important moist air properties as: wet-bulb temperature; enthalpy; dewpoint or saturation temperature; relative humidity; and specific volume. For explanation of these terms. Moist air can be described by finding the intersection of any two of these properties and from that point all the other properties can be read. The key is to determine which set of lines on the chart represent the air property of interest. Some practice with examples will help.

An understanding of the shape and use of the psychrometric chart will help in diagnosing air temperature and humidity problems. Note that cooler air (located along lower, left region of chart) will not hold as much moisture (as seen on the y-axis' humidity ratio) as warm air (located along right side of chart). A rule of thumb, inside typical greenhouses or animal buildings during winter conditions, is that a 10°F rise in air temperature can decrease relative humidity 20 percent. Use of a psychrometric chart will show that this is roughly true. For example, to decrease relative humidity in a winter greenhouse during a critical time period, we could heat the air.

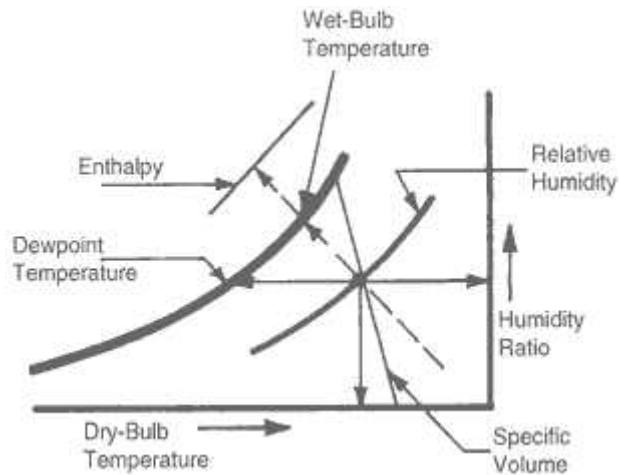


Figure [2.5] Properties of moist air on a psychrometric chart. Wet-bulb temperature and enthalpy use the same chart line but values are read off separate scales.

2.6. 1 Psychrometrics processes

Just as we have several commonly used processes in the thermodynamics of pure substances (isobars, isotherms, isochores), there are several common processes for air+water vapor mixtures.

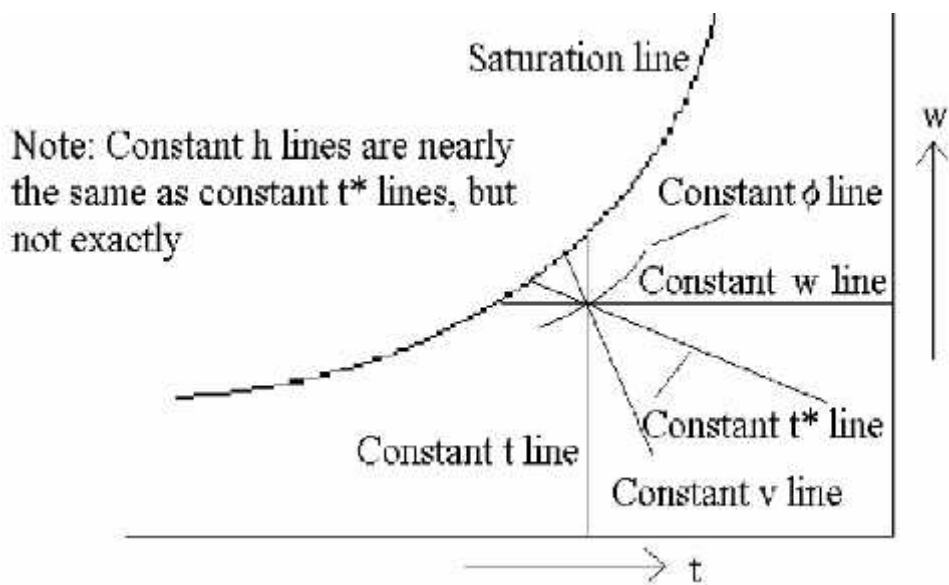


Figure [2.6] constant lines in psychrometric chart

2.6.1.1 Heating or cooling of moist air

The addition or removal of heat, without any change in the moisture content (i.e. the humidity ratio), must result in a change of the dry bulb temperature (DBT). The state will move horizontally left (cooling) or right (heating):

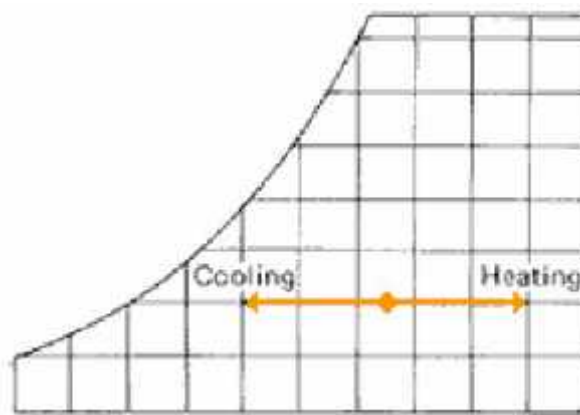


Figure [2.7] heating and cooling process

The amount of heat transferred to/from the mixture is of course governed by the

$$q = m_a (h_2 - h_1) \quad (2.15)$$

Where it is noted that since the enthalpies are per unit mass of the dry air in the mixture, this enthalpy difference is multiplied by the mass of air to obtain the heat transfer. if, as a result of the cooling, the left moving point reaches the saturation line, some condensation will start:

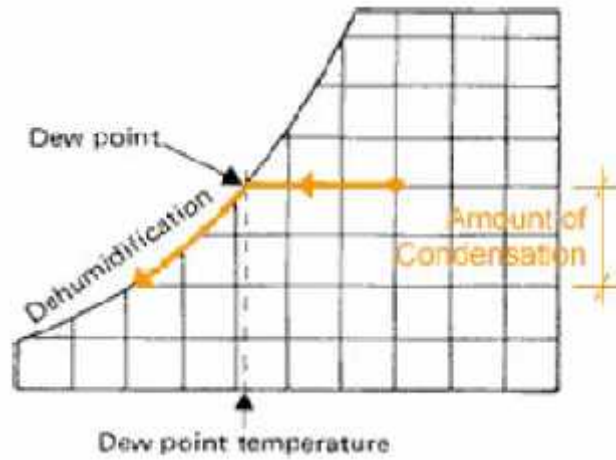


Figure [2.8] dehumidification

The DBT that corresponds to this point is referred to as the ‘dew point temperature’ of the original mixture, as this is the first point at which liquid water (i.e. dew, fog or mist) forms. If there is further cooling, the state point moves along the saturation line and further condensation will occur.

application of the first law to this process yields

$$q = m_a (h_2 - h_1) + m_w h_w \quad (2.16)$$

where m_w and h_w are the mass and enthalpy of the liquid water present at the end of the process (this water separates out from the *vapor* mixture as condensate, and so is not represented on the chart, but *must* be considered in the any mass or energy balance). The initial and final moisture contents during this process are w_1 and w_2 respectively. Since the water must be conserved,

$$m_a w_1 = m_a w_2 + m_w$$

$$m_w = m_a (w_1 - w_2)$$

$$q = m_a [(h_2 - h_1) - (w_2 - w_1) h_w] \quad (2.17)$$

This cooling process can therefore also reasonably be called ‘*dehumidification by cooling*’ since the absolute humidity (i.e. the humidity ratio) decreases.

2.6.1.2 Adiabatic humidification (or evaporative cooling)

If water is evaporated into the air-water vapor mixture without any heat addition or removal (i.e. adiabatically), the heat required to evaporate the water is taken from the vapor mixture. The DBT is therefore reduced whilst the state point moves along a line of constant wet bulb temperature (WBT).

consider a stream of air-water vapor mixture into which a water spray evaporates.

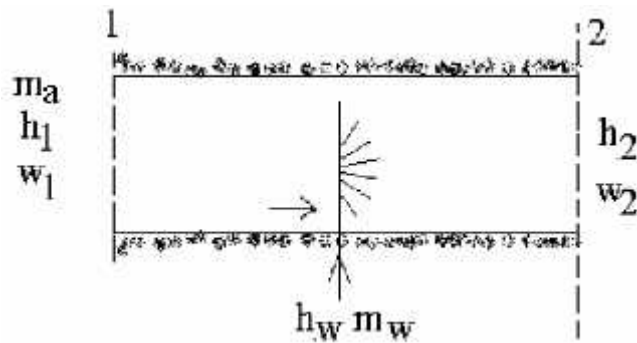


Figure [2.9] adiabatic humidification

$$m_a (h_2 - h_1) = m_w h_w = 0 \quad (2.18)$$

once again, since the mass of water is conserved,

$$m_a w_1 + m_w = m_a w_2$$

$$m_w = m_a (w_2 - w_1) \quad (2.19)$$

and thus

$$h_w = \frac{h_2 - h_1}{w_2 - w_1}$$

if the air-water vapor mixture is passed through a chemical sorbent material (e.g. a silica gel), some of the moisture is removed and the latent heat of evaporation is released. Thus, the DBT increases along a line of constant WBT if this process is adiabatic.

2.6.1.3 Adiabatic mixing of two vapor streams

- consider the mixing of two air streams,

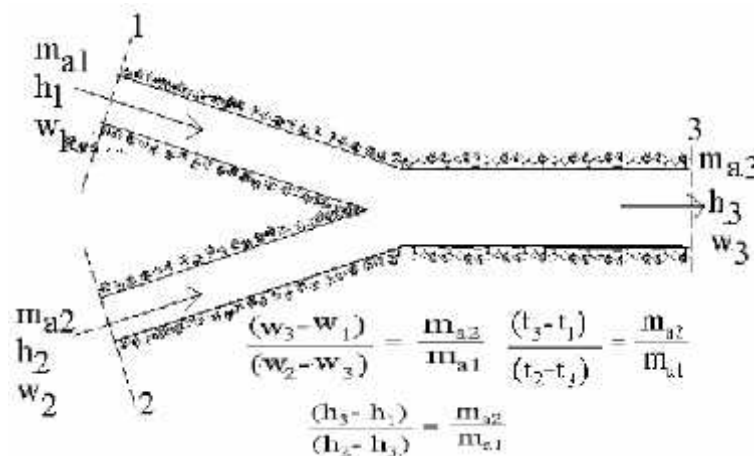


Figure [2.10] adiabatic mixing

$$m_{a3}h_3 - m_{a1}h_1 - m_{a2}h_2 = 0 \quad (2.21)$$

conservation of air

$$m_{a3} = m_{a1} + m_{a2} \quad (2.22)$$

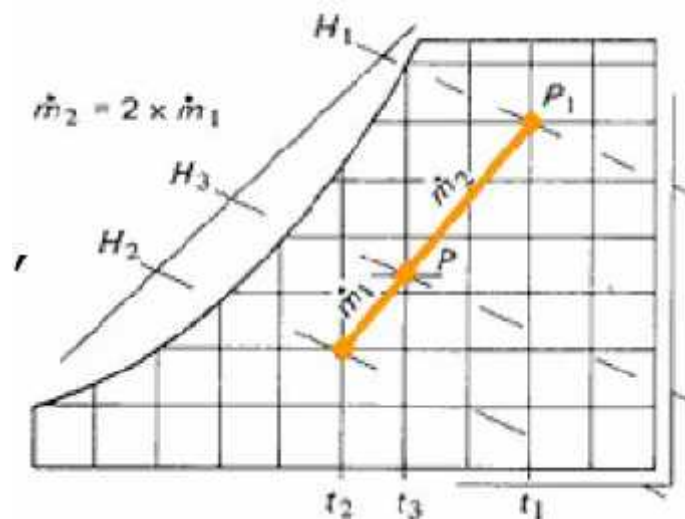
conservation of water

$$m_{a3}W_3 = m_{a1}W_1 + m_{a2}W_2 \quad (2.23)$$

combining (8.11) and (8.12) with (8.10) to eliminate

$$H_3 = \frac{m_1 h_1 + m_2 h_2}{(m_1 + m_2)} \quad (2.24)$$

thus, the process is as follows on the psychrometric chart,

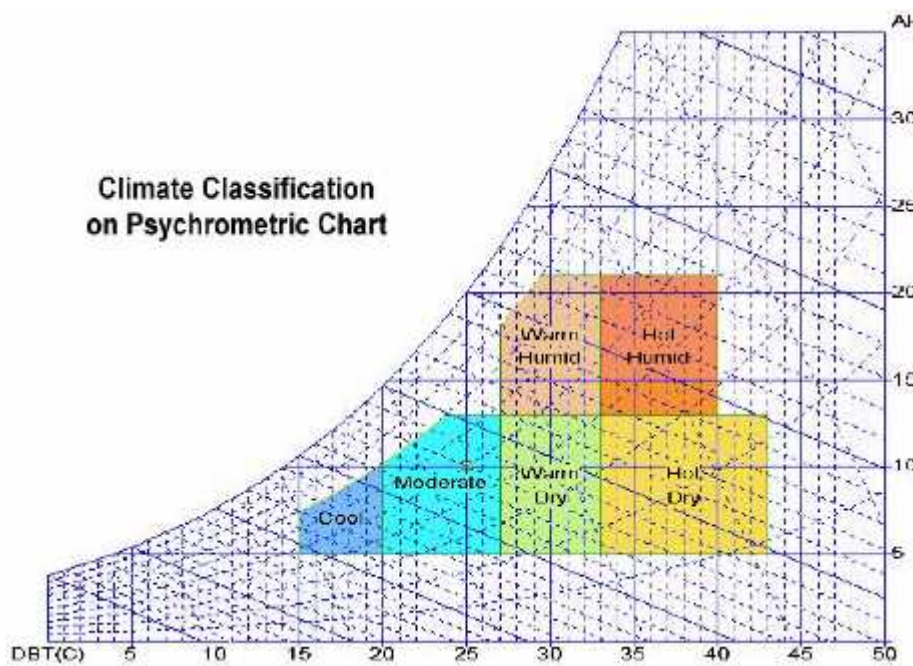


Figure[2.11]adiabatic mixing process

2.6.1.4 Air conditioning

in terms of the psychrometric chart, our perception of 'comfort' is roughly as

Follows:



Figure[2.12] climate classifications on psychrometric chart

'air conditioning' is the generic term given to use of psychrometric processes that move the state of the air-water vapor mixture to an intended place on the chart. This is usually to 'cool' or 'moderate' conditions, and may involve both heating and cooling the mixture. a simple arrangement of a summer air conditioning cycle,

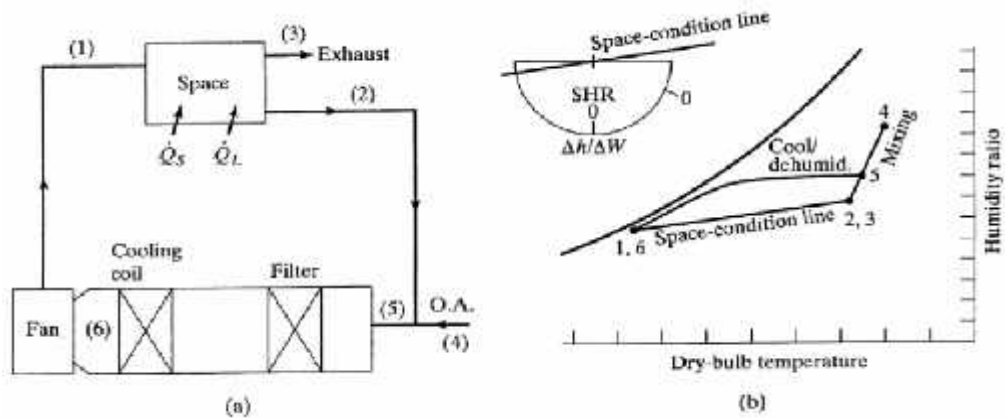
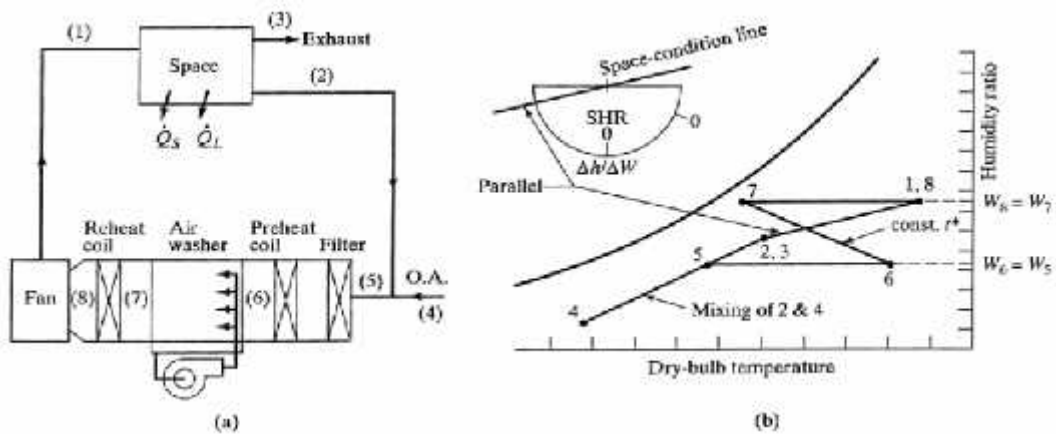


Figure [2.13] summer air conditioning cycle

a simple arrangement of a winter air conditioning cycle,



Figure[2.14] winter air conditioning cycle

Cooling towers

Cooling towers are a very important part of almost all power plants. Their operation is in principle very simple. They cool the cooling water by evaporating some of it into a passing stream of moist air. Considering a spray of cooling water

Droplets in the tower,

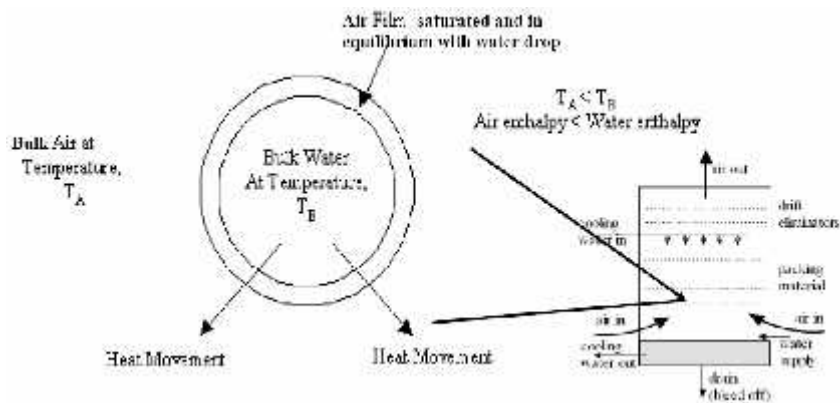


Figure [2.15] cooling tower

cooling towers are closely adiabatic devices, with the vapor phase represented as follows on the psychrometric chart for the ideal process,

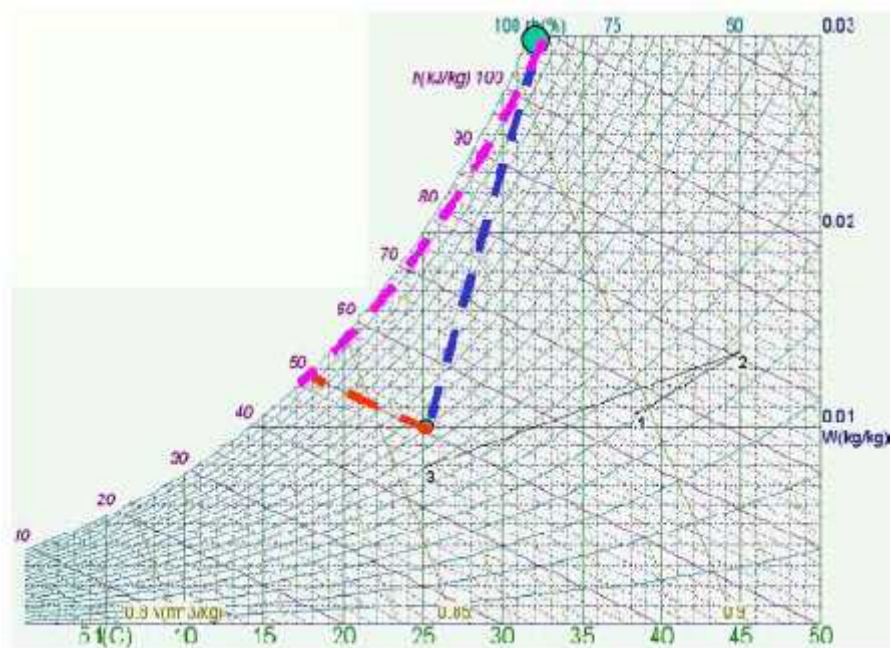


Figure [2.16] cooling tower processes in psychrometric chart

here the red and pink lines represent the paths taken by the vapour as it cools and then as the cooling water evaporates. a typical cooling water circulation system:

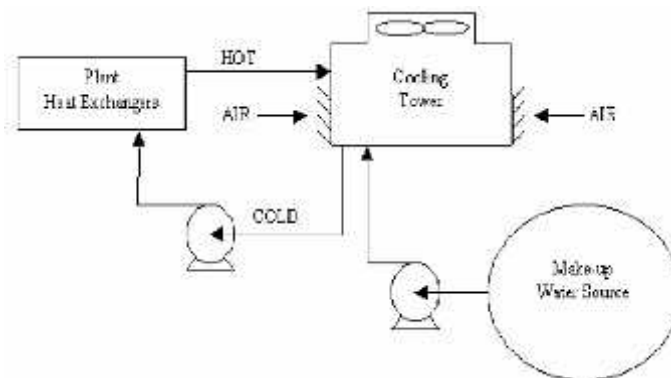


Figure [2.17] typical cooling water circulation system

hot water from the heat exchangers is sent to the cooling tower. The water (minus that evaporated) is sent back to the heat exchangers for further cooling. Make-up water is used to replenish water lost to evaporation. There are essentially 2 types of cooling tower designs:

Natural draft cooling towers

As the name suggests, natural draft cooling towers exploit natural (or free) convection to move air through the cooling water. These types of towers are typically very large (~150m high and ~100m base diameter) and are generally used with high water flow rates (~10-20 m³/s)

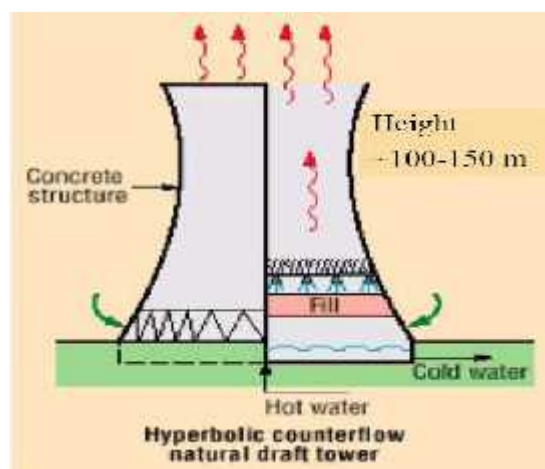


Figure 2.18 Natural draft cooling towers

often these are used in coal fired power stations. When you see a vapor plume coming from the top, it is of course not smoke, and means that the tower is performing as intended!

Mechanical draft cooling towers

Mechanical draft cooling towers are used for low and moderate water flow rates, especially in central air conditioning and refrigeration plants. Fans force air through the circulated water. There are many configurations of mechanical draft cooling towers, for example,

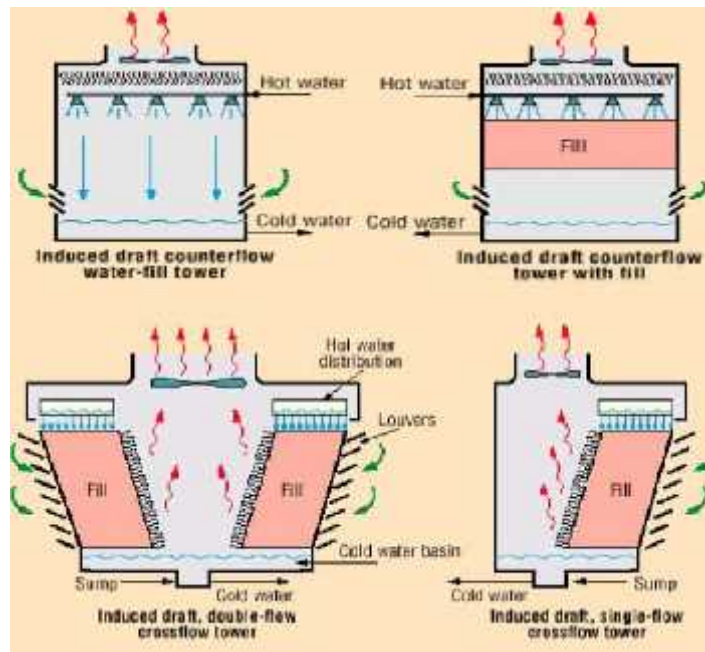


Figure [2.19] Mechanical draft cooling tower

Chapter three

Data collection and psychrometric chart for Palestine main locations

- Palestine main metrological locations.
- Palestine main locations psychrometric chart.

3.1 Palestine metrological locations.

Studying the psychometrics properties for Palestine different metrological location need information's about the metrological and climate properties. Each metrology department in Palestine collects information about its location metrology and climate. The project need five location to cover all Palestine different climate these location distributed in five metrological different locations these location are Hebron, Jerusalem, Nablus, Jericho, and Gaza. So collecting statistical psychrometric and climates data about these from the metrology department in Hebron. The information's need in this project was taken from Hebron meteorology department. The information's given as the follow:

- 1) Hebron located in the south of Palestine, its psychrometric properties as in the following table:

Table 3.1 Hebron Monthly climate average

Element	Jan	Feb.	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean max temp ()	10.2	11.5	14.6	19.6	23.6	25.9	27.2	27.2	26	23.2	17.5	12.1
Mean min temp ()	4	4.7	6.5	9.9	13.2	15.8	17	17	15.9	14	9.9	5.6
Absolute max temp ()	21.4	21	23.6	32.6	34	33.5	38	33.4	34.6	31.6	31.6	22
Absolute min temp ()	-1	-3	-0.5	1	6.5	10	13	12	12	9	2	-0.4
Mean temp ()	7.1	8.1	10.5	14.7	18.4	20.8	22.1	22.1	20.9	18.6	13.7	8.8
Pressure (mbar)	903	902	901	901	901	900	899	899	902	903	904	904
Mean RH%	74	72	66	55	48	51	57	60	62	59	64	73

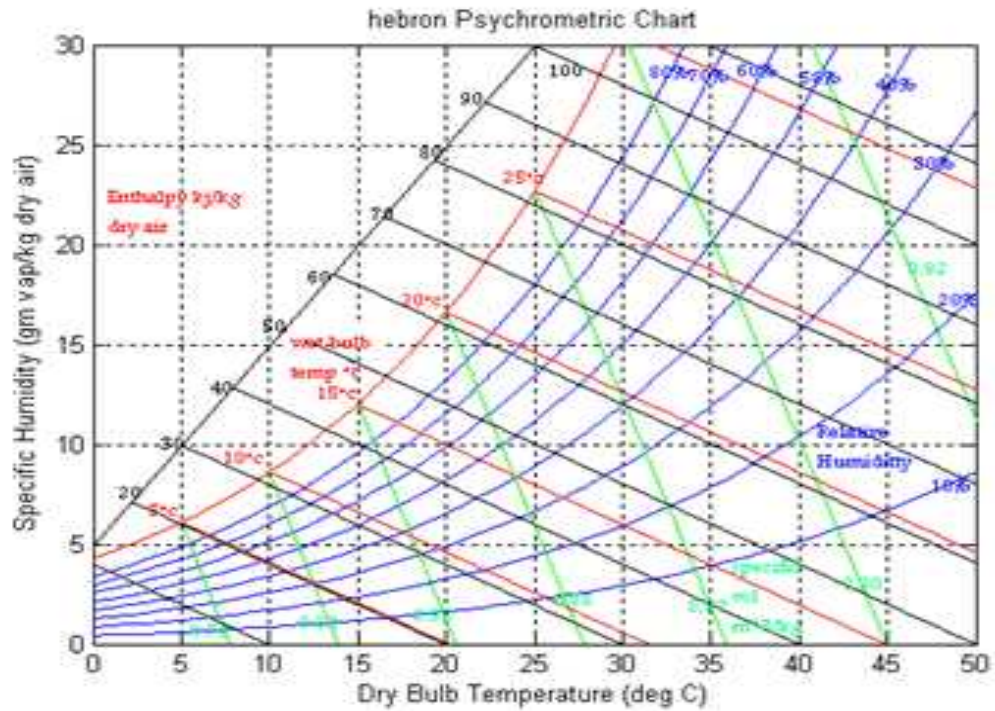


Fig 3.1 Hebron psychrometric chart

2) Jerusalem located in the middle of Palestine, its psychrometric properties and psychrometric chart as in the following table:

Table 3.2 Jerusalem Monthly climate average

Element	Jan	Feb.	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean max temp ()	11.4	12.9	16	20.9	24.8	27.3	28.4	28.6	27.5	24.5	18.7	13.3
Mean min temp ()	6.1	6.9	8.7	10.3	15.3	17.7	18.9	19	18.1	16.4	12.3	8
Absolute max temp ()	20.2	21.8	26.3	34.5	38	36	35.6	37.3	37.2	32.7	27.2	26.5
Absolute min temp ()	-4.1	-3.4	1	2	4.6	9	13.6	14.4	8.6	8.5	0.2	-1
Mean temp ()	8.7	9.9	12.3	15.6	20	22.5	23.6	23.8	22.8	20.4	15.5	10.6
Pressure (mbar)	924	923	922	921	922	921	919	919	922	924	925	925
Mean RH%	67	66	59	50	45	48	53	57	58	56	59	66

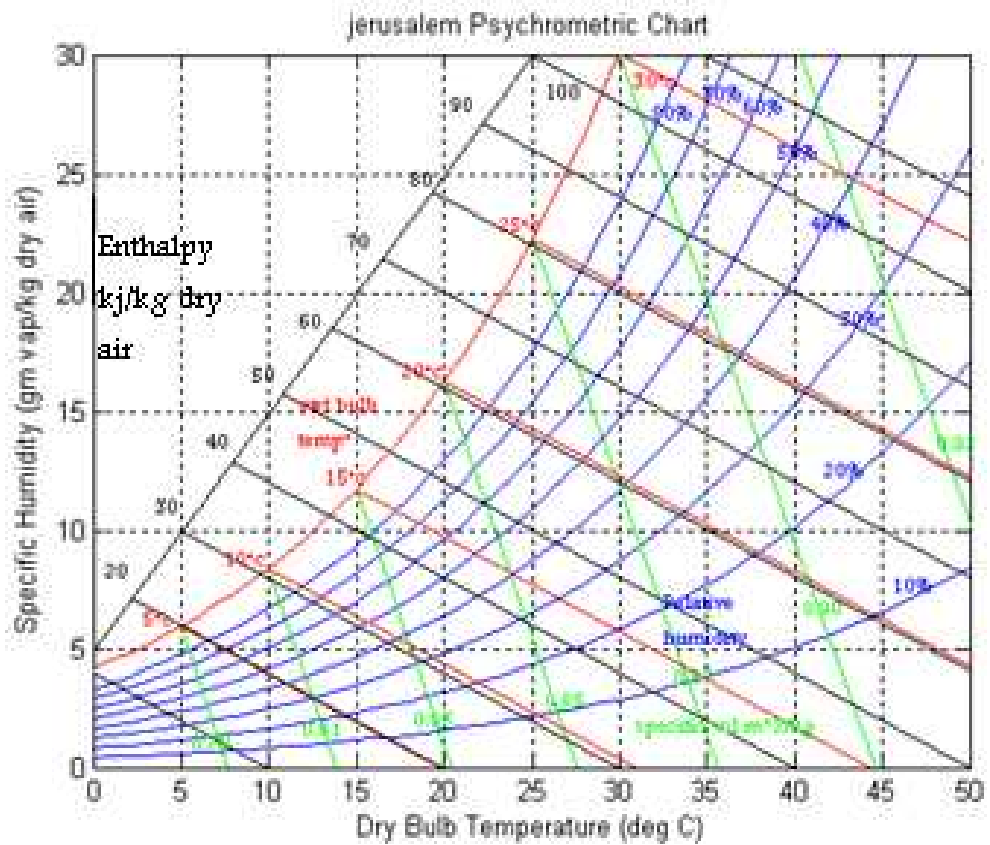


Fig 3.2 jerusalem psychrometric chart

3) Nablus located in the north of Palestine, its psychometrics properties as the following table:

Table 3.3 Nablus Monthly climate average

Element	Jan	Feb.	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean max temp ()	13.1	14.4	17.2	22.2	25.7	27.9	29.1	29.4	28.4	25.8	20.2	14.6
Mean min temp ()	6.2	6.7	8.8	12.1	14.9	17.4	19.3	19.5	18.5	16.2	12.1	7.8
Absolute max temp ()	22.9	28.1	30.4	35	38.6	38	38.1	38.6	38.8	35.3	30.7	28

Absolute min temp ()	-0.6	-2.8	-1	0.6	6.9	11.4	12.3	15.9	13	9.3	1.4	0.3
Mean temp ()	9.6	10.5	13	17.1	20.3	22.6	24.2	24.4	23.4	21	16.1	11.2
Pressure (mbar)	953	952	951	949	948	946	944	945	948	951	953	953
Mean RH%	67	67	62	53	51	55	61	65	64	57	57	67

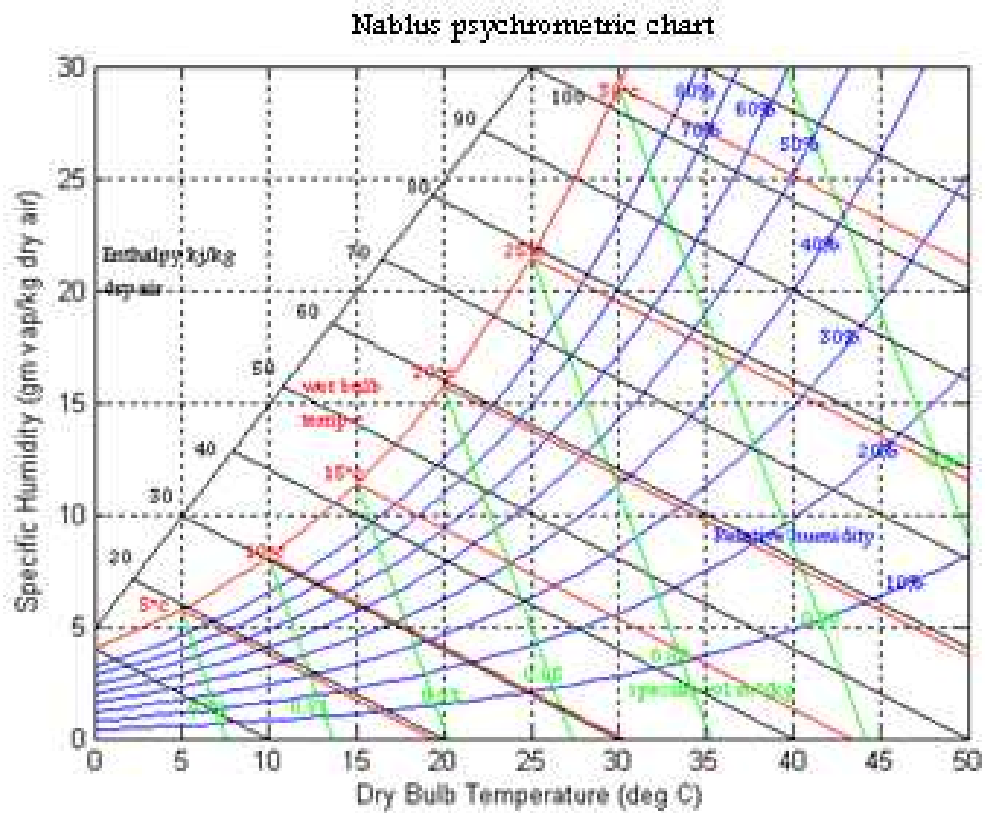


Fig 3.3 Nablus psychrometric chart

4) Jericho is located in the east , its psychometrics properties as the following table:

Table 3.4 Jericho Monthly climate average

Element	Jan	Feb.	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean max temp (°)	19.1	20.9	24.3	29.3	33.7	36.7	37.8	37.6	36.1	32.3	26.4	20.5
Mean min temp (°)	7.4	8.3	10.5	14.2	17.6	20.4	22.1	22.4	21.2	17.9	12.9	9
Absolute max temp (°)	25	27.6	33.8	41.4	46.4	45	44	45.6	43.4	40.6	34.8	28.8
Absolute min temp (°)	0.2	-0.4	2.8	2.4	10.4	15.4	18	19	13.2	11.4	4.2	2.1
Mean temp (°)	13.2	14.6	17.4	21.7	25.6	28.5	29.9	30	28.6	25.1	19.6	14.7
Pressure (mbar)	1048	1046	1044	1041	1040	1037	1034	1035	1039	1042	1046	1048
Mean RH%	70	65	57	45	38	38	40	44	47	51	60	70

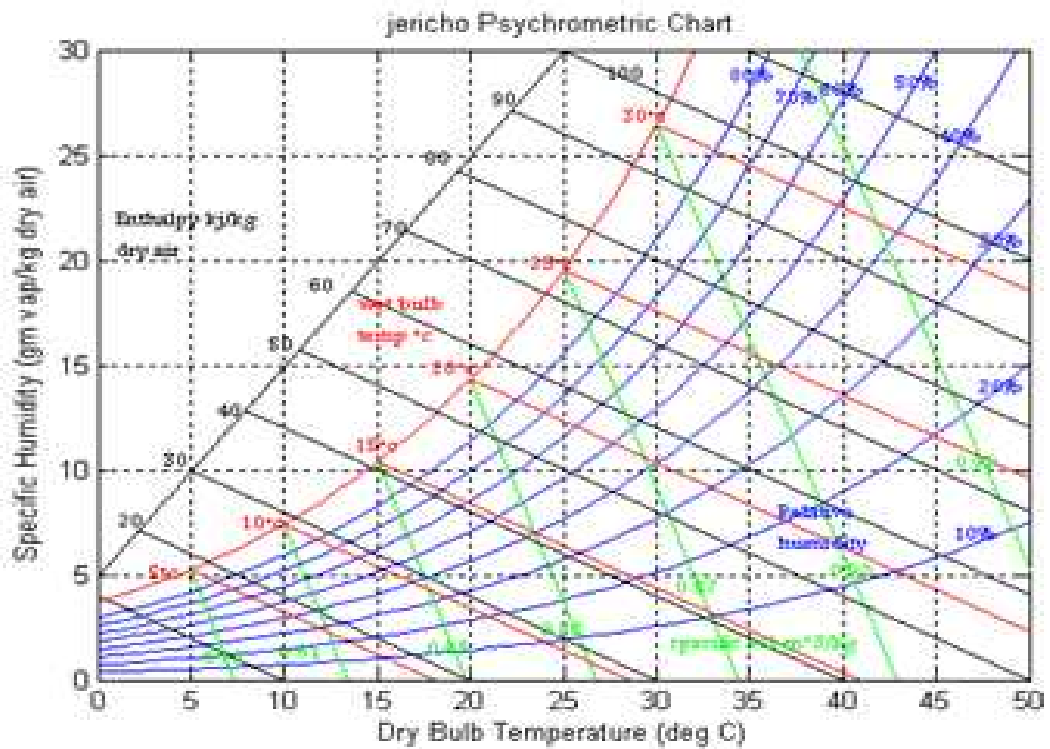


Fig 3.4 jericho psychrometric chart

5) Gaza it located at the sea level its psychrometric properties as in the following table:

Table 3.5 Gaza Monthly climate average

Element	Jan	Feb.	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean max temp ()	17.5	17.5	19.5	23	24.5	27	29	29.5	27.5	26.5	23	19
Mean min temp ()	9.4	10	11.7	14.5	16.9	19.7	21.8	22.2	21.2	19.4	14.5	11.3
Absolute max temp ()	31.2	34.4	34.8	41.2	43.5	40	36	32.8	38.8	37.4	35.4	31.6
Absolute min temp ()	2	2.6	3.6	7.4	11.4	14.8	18.5	19.2	16.2	12.2	7.5	3.4
Mean temp ()	13.4	13.7	15.6	18.7	20.7	23.3	25.4	25.8	24.3	22.9	18.7	15.1
Pressure (mbar)	1016	1016	1013	1012	1011	1009	1006	1008	1011	1013	1014	1017
Mean RH%	67	67	70	70	73	75	76	75	73	69	67	68

Gaza psychrometric chart

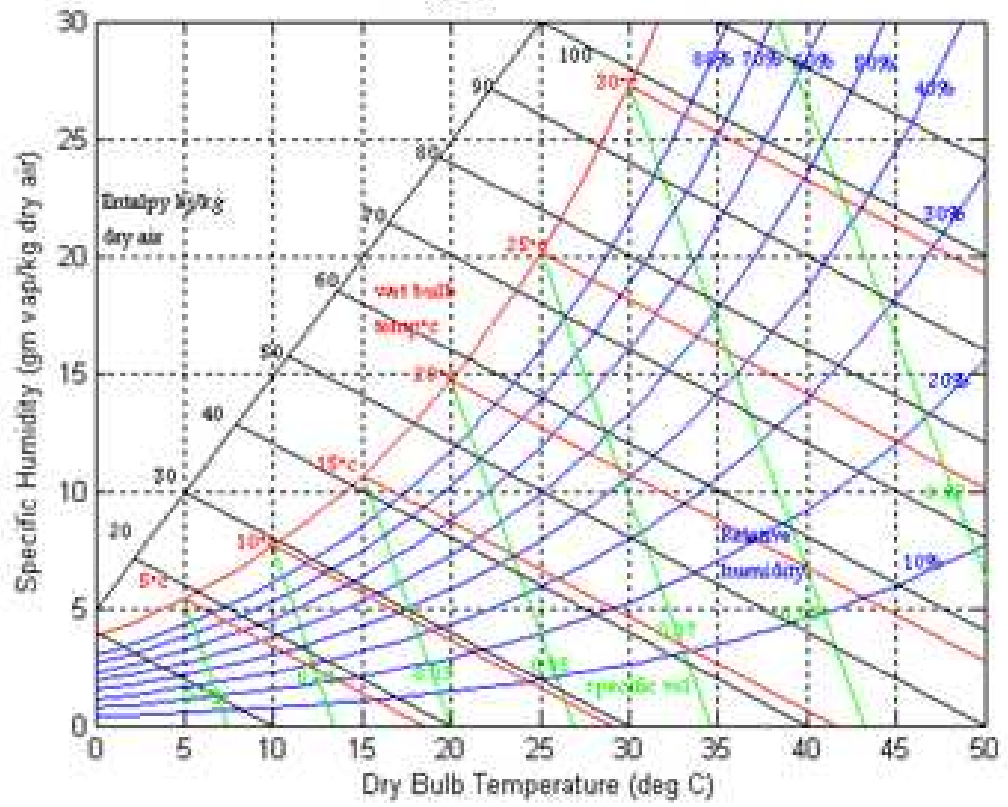


Fig 5.5 Gaza psychrometric chart

Chapter Four

Resultes

- Matlab program for different pressure psychrometric chart.
- Relation between relative humidity and pressure.
- Relation between specific humidity and pressure.
- Relation between specific volume and pressure.
- Relation between dry bulb temperature and pressure.
- Relation between wet bulb temperature and pressure.

4.1 matlab program for drawing different pressure psychrometric chart

```
% %psychrometric chart for different values of pressure
unit= input('1-KPa  2-bar  3-atm=\n');
unit1= input('1-C  2-K=\n');
tpg = [0.01      0.61165
1      0.65709
2      0.70599
3      0.75808
4      0.81355
5      0.87258
6      0.93536
7      1.00210
8      1.07300
9      1.14830
10     1.22820
11     1.31300
12     1.40280
13     1.49810
14     1.59900
15     1.70580
16     1.81880
17     1.93840
18     2.06470
19     2.19830
20     2.33930
21     2.48820
22     2.64530
23     2.81110
24     2.98580
25     3.16990
26     3.36390
27     3.56810
28     3.78310
29     4.00920
30     4.24700
31     4.49690
32     4.75960
33     5.03540
34     5.32510
35     5.62900
36     5.94790
37     6.28230
38     6.63280
39     7.00020
40     7.38490
41     7.78780
42     8.20960
43     8.65080
44     9.11240
45     9.59500
46     10.09900
47     10.62700
48     11.17700
49     11.75200
50     12.35200
];

t = tpg(:,1); % temperature (C)
pg = tpg(:,2); % saturation vapor pressure (kPa)
```

```

patm1= input('atmospheric pressure=\n');% standard atmosphere (kPa)
    if(unit==1)
patm= patm1;
        else if(unit==2)
            patm=patm1*100 ;
        else if(unit==3)
            patm=patm1*101.325;
        end
    end
end
end
rair = 0.287; % gas constant of air (kJ/kg.K)
wg = 622*pg./(patm-pg); % saturation specific humidity
plot(t,wg,'r-')
hold
grid
T= input('T=\n')
if(unit1==1)
    T=T;
else if(unit1==2)
    T= T-273;
end
end
for n= 1:50
    if(T==t(n))
        break
    end
end
rh= input('relative humidity= \n')
for phi = 0.1:0.1:0.8% phi = relative humidity 10%- 80%
    w = 622*phi*pg./(patm-phi*pg);
    if(rh== phi)
        SpecificHumidity = w(n)
    end
end
plot(t,w)
end

% % specific volume and enthalpy/wet-bulb-temp
tpg1 = [5    0.87258
10   1.22820
15   1.70580
20   2.33930
25   3.16990
30   4.24700
35   5.62900];
t1 = tpg1(:,1); % saturation temperature (C)
pg1 = tpg1(:,2); % saturation pressure (kPa)
wg1 = 622*pg1./(patm-pg1); % saturation specific humidity
% % specific volume of dry air (cubic m/kg dry air) (green)
T1= input('T1=\n')
if(unit1==1)
    T1=T1;
else if(unit==2)
    T1= T1-273;
end
end
for n= 1:50
    if(T1==t1(n))
        break
    end
end
vol = rair.*(t1+273)./(patm-pg1); % specific vol at saturation

```

```

SpecificVolume= vol(n)
tv0 = patm*vol/rair-273; % air temperature at zero humidity
for i = 1:7
    plot([t1(i),tv0(i)],[wg1(i),0],'g-')
end
% % wet bulb temperature (also enthalpy) lines (red)
h = t1 + 2.5*wg1; % enthalpy (kJ/kg-dry-air) (displayed)
Enthalpy= h(n)
t0 = h; % temperature at zero humidity for enthalpy h
for i = 1:6
    plot([t1(i),t0(i)],[wg1(i),0],'r-')
end

% % enthalpy axis and enthalpy lines (black)
for h = 10:10:110, % enthalpy (kJ/kg-dry-air)
    t0 = h; % temperature at zero humidity
    t1 = (h - 12.5)/3.5; % temperature on the enthalpy axis

    w1 = t1 + 5; % specific humidity on the enthalpy axis
    plot([t0,t1],[0,w1],'k-')
end
plot([0,25],[5,30],'k-') % the oblique enthalpy axis
axis([0,50,0,30]) % limit the range of the chart
title('90kPa Psychrometric Chart')
xlabel('Dry Bulb Temperature (deg C)')
ylabel('Specific Humidity (gm vap/kg dry air)')

```

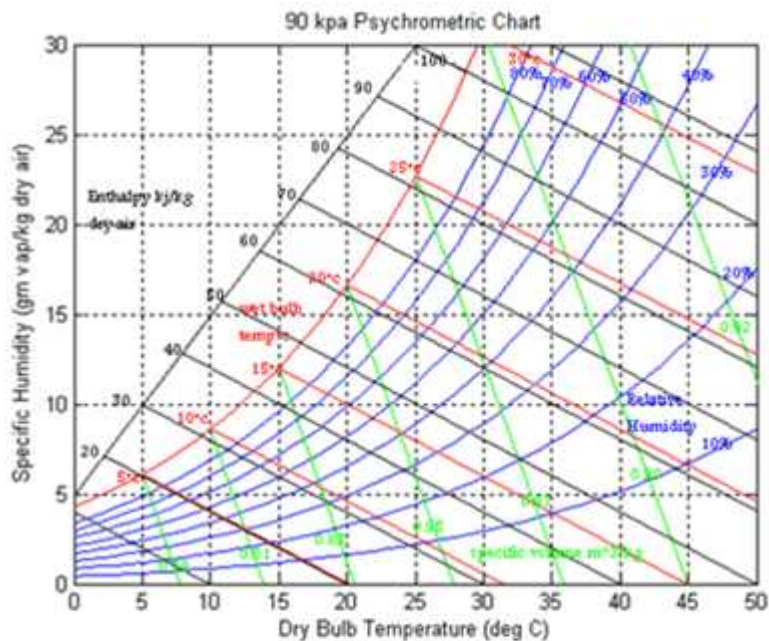


Figure 5.1 90kpa psychrometric chart

```

% %psychrometric chart for different values of pressure
unit= input('1-KPa  2-bar  3-atm=\n');
unit1= input('1-C  2-K=\n');
tpg = [0.01      0.61165
1      0.65709
2      0.70599
3      0.75808
4      0.81355
5      0.87258
6      0.93536
7      1.00210
8      1.07300
9      1.14830
10     1.22820
11     1.31300
12     1.40280
13     1.49810
14     1.59900
15     1.70580
16     1.81880
17     1.93840
18     2.06470
19     2.19830
20     2.33930
21     2.48820
22     2.64530
23     2.81110
24     2.98580
25     3.16990
26     3.36390
27     3.56810
28     3.78310
29     4.00920
30     4.24700
31     4.49690
32     4.75960
33     5.03540
34     5.32510
35     5.62900
36     5.94790
37     6.28230
38     6.63280
39     7.00020
40     7.38490
41     7.78780
42     8.20960
43     8.65080
44     9.11240
45     9.59500
46     10.09900
47     10.62700
48     11.17700
49     11.75200
50     12.35200
];

t = tpg(:,1); % temperature (C)
pg = tpg(:,2); % saturation vapor pressure (kPa)
patm1= input('atmospheric pressure=\n'); % standard atmosphere (kPa)
if(unit==1)
patm= patm1;

```

```

        else if(unit==2)
            patm=patm1*100 ;
            else if(unit==3)
                patm=patm1*101.325;
            end
        end
    end
end
end
rair = 0.287; % gas constant of air (kJ/kg.K)
wg = 622*pg./(patm-pg); % saturation specific humidity
plot(t,wg,'r-')
hold
grid
T= input('T=\n')
if(unit1==1)
    T=T;
else if(unit1==2)
    T= T-273;
    end
end
end
for n= 1:50
    if(T==t(n))
        break
    end
end
rh= input('relative humidity= \n')
for phi = 0.1:0.1:0.8% phi = relative humidity 10%- 80%
    w = 622*phi*pg./(patm-phi*pg);
    if(rh== phi)
        SpecificHumidity = w(n)
    end
end
plot(t,w)
end

%% % specific volume and enthalpy/wet-bulb-temp
tpg1 = [5    0.87258
10  1.22820
15  1.70580
20  2.33930
25  3.16990
30  4.24700
35  5.62900];
t1 = tpg1(:,1); % saturation temperature (C)
pg1 = tpg1(:,2); % saturation pressure (kPa)
wg1 = 622*pg1./(patm-pg1); % saturation specific humidity
%% % specific volume of dry air (cubic m/kg dry air) (green)
T1= input('T1=\n')
if(unit1==1)
    T1=T1;
else if(unit==2)
    T1= T1-273;
    end
end
end
for n= 1:50
    if(T1==t1(n))
        break
    end
end
end
vol = rair.*(t1+273)./(patm-pg1); % specific vol at saturation
SpecificVolume= vol(n)
tv0 = patm*vol/rair-273; % air temperature at zero humidity
for i = 1:7

```

```

    plot([t1(i),tv0(i)],[wg1(i),0], 'g-')
end
% % wet bulb temperature (also enthalpy) lines (red)
h = t1 + 2.5*wg1; % enthalpy (kJ/kg-dry-air) (displayed)
Enthalpy= h(n)
t0 = h; % temperature at zero humidity for enthalpy h
for i = 1:6
    plot([t1(i),t0(i)],[wg1(i),0], 'r-')
end

% % enthalpy axis and enthalpy lines (black)
for h = 10:10:110, % enthalpy (kJ/kg-dry-air)
    t0 = h; % temperature at zero humidity
    t1 = (h - 12.5)/3.5; % temperature on the enthalpy axis

    w1 = t1 + 5; % specific humidity on the enthalpy axis
    plot([t0,t1],[0,w1], 'k-')
end
plot([0,25],[5,30], 'k-') % the oblique enthalpy axis
axis([0,50,0,30]) % limit the range of the chart
title('100 kPa Psychrometric Chart')
xlabel('Dry Bulb Temperature (deg C)')
ylabel('Specific Humidity (gm vap/kg dry air)')

```

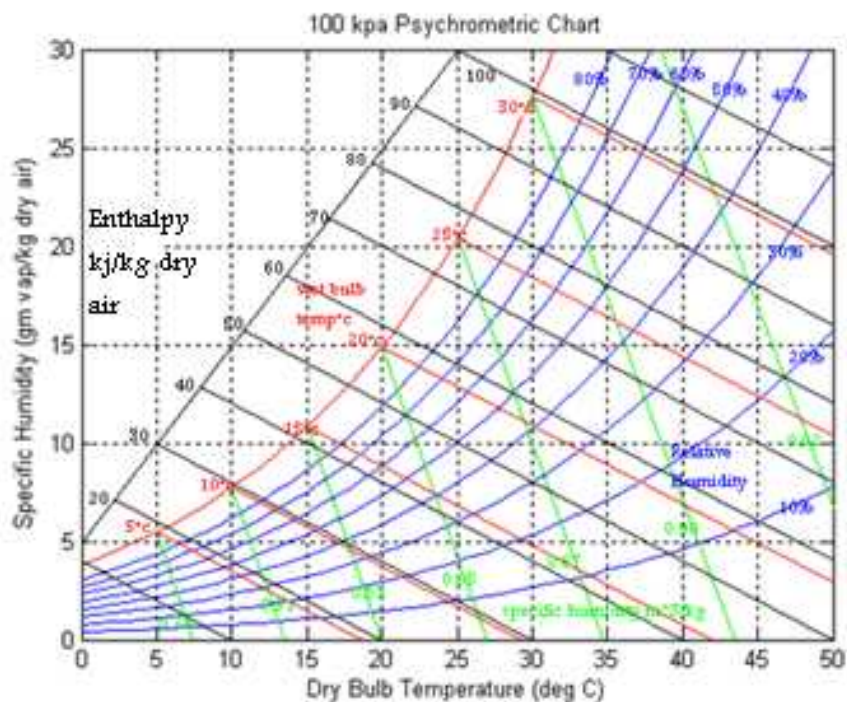


Fig 5.2 100kpa psychrometric chart

```

% %psychrometric chart for different values of pressure
unit= input('1-KPa  2-bar  3-atm=\n');
unit1= input('1-C  2-K=\n');
tpg = [0.01      0.61165
1      0.65709
2      0.70599
3      0.75808
4      0.81355
5      0.87258
6      0.93536
7      1.00210
8      1.07300
9      1.14830
10     1.22820
11     1.31300
12     1.40280
13     1.49810
14     1.59900
15     1.70580
16     1.81880
17     1.93840
18     2.06470
19     2.19830
20     2.33930
21     2.48820
22     2.64530
23     2.81110
24     2.98580
25     3.16990
26     3.36390
27     3.56810
28     3.78310
29     4.00920
30     4.24700
31     4.49690
32     4.75960
33     5.03540
34     5.32510
35     5.62900
36     5.94790
37     6.28230
38     6.63280
39     7.00020
40     7.38490
41     7.78780
42     8.20960
43     8.65080
44     9.11240
45     9.59500
46     10.09900
47     10.62700
48     11.17700
49     11.75200
50     12.35200
];

t = tpg(:,1); % temperature (C)
pg = tpg(:,2); % saturation vapor pressure (kPa)
patm1= input('atmospheric pressure=\n'); % standard atmosphere (kPa)
if(unit==1)
patm= patm1;

```

```

        else if(unit==2)
            patm=patm1*100 ;
            else if(unit==3)
                patm=patm1*101.325;
            end
        end
    end
end
end
rair = 0.287; % gas constant of air (kJ/kg.K)
wg = 622*pg./(patm-pg); % saturation specific humidity
plot(t,wg,'r-')
hold
grid
T= input('T=\n')
if(unit1==1)
    T=T;
else if(unit1==2)
    T= T-273;
    end
end
end
for n= 1:50
    if(T==t(n))
        break
    end
end
rh= input('relative humidity= \n')
for phi = 0.1:0.1:0.8% phi = relative humidity 10%- 80%
    w = 622*phi*pg./(patm-phi*pg);
    if(rh== phi)
        SpecificHumidity = w(n)
    end
end
plot(t,w)
end

%% % specific volume and enthalpy/wet-bulb-temp
tpg1 = [5    0.87258
10  1.22820
15  1.70580
20  2.33930
25  3.16990
30  4.24700
35  5.62900];
t1 = tpg1(:,1); % saturation temperature (C)
pg1 = tpg1(:,2); % saturation pressure (kPa)
wg1 = 622*pg1./(patm-pg1); % saturation specific humidity
%% % specific volume of dry air (cubic m/kg dry air) (green)
T1= input('T1=\n')
if(unit1==1)
    T1=T1;
else if(unit==2)
    T1= T1-273;
    end
end
end
for n= 1:50
    if(T1==t1(n))
        break
    end
end
end
vol = rair.*(t1+273)./(patm-pg1); % specific vol at saturation
SpecificVolume= vol(n)
tv0 = patm*vol/rair-273; % air temperature at zero humidity
for i = 1:7

```



```

    plot([t1(i),tv0(i)],[wg1(i),0], 'g-')
end
% % wet bulb temperature (also enthalpy) lines (red)
h = t1 + 2.5*wg1; % enthalpy (kJ/kg-dry-air) (displayed)
Enthalpy= h(n)
t0 = h; % temperature at zero humidity for enthalpy h
for i = 1:6
    plot([t1(i),t0(i)],[wg1(i),0], 'r-')
end

% % enthalpy axis and enthalpy lines (black)
for h = 10:10:110, % enthalpy (kJ/kg-dry-air)
    t0 = h; % temperature at zero humidity
    t1 = (h - 12.5)/3.5; % temperature on the enthalpy axis

    w1 = t1 + 5; % specific humidity on the enthalpy axis
    plot([t0,t1],[0,w1], 'k-')
end
plot([0,25],[5,30], 'k-') % the oblique enthalpy axis
axis([0,50,0,30]) % limit the range of the chart
title('Simplified Psychrometric Chart')
xlabel('Dry Bulb Temperature (deg C)')
ylabel('Specific Humidity (gm vap/kg dry air)')

```

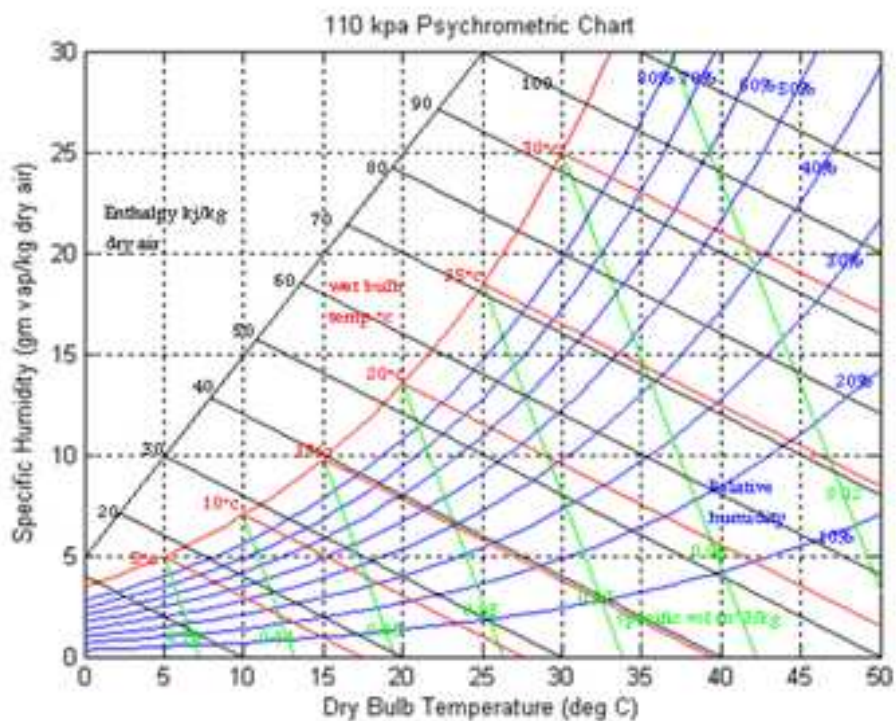


Fig 5.3 120kpa psychrometric chart

```

% %psychrometric chart for different values of pressure
unit= input('1-KPa  2-bar  3-atm=\n');
unit1= input('1-C  2-K=\n');
tpg = [0.01      0.61165
1      0.65709
2      0.70599
3      0.75808
4      0.81355
5      0.87258
6      0.93536
7      1.00210
8      1.07300
9      1.14830
10     1.22820
11     1.31300
12     1.40280
13     1.49810
14     1.59900
15     1.70580
16     1.81880
17     1.93840
18     2.06470
19     2.19830
20     2.33930
21     2.48820
22     2.64530
23     2.81110
24     2.98580
25     3.16990
26     3.36390
27     3.56810
28     3.78310
29     4.00920
30     4.24700
31     4.49690
32     4.75960
33     5.03540
34     5.32510
35     5.62900
36     5.94790
37     6.28230
38     6.63280
39     7.00020
40     7.38490
41     7.78780
42     8.20960
43     8.65080
44     9.11240
45     9.59500
46     10.09900
47     10.62700
48     11.17700
49     11.75200
50     12.35200
];

t = tpg(:,1); % temperature (C)
pg = tpg(:,2); % saturation vapor pressure (kPa)
patm1= input('atmospheric pressure=\n'); % standard atmosphere (kPa)
if(unit==1)
patm= patm1;

```

```

        else if(unit==2)
            patm=patm1*100 ;
            else if(unit==3)
                patm=patm1*101.325;
            end
        end
    end
end
end
rair = 0.287; % gas constant of air (kJ/kg.K)
wg = 622*pg./(patm-pg); % saturation specific humidity
plot(t,wg,'r-')
hold
grid
T= input('T=\n')
if(unit1==1)
    T=T;
else if(unit1==2)
    T= T-273;
    end
end
end
for n= 1:50
    if(T==t(n))
        break
    end
end
rh= input('relative humidity= \n')
for phi = 0.1:0.1:0.8% phi = relative humidity 10%- 80%
    w = 622*phi*pg./(patm-phi*pg);
    if(rh== phi)
        SpecificHumidity = w(n)
    end
end
plot(t,w)
end

%% % specific volume and enthalpy/wet-bulb-temp
tpg1 = [5    0.87258
10  1.22820
15  1.70580
20  2.33930
25  3.16990
30  4.24700
35  5.62900];
t1 = tpg1(:,1); % saturation temperature (C)
pg1 = tpg1(:,2); % saturation pressure (kPa)
wg1 = 622*pg1./(patm-pg1); % saturation specific humidity
%% % specific volume of dry air (cubic m/kg dry air) (green)
T1= input('T1=\n')
if(unit1==1)
    T1=T1;
else if(unit==2)
    T1= T1-273;
    end
end
end
for n= 1:50
    if(T1==t1(n))
        break
    end
end
end
vol = rair.*(t1+273)./(patm-pg1); % specific vol at saturation
SpecificVolume= vol(n)
tv0 = patm*vol/rair-273; % air temperature at zero humidity
for i = 1:7

```

```

    plot([t1(i),tv0(i)],[wg1(i),0], 'g-')
end
% % wet bulb temperature (also enthalpy) lines (red)
h = t1 + 2.5*wg1; % enthalpy (kJ/kg-dry-air) (displayed)
Enthalpy= h(n)
t0 = h; % temperature at zero humidity for enthalpy h
for i = 1:6
    plot([t1(i),t0(i)],[wg1(i),0], 'r-')
end

% % enthalpy axis and enthalpy lines (black)
for h = 10:10:110, % enthalpy (kJ/kg-dry-air)
    t0 = h; % temperature at zero humidity
    t1 = (h - 12.5)/3.5; % temperature on the enthalpy axis

    w1 = t1 + 5; % specific humidity on the enthalpy axis
    plot([t0,t1],[0,w1], 'k-')
end
plot([0,25],[5,30], 'k-') % the oblique enthalpy axis
axis([0,50,0,30]) % limit the range of the chart
title('120 kPa Psychrometric Chart')
xlabel('Dry Bulb Temperature (deg C)')
ylabel('Specific Humidity (gm vap/kg dry air)')

```

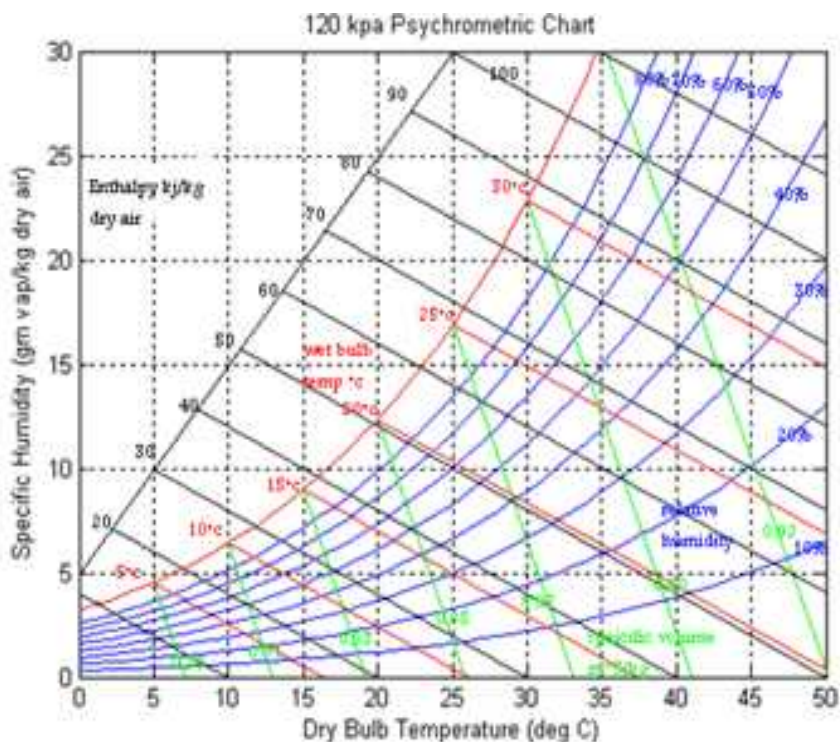


Fig 8.4 120kpa psychrometric chart

```

                                % %psychrometric chart for
different values of pressure
unit= input('1-KPa  2-bar  3-atm=\n');
unit1= input('1-C  2-K=\n');
    tpg = [0.01      0.61165
1      0.65709
2      0.70599
3      0.75808
4      0.81355
5      0.87258
6      0.93536
7      1.00210
8      1.07300
9      1.14830
10     1.22820
11     1.31300
12     1.40280
13     1.49810
14     1.59900
15     1.70580
16     1.81880
17     1.93840
18     2.06470
19     2.19830
20     2.33930
21     2.48820
22     2.64530
23     2.81110
24     2.98580
25     3.16990
26     3.36390
27     3.56810
28     3.78310
29     4.00920
30     4.24700
31     4.49690
32     4.75960
33     5.03540
34     5.32510
35     5.62900
36     5.94790
37     6.28230
38     6.63280
39     7.00020
40     7.38490
41     7.78780
42     8.20960
43     8.65080
44     9.11240
45     9.59500
46     10.09900
47     10.62700
48     11.17700
49     11.75200
50     12.35200
];

t = tpg(:,1); % temperature (C)
pg = tpg(:,2); % saturation vapor pressure (kPa)
patm1= input('atmospheric pressure=\n');% standard atmosphere (kPa)
    if(unit==1)

```

```

patm= patm1;
    else if(unit==2)
        patm=patm1*100 ;
    else if(unit==3)
        patm=patm1*101.325;
    end
end
end
rair = 0.287; % gas constant of air (kJ/kg.K)
wg = 622*pg./(patm-pg); % saturation specific humidity
plot(t,wg,'r-')
hold
grid
T= input('T=\n')
if(unit1==1)
    T=T;
else if(unit1==2)
    T= T-273;
    end
end
for n= 1:50
    if(T==t(n))
        break
    end
end
rh= input('relative humidity= \n')
for phi = 0.1:0.1:0.8% phi = relative humidity 10%- 80%
    w = 622*phi*pg./(patm-phi*pg);
    if(rh== phi)
        SpecificHumidity = w(n)
    end
    plot(t,w)
end

% % specific volume and enthalpy/wet-bulb-temp
tpg1 = [5    0.87258
10  1.22820
15  1.70580
20  2.33930
25  3.16990
30  4.24700
35  5.62900];
t1 = tpg1(:,1); % saturation temperature (C)
pg1 = tpg1(:,2); % saturation pressure (kPa)
wg1 = 622*pg1./(patm-pg1); % saturation specific humidity
% % specific volume of dry air (cubic m/kg dry air) (green)
T1= input('T1=\n')
if(unit1==1)
    T1=T1;
else if(unit==2)
    T1= T1-273;
    end
end
for n= 1:50
    if(T1==t1(n))
        break
    end
end
vol = rair.*(t1+273)./(patm-pg1); % specific vol at saturation
SpecificVolume= vol(n)
tv0 = patm*vol/rair-273; % air temperature at zero humidity

```

```

for i = 1:7
    plot([t1(i),tv0(i)],[wg1(i),0],'g-')
end
% % wet bulb temperature (also enthalpy) lines (red)
h = t1 + 2.5*wg1; % enthalpy (kJ/kg-dry-air) (displayed)
Enthalpy= h(n)
t0 = h; % temperature at zero humidity for enthalpy h
for i = 1:6
    plot([t1(i),t0(i)],[wg1(i),0],'r-')
end

% % enthalpy axis and enthalpy lines (black)
for h = 10:10:110, % enthalpy (kJ/kg-dry-air)
    t0 = h; % temperature at zero humidity
    t1 = (h - 12.5)/3.5; % temperature on the enthalpy axis

    w1 = t1 + 5; % specific humidity on the enthalpy axis
    plot([t0,t1],[0,w1],'k-')
end
plot([0,25],[5,30],'k-') % the oblique enthalpy axis
axis([0,50,0,30]) % limit the range of the chart
title('Simplified Psychrometric Chart')
xlabel('Dry Bulb Temperature (deg C)')
ylabel('Specific Humidity (gm vap/kg dry air)')

```

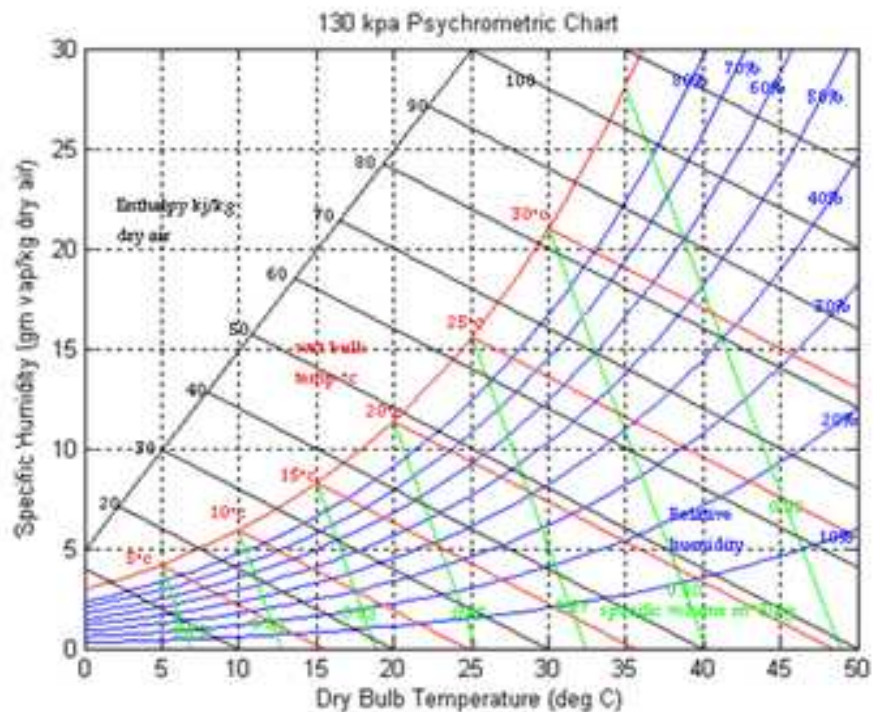


Fig 5.5 130kpa psychrometric chart

4.1.1 Relation between relative humidity and pressure.

From drawing different pressure psychrometric chart the relation between the pressure and relative humidity is as the following:

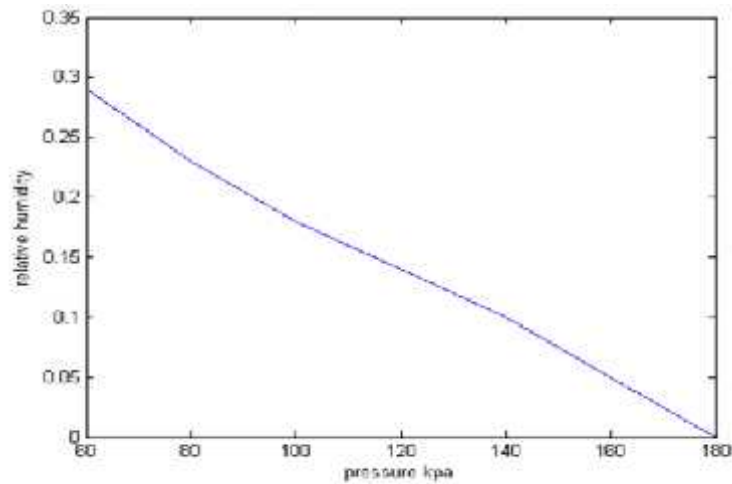


Fig. 3.6 relation between pressure and relative humidity

Relative humidity decreases when the pressure increases

4.1.2 Relation between specific humidity and pressure.

From drawing different pressure psychrometric chart the relation between the pressure and specific humidity is as the following:

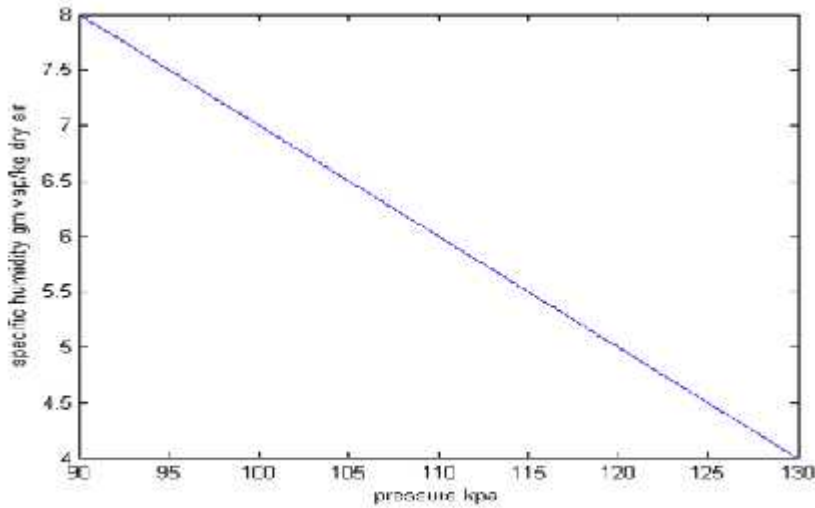


Fig 8.7 relation between pressure and specific humidity

Specific

humidity decreases when the pressure increases

4.1.3 Relation between specific volume and pressure.

From drawing different pressure psychrometric chart the relation between the pressure and specific volume is as the following:

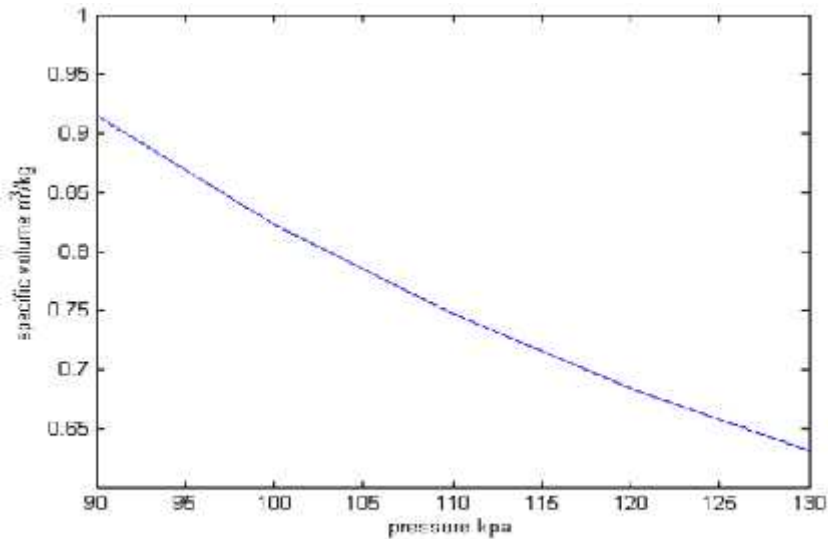


Fig 8.8 relation between specific volume and pressure

Specific volume decreases when the pressure increases

4.1.4 Relation between dry bulb temperature and pressure.

From drawing different pressure psychrometric chart the relation between the pressure and dry bulb temperature is the following.

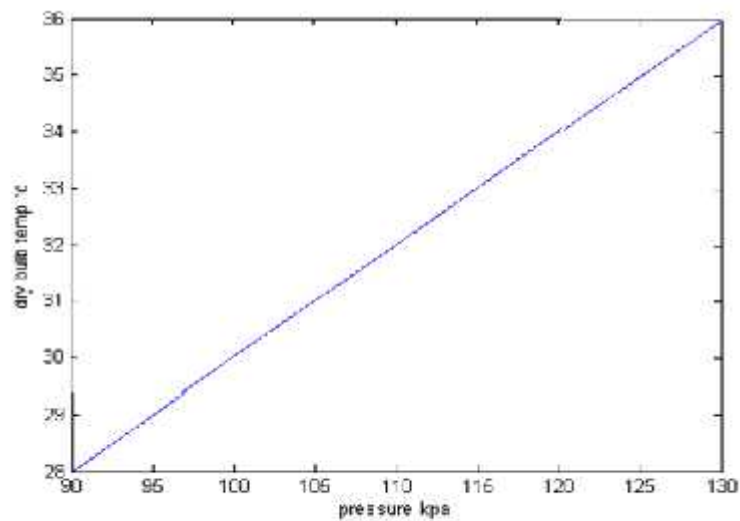


Fig. 3.4 Relation between pressure and dry bulb temp.

Dry bulb temperature increases when the pressure increases

4.1.5 Relation between wet bulb temperature and pressure.

From drawing different pressure psychrometric chart the relation between the pressure and wet bulb temperature is as the following:

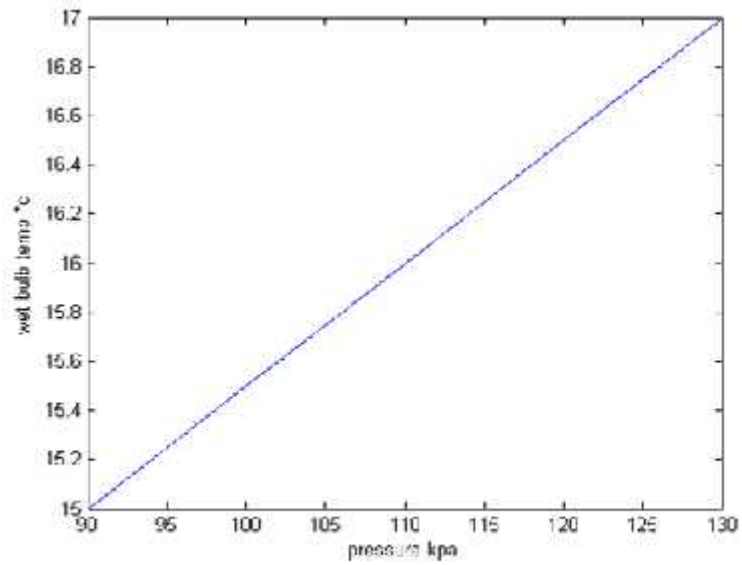


Fig 8.1.1 Relation between pressure and wet bulb temp

Wet bulb temperature increases when the pressure increases

4.1.6 Relation between Enthalpy and pressure.

From drawing different pressure psychrometric chart the relation between the pressure and enthalpy is as the following:

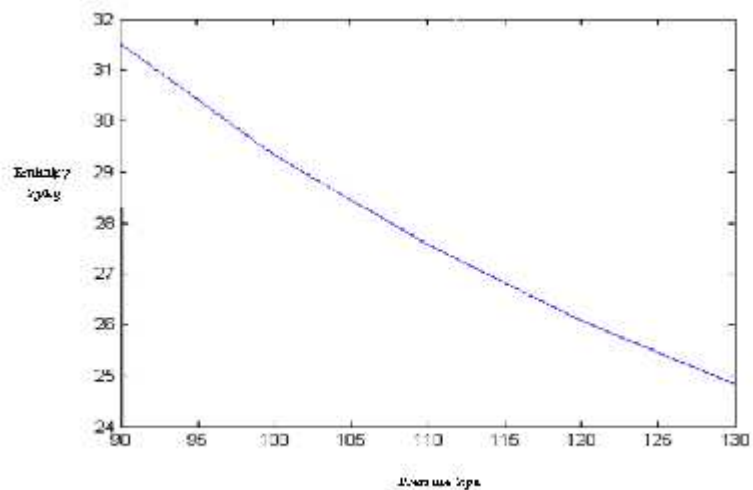


Fig 8.1.1 pressure and enthalpy

Enthalpy decreases when the pressure increases

4.2 Comparison between atmospheric pressure and other pressures using psychrometric chart:

In this section 101.325kPa, 90kPa and 104 kPa psychrometric chart were taken and compare between the results.

When $T_{\text{wet}} = 25\text{C}$ and $T_{\text{dry}} = 10\text{C}$:

	T_{wet} C	T_{dry} C	Enthalpy Kj/kg	RH()	Sh() Gm vapor/kg dry air	Spe vol(v) m^3/kg
101.325kPa psychrometric chart	25	10	29	0.10	2.3	0.843
104 kPa psychrometric chart	25	10	28	0.095	2	0.845
90 kPa psychrometric chart	25	10	31	0.12	2.8	0.847

Example:

Air at 15C and 80% relative humidity is sensibly heated to 25C . determine the final relative humidity and the heat rate added for an air flow rate of 0.5kg/s using 101.3kPa, 104kPa and 90 kPa.

101.3 kPa :

$$\phi_2 = 43\% \quad h_1 = 37\text{kJ/kg} \quad h_2 = 47\text{kJ/kg}$$

$$Q_{1-2} = \dot{m} \cdot (h_2 - h_1)$$

$$= 0.5(47-37)$$

$$= 5\text{Kw}$$

104 kpa:

$$\eta = 42\% \quad h_1 = 36\text{kJ/kg} \quad h_2 = 45\text{kJ/kg}$$

$$Q_{1-2} = \dot{m} \cdot (h_2 - h_1) = 0.5(45-36)$$

$$= 4.5\text{kw}$$

90 kpa:

$$\eta = 45\% \quad h_1 = 40\text{kJ/kg} \quad h_2 = 51\text{kJ/kg}$$

$$Q_{1-2} = \dot{m} \cdot (h_2 - h_1) = 0.5(51-40)$$

$$= 5.5 \text{ kw}$$