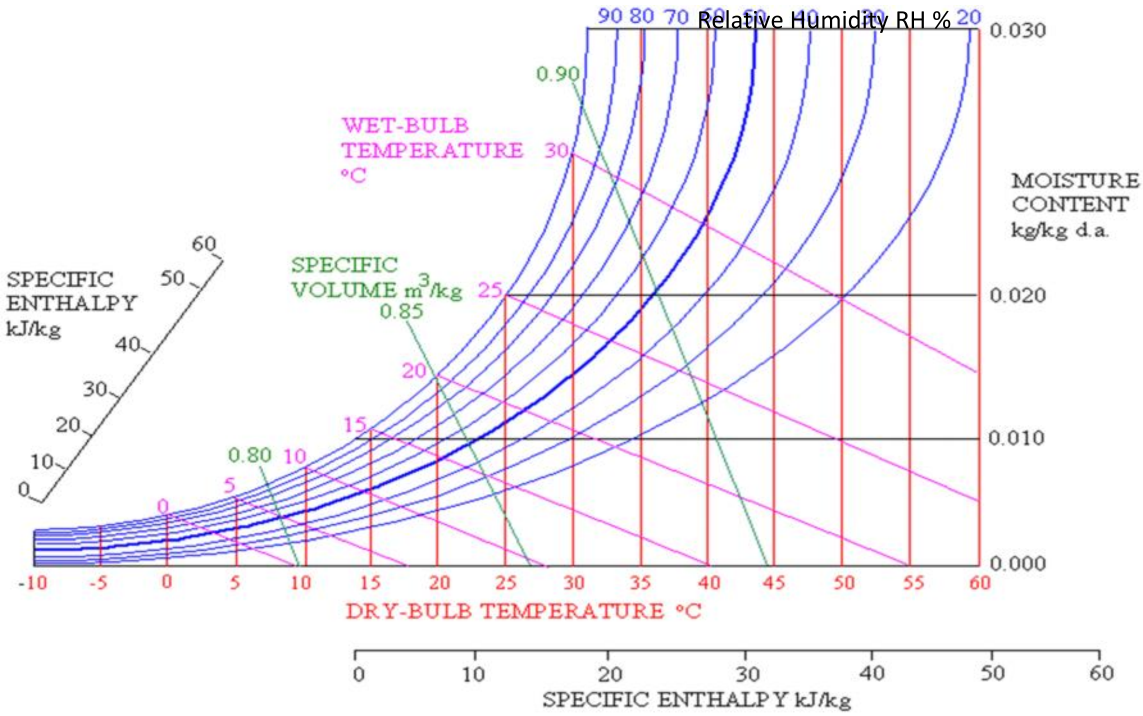
ExperimentNo.1:THE PSYCHROMETRIC PROCESSES

Psychrometric is the study of air and water vapor mixtures. Air is amixture of five main gases. Nitrogen 78.03%, Oxygen 20.99%, Argon 0.94%, Carbon Dioxide 0.03%, and Hydrogen 0.01% by volume.

The Ideal Gas Laws are used to determine psychrometric data for air so that the engineer can carry out calculations. easier a chart has been compiled with all the relevant psychrometric data indicated. This is called the Psychrometric Chart.

A typical chart is shown below.



Air at any state point can be plotted on the psychrometric chart. The information that can be obtained from a Psychrometric Chart as follows:

. Dry bulb temperature (DBT) ºC
. Wet bulb temperature (WBT) ºC
. Moisture content (humidity ratio or specific humidity)(ω) $\frac{kg_{water\ vapour}}{kg_{dry\ air}}, \frac{kg_{w.v}}{kg_{d.a}}$
. Relative humidity (RH) (φ =100 %)
. Specific enthalpy (h) kJ/kg
. Specific volume (ν) m^3/kg
.

If any two properties of air are known then the other four can be found from the psychrometric chart.

This chart is designed for a barometric pressure of 1.01325 Bar which is a figure for a standard atmosphere at sea level.

However, under extreme weather conditions or at very high or very low (below sea level) altitudes the effect of barometric pressure will become significant.

Note: 1 mbar = 0.001 bar = 100 N/m^2 = 10^2 Pa = 0.749mm Mercury

Bar= 10^5 Pa= 10^2 kPa

practice: Find the specific volume, wet-bulb temperature, moisture content(W) and specific enthalpy of air at 35°C dry-bulb temperature and 30% Relative Humidity.

Sol: A vertical line is drawn upwards from 35°C dry-bulb temperature until it intersects with the 30% RH

This intersection is the state point. Where:

specific volume = 0.88775 m^3/kg

wet-bulb temperature =21.55°C

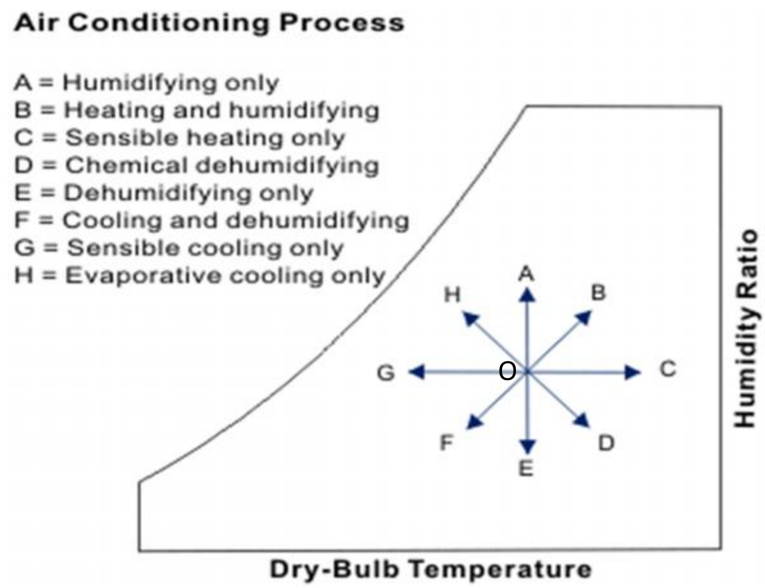
dew-point temperature=14.87 °C (horizontal line to the lift)

moisture content =0.0105 $kg_{w.v}/kg_{dry\ air}$ (horizontal line to the right)

specific enthalpy =62.25 kJ/kg

vapor pressure =1.68835 bar (horizontal line to the right)

Basic Air Conditioning Processes



1. Sensible Cooling and Heating

When air is heated or cooled sensibly, that is, when no moisture is added or removed, this process is represented by a horizontal line on a psychrometric chart.

For sensible heating: (OC)

2. humidification and dehumidification: (latent heat)

Is the process in which the moisture or water vapor or humidity is added to the air without changing its dry bulb (DB) temperature. This process is represented by a straight vertical line on the psychrometric chart starting from the initial value of relative humidity, extending upwards and ending at the final value of the relative humidity.

Humidification (OA)

Dehumidification (OE)

In actual practice the pure humidification process is not possible, since the humidification is always accompanied by cooling or heating of the air.

Heating and Humidification (OB)

Add some moisture to the supply air by injecting steam into the air stream.

Cooling and Humidification (OH)

The moisture is added to the air by passing it over the stream or spray of water which is at temperature lower than the dry bulb temperature of the air (evaporative cooler), (adiabatic cooling).

Heating and Dehumidification (OD)

Same chemical industry needs heating with dehumidification process.

Cooling and Dehumidification (OF)

The most commonly used method of removing water vapour from air (dehumidification) is to cool the air below its dew point.

where: Q = Heat or cooling energy (kW)

m_{air} = mass flow rate of air (kg/s)

C_p = Specific heat capacity of air, may be taken as 1.005 kJ/kg ^oC.

T = Dry bulb temperature of air (^oC)

h = specific enthalpy of air (kJ/kg) found from psychrometric chart.

ω = moisture content (kg water vapour /kg dry air)

Exp No.2: Thermo-Electric Heat pump (TEHP) Performance

1-Introduction

Thermo electric cooling uses the Peltier effect to creat a heat flux between the junctions of two different type of material. Apeltier cooler, heater or thermo electric heat pump is a solid -state active heat pump which transfer heat from one side of the device to the other with consumption of electric energy, depending on the direction of the current. They can be used either for heating or cooling (Refrigeration), although in practice the main application is cooling.

A peltier cooler can also be used as a thermo electric generator .when operate as a cooler, a voltage is applied across the device, and as a result in difference in temperature will build up between the two side .when operating as generator, one side of the device is heated to a temperature greater than the other side, and as a result a difference in voltage will build up between the two side (the see beck effect).

2-Object of experiment

To study the performance of the thermo electric, heat pump by calculation:

1- peltier effect

2-Thomson effect

3-seebeck effect

4-C.O.P

3-Semi Conductors

The material that used in the thermo electric heat pump are 36 semiconductors which have the following properties .

1-High convesion factor with respect to flowing current

2-High electric conductivity = I^2R

3-Low thermal conductivity.

there semiconductors are an alloy made of Biz mouth chloride (Sb_2te_3 -$b_{12}te_3$) represent the P type as it is poor in electrons and the other alloy is (bi_2se_3 -$b_{12}te_3$) which represent the N type and it is rich with electrons .the two unique semiconductors one N type and one P type are used because they need to have different electron densities .the semiconductors are placed thermally in parallel to each other and electrically in series and then joined with thermally conducting plate on each side.

when a voltage is applied to the free end of the two semiconductors there is a flow of DC current across the junction of the semi-conductors causing temperature different .the side with the cooling plate a bsorbit heat which is then moved to the other side end of the device where the heat sink is TEHP are typically connected side by side and sandwiched between two ceramic plate.

the device is equiped with a variable resistance(loud) ,voltmeter ,a meter ,wattmeter ,fan , thermometer ,for cold and hot side and two away switch and electrical heater (loud).

4

Experiment No 3: Refrigeration System

1-Object:

To demonstration the refrigeration cycle components and to determint the coefficient of performance of the cycle.

2-Apparatus:

The electric refrigeration training unit work with R 134a and consists of compressor, condenser, expansion valve and evaporator.

There are also measurement device for temperature, pressure, voltage, current and mass flow rate of the system show in figure.

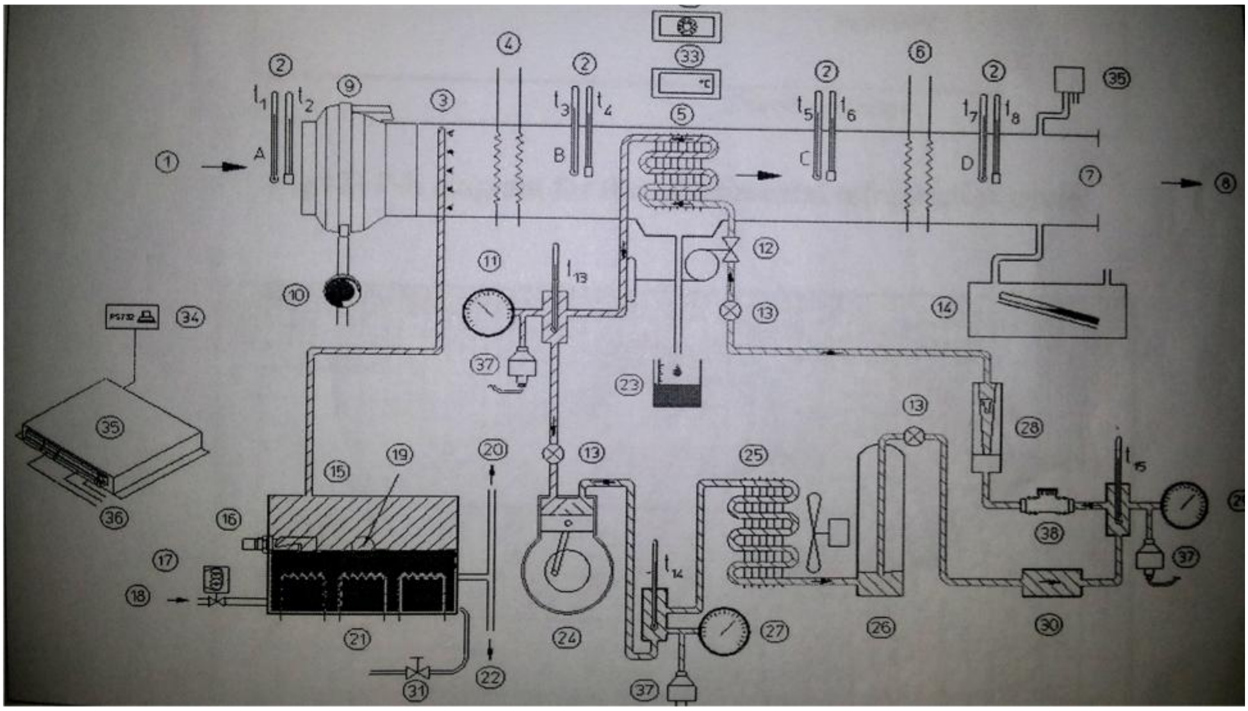


Figure (1) Air conditioning laboratory Unit A660

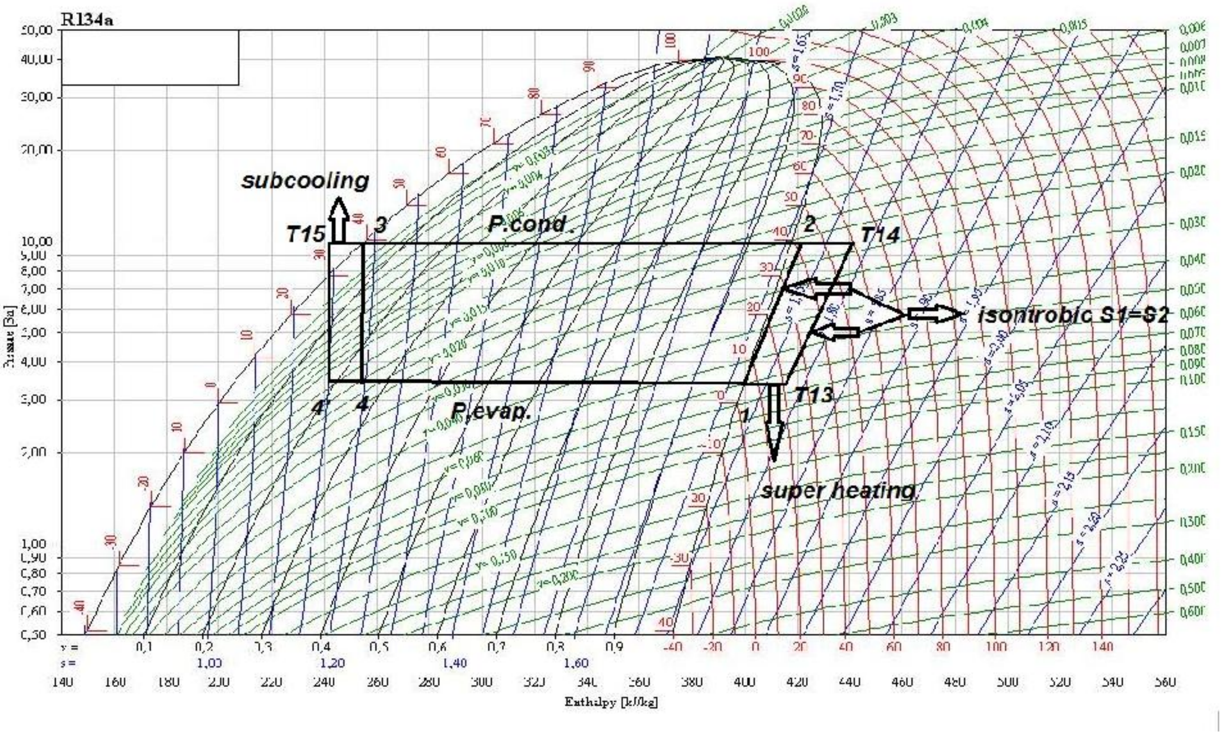


Figure (2) The P-H diagram for the refrigeration cycle

Experiment No 4: Refrigeration Unit Performance

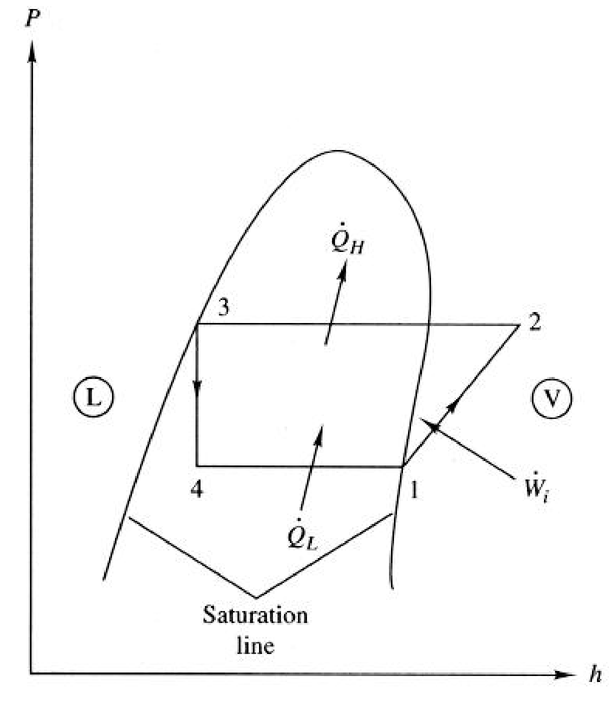
4.1 Object:

To demonstration the refrigeration cycle components and to determine the coefficient of performance of the cycle experimental.

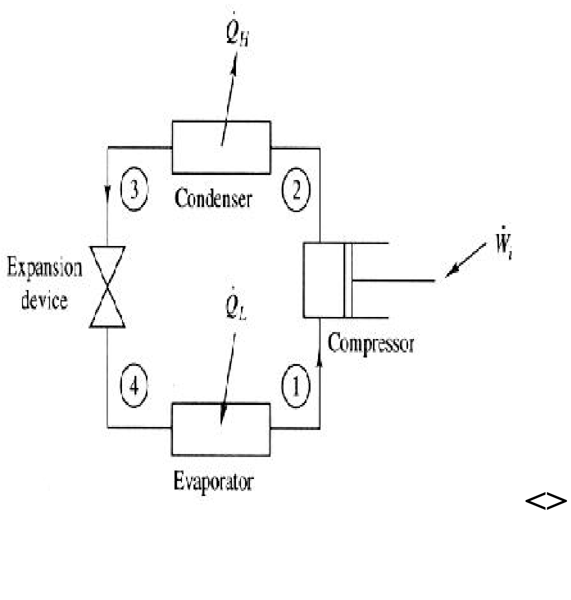
4.2 Apparatus:

The electric refrigeration training unit work with R134a and consists of compressor,condenser, expansion valve and evaporatoras show in figure (4-1).

There are also measurement devices for temperature, pressure and mass flow rate of the refrigeration.



Ideal refrigeration cycle plotted on P-h diagram



Ideal refrigeration cycle schematic arrangement of mechanical equipment

Figure 4-1

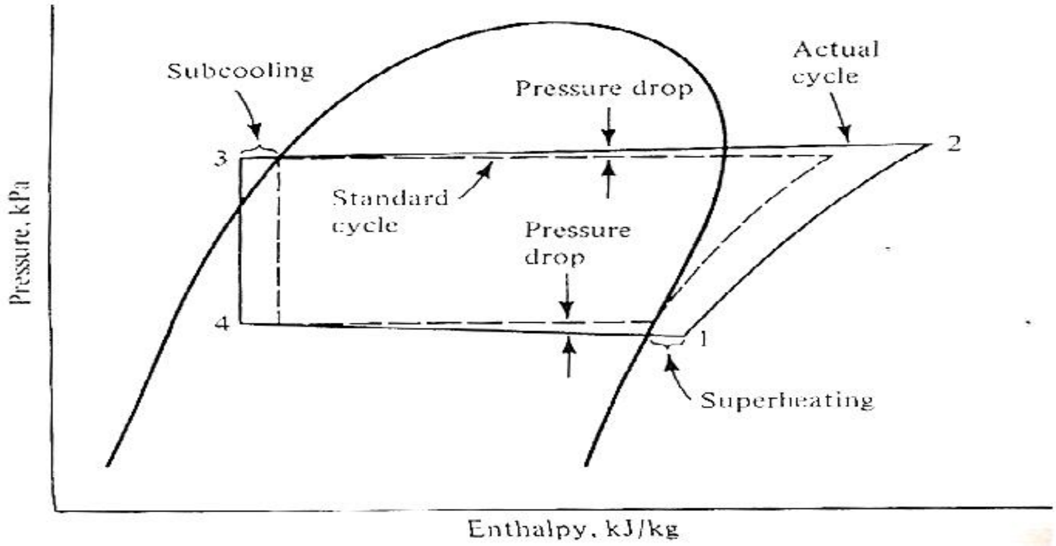

Subcooling
Pressure drop
Actual
cycle
3
2
Standard
cycle
Pressure
drop
4
1
Superheating
Pressure, kPa
Enthalpy, kJ/kg

Figure (4-2)

Experiment No.7:MIXING OF OUTDOOR AIR AND RECIRCULATED AIR

INTRODUCTION:

Mixing of several streams is the process which very frequently used in air conditioning. The mixing normally takes place without edition or rejection of heat or moisture i.e adiabatically at constant total moisture constant. The mixing process are used in determines a confortable climate inside occupation zones and supply the required amount of fresh air to the space in order to maintain human comfort and energy conservation purposes.

OBJECT OF EXPERIMENT

To obtain the properties of air after mixing of specified quantities of return air fresh [outside] air. The mixing is obtained by adjusting the return air control damper from 0 to 100% . the required mixing properties include [DBT, WBT, RH, h, … etc]

APPARATUS

Figure [1] shows the apparatus used in the mixing. The locations of points A to F are as follows:

Point A is before the fan.

Point B is after Pre- heater.

Point C is after the cooling coil .

Point D is after Re-heater.

Point E is at the return duct, near and before the exhaust outlet .

Point F is the fresh air inlet section.

At Point E there is internal orifice plate to allow for measuring air flow rate . after the orifice plate there is a T- section with an exhaust and gravity operated flap valve on discharge. There is a main volume flow damper and mixing box at the end of return bend duct.

Fresh air is brought into the system through an orifice plate at measuring Station F. This orifice plate is retained from the discharge of the basic Air Conditioning Laboratory unit A660.

By comparing the total flow through the internal orifice plate at Station E and the fresh air at Station F, the volume of recirculated air may be adjusted as required.

After mixing, the air continues to the fan inlet measuring Station A.

Adjustment of the volume control damper allows the recirculation to be varied from 0 to approximately 100%. However, the maximum sustainable degree of recirculation will depend upon the local ambient conditions and the amount of steam or heating that is applied, assuming that the refrigeration plant is also running.

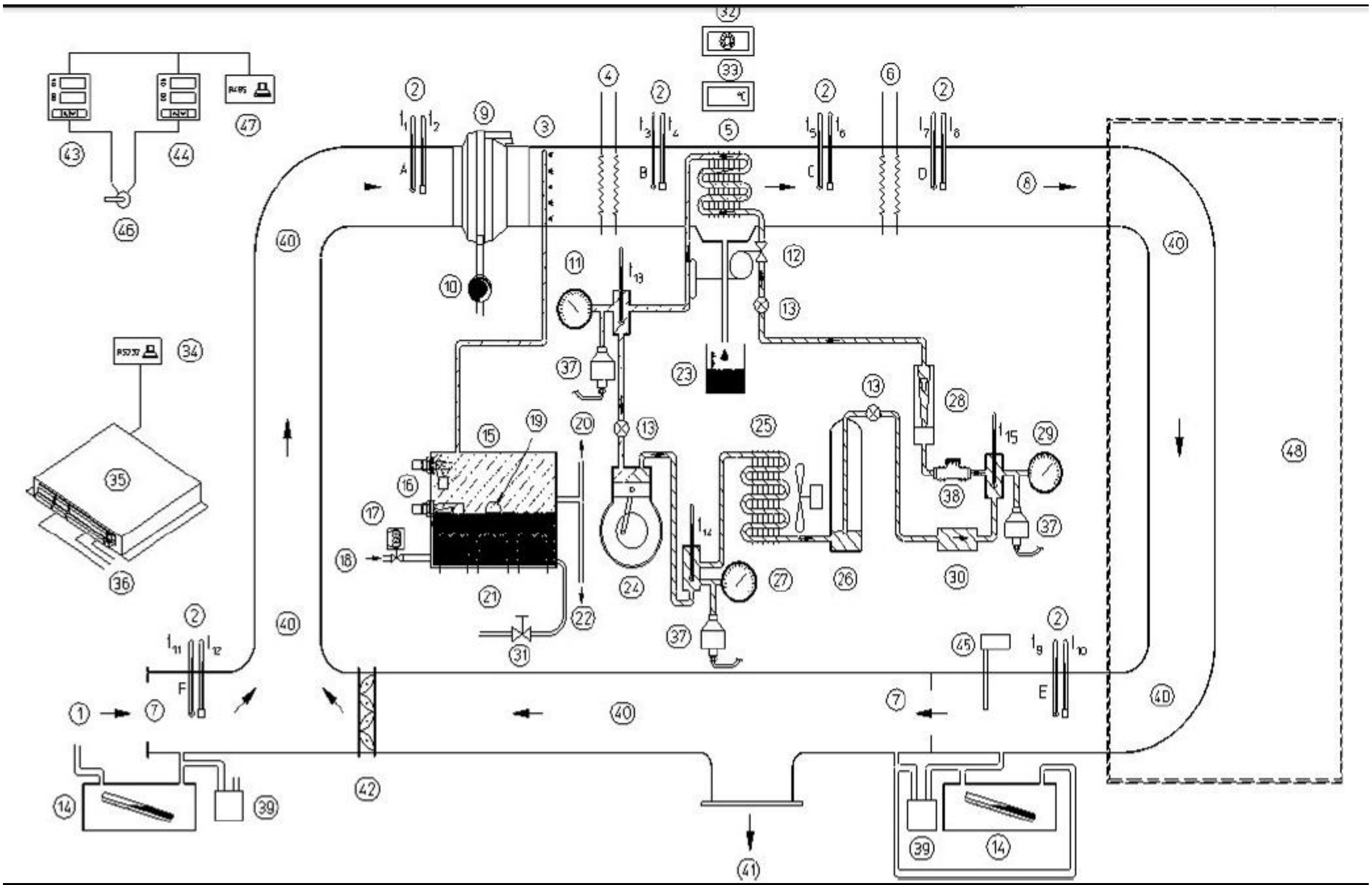


Fig. 1

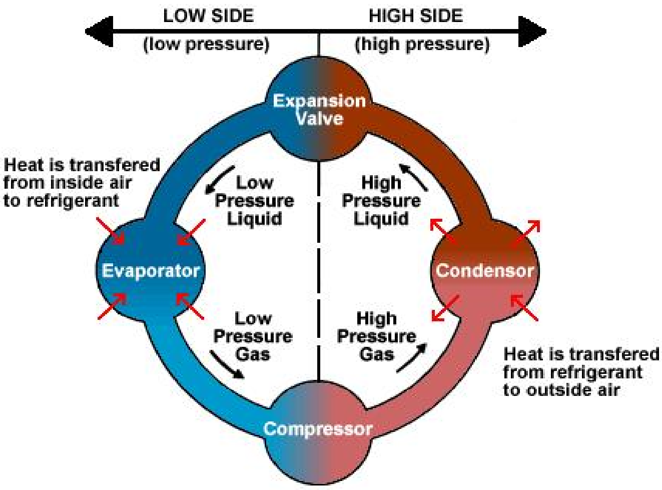
Experiment No.6:Cooling coil capacity calculation

1:Introduction:

For an air conditioning system to operate continsety, the refrigerant must be used repeatedly. For this reason, all air conditioners use the same cycle of compression, condensation, expansion, and evaporation in a closed circuit. The same refrigerant is used to move the heat from one area, to cool this area, and to expel this heat to another area evaporator represent and cooling coil in A/C system.

2- Object:

Calculating the cooling coil capacity.



3- Basic Refrigeration Cycle

- The refrigerant enther the compressor at a low-pressure and temperature gas, it is compressed and then discharge out of the compressor as a high-pressure and temperature gas.
- The gas then flows to the condenser. Here the gas condenses to a liquid, and gives off its heat to the outside air.
- The liquid then moves to the expansion valve under high pressure. This valve restricts the flow of the fluid, and reduuse its pressure and then leaves the expansion valve.
- then The low-pressure liquid and gas moves to the evaporator, where is absorbed from room air and the refrigeration changes from a liquid to a gas.
- The low-pressure gas, of refrigerant moves to the compressor and the cycle is repeated.

Refrigeration in side the evaporator and condenser charge

- Liquids absorb heat when changed from liquid to gas.(ie.Latent heat for vaporation)
- Gases give off heat when changed from gas to liquid. (ie.Latent heat for condensation).

The four-part of cycle can be divided a high pressure side and a low pressure side refers to the pressures of the refrigerant in each side of the system

The pressures recorded from the system are in gauge relative to atmosphere. In order to convert these to absolute pressure the local atmospheric pressure must be added.

The atmospheric pressure was 1010 mBar=101 kN/m2

$$P_{abs} = P_g + P_{atm}$$

A measurable pressure drop exists in the condenser due to friction effects. The condenser is a commercial unit and as such is designed by the manufacturers with minimum cost as a prime consideration. The evaporator, designed for the A660 unit was oversize diameter tube to reduce the pressure drop to a negligible value.

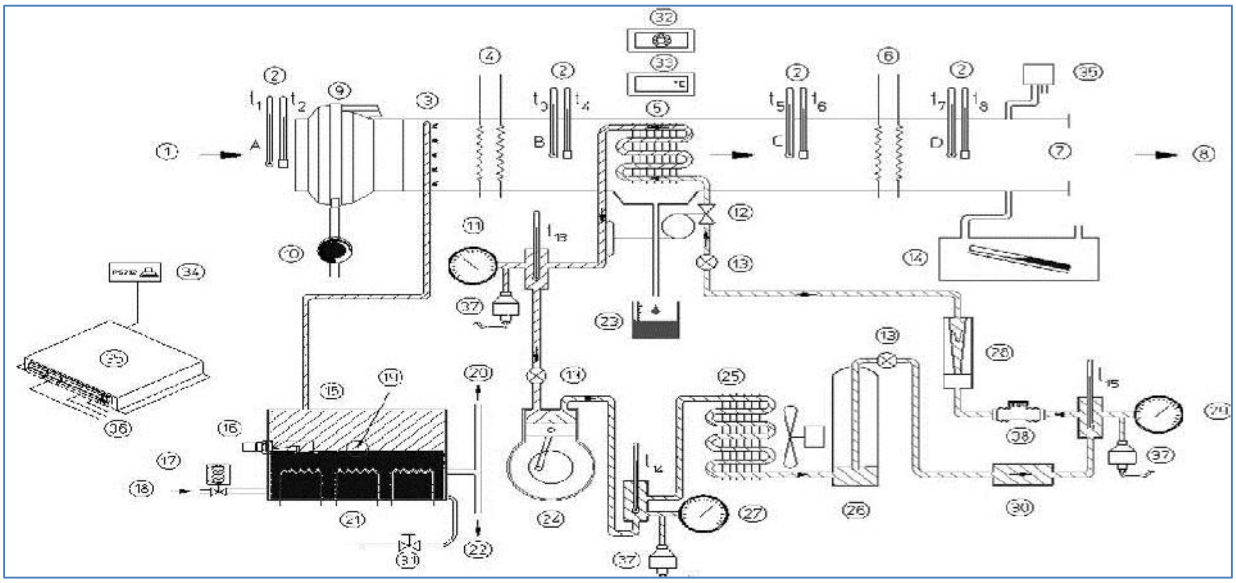


Fig (1)Air conditioning Laboratory Unit A660.

4- Experiment Apparates:

The air condition unit is shown in figure (1) is the A660 air condition laboratory unit. The details of its component is give.

5- P-h Diagram of the basic Refrigerant cycle:

Using the absolute pressures and temperatures recorded around the refrigeration system, a full cycle diagram may be drawn on a refrigerant R134a pressure-enthalpy diagram.

The state points may be determined as follows. Refer to Figure (2) where the state points are shown diagrammatically.

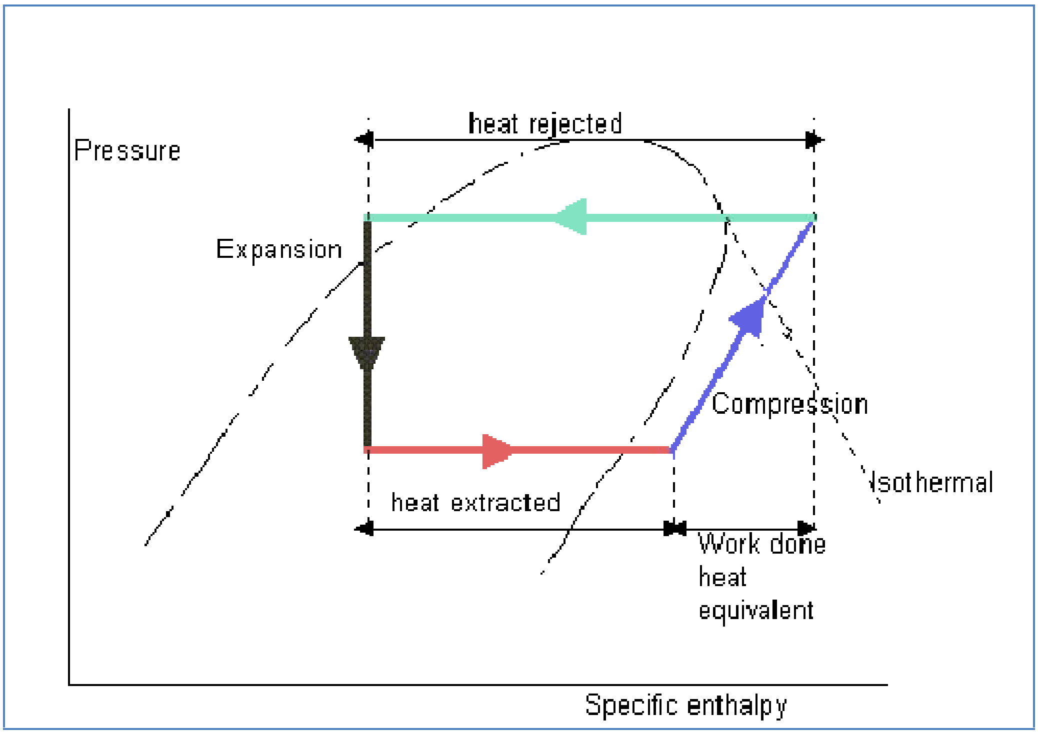
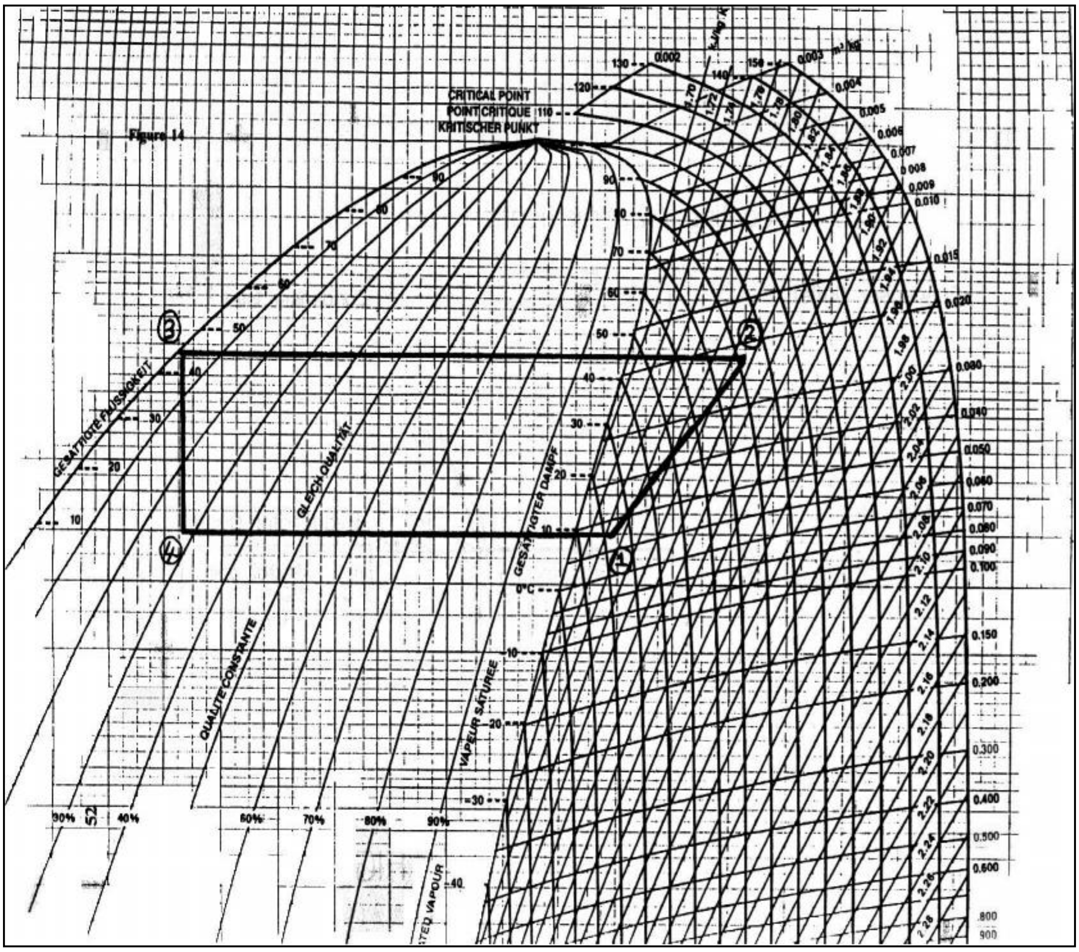


Fig (2) P-h diagram for the experimental refrigeration cycle.



Fig(3)Refrigeration cycle processes on a P-h diagram of R 134 a .

Vapor compression Refrigeration Cycle Processes:

1. Evaporator Outlet/Compressor Inlet (State Point 1)

Locate pressure $\mathbf{P_1}$ on the chart a horizontal line and its intersection with a superheated temperature of $\mathbf{(t_{13})}$. The vertical Enthalpy line $\mathbf{h_1}$ and the specific volume ν_1 at this point can be found.

2. Condenser Inlet (State Point 2)

Locate the pressure $\mathbf{P_2}$ at Condenser inlet as a horizontal pressure line and its intersection with a superheated temperature of $\mathbf{(t_{14})}$. The vertical Enthalpy line $\mathbf{h_2}$ at this point can be found.

3. Condenser Outlet (State Point 3)

Locate the pressure $\mathbf{P_3}$atCondenser outletas a horizontal pressure line and its intersection with the vertical sub-cooled liquid line from $\mathbf{(t_{15})}$ saturated liquid condition.

If this point (3)found on the saturated liquid line. This indicates that the liquid is not sub-cooled. The Enthalpy $\mathbf{h_3}$at this point can be found.

After leaving the condenser the liquid enters the receiver and passes to the expansion valve where it is assumed to expand adiabatically from $\mathbf{P_3}$ to $\mathbf{P_4}$. Hence a vertical line is drawn from State point 3 to State Point 4. Thehorizontal pressure $\mathbf{P_4}$ line also corresponds to a line of constant enthalpy between the saturated liquid and saturated vapour conditions at $\mathbf{P_4}$. The temperature$\mathbf{t_{16}}$ of saturation at $\mathbf{P_4}$ can be found from tables.

The state points are shown on a real R134a Pressure-Enthalpy Diagram for reference in Figure (3). The conditions may also be determined from the R134a tables provided.

The following conditions may be determined for the refrigeration system:

h_1, h_2 , h_3 , h_4 , ν_1(from P-h diagram)

and t_{16} (temperature saturation from tables at P_4)

Experiment.No5:Automobile Air Conditioner

5.1 General :

Refrigeration is defined as “the transfer of heat from a lower temperature region to a higher temperature one”. Some examples of refrigeration devices are refrigerators, automotive air-conditioners, and residential / commercial air-conditioners. All of these devices have one thing in common, to reduce the temperature of an enclosed environment.

5.2 Object :

a)Demonstration on refrigeration cycle configuration and apparatus.

b) study:

1- Effect of variable load on c.o.p

2-Effect of variable compressor speed on c.o.p

5.3 Apparatus :

The automobile air conditioner training unit is shown in figure 5.1 and Figure 5.2. It is consist of three phase induction motor , compressor , condenser ,evaporator , dehydrating filter , pressure gauges ,digital thermometers ,expansion valve and electrical resistances (is simulate the human body heat rejection) . The unit works with R134a and the charge is 0.6 kg.

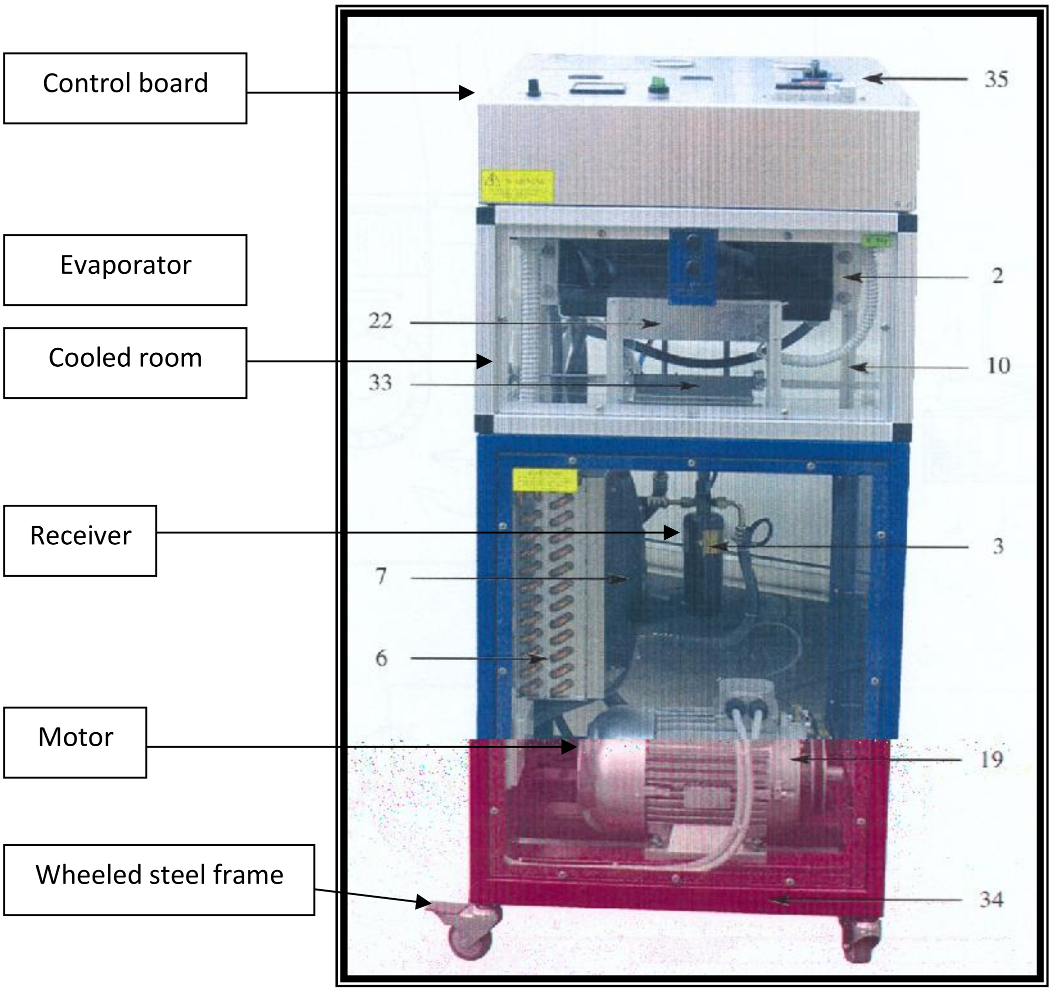


Figure 5.1 Automobile training Air Conditioner