Title: Trial on Vapor Compression Refrigeration System.

Aim: Trial on Vapor Compression Refrigeration System.

Objectives:

1. To evaluate the cooling capacity in watts and in tons of system
2. To evaluate actual and theoretical cop of vapor compression cycle
3. To plot the actual Refrigeration cycle on PH chart
4. To study various components and controls used in vapour compression cycle

Theory:

a) Description:

The refrigeration test Rig enables students to study and understand vapour compression cycle, its component, principle and working. All the components are mounted on rigid Steel frames. The trainer consists of hermetically sealed compressor forced convection air cooled condenser filter drier flow metre expansion device & shell and coil type evaporator. Separate pressure gauges are provided to record and discharge and digital temperature indicators for various temperature measurement. The refrigerant used R1 34A which is environment friendly.
The calorimeter consists of an insulated Stainless Steel tank in which the heater is fixed. The heat absorbed by the refrigerant is balanced by heater input. The heater is an immersion type resistive water heater. The calorimeter temperature can be set by a digital thermostat. Adequate safety devices such as HP/ LP cut out heating thermostat and overload protection for compressor are Incorporated to prevent any malfunctioning of the system.

b) Principle of operation:

The refrigeration test rig works on vapour compression cycle. The refrigeration (process of maintaining a closed space temperature below ambient temperature) is accomplished by continuously circulating, evaporating and condensing a fixed supply of refrigerant in a closed system. Evaporation occurs at a low temperature and low pressure, while condensation occurs at high temperature and pressure. Thus it is possible

to transfer heat from an area of low temperature to an area of high temperature, the surrounding.

The compressor pumps the low pressure refrigerant from the evaporator, increases its pressure and discharges the high pressure gas to the condenser. The refrigerant rejects its heat to the surroundings by passing air over it. At that pressure, the refrigerant loses its latent heat and liquefied. Then the refrigerant passes through the dryer /filter where any residual moisture/ foreign particles present these are plugged. The flow of refrigerant into the evaporator is controlled by an expansion device where its pressure and temperature is lowered to the saturation temperature of the corresponding pressure. The low temperature refrigerant enters the evaporator where it absorbs heat from this surrounding medium and evaporates. The compressor draws the cold vapour and the cycle repeats.

The required instrumentation is provided to measure the various parameters at different points. This included pressure gauges temperature indicators and controller energy meter heater for applying load and flow meter to measure the refrigerant flow.

Technical specifications of refrigeration test rig:

Capacity	500 W At Rated Test Condition
Refrigerant	R134a
Compressor	Hermetically Sealed
Condenser	Copper Tube Aluminium Fines, Forced Convection Air Cooled
Condenser Fan Motor	Axial Flow Induction Type
Dryer/Filter	Molecular Sleeve Type

Expansion Device	Capillary Tube
Refrigerant Flow Measurement	Glass Tube Rotameter
HP/ LP Cut Out	Provided
Pressure Indication	Pressure Gauges, Two Numbers Provided
Energy Metre	Jaypur Make 2nos
Heater	500 W
Temperature Control Of The Calorimeter	Automatic By Digital Temperature Controller
Evaporator For Refrigeration Test Rig	Direct Expansion Shell And Coil Type Refrigerant Through Pipe Water Around The Coil
Temperature Indication	Digital LED
Insulation For Water Tank	Nitrile Foam
Supply	230 Volts 50 Hertz Single Phase AC
Construction	Main Body 18G CRCA Powder Coated, Calorimeter: SS304

Operating instruction:

1. Place the machine in the proper position where it is level horizontal and it is well ventilated. The machine must have at least 1 metre clearance from all sides.
2. Give 230v 50 hertz and single phase supply to the unit
3. Incoming cable should be adequate size (at least 1.5 square mm) to prevent overheating of it.
4. The electrical point should have a MCB of 16a rating
5. Ensure proper earthing
6. Fill the calorimeter or isothermal bath with clean water
7. Start the compressor and heater after a 5 seconds interval by putting the switch on
8. The pump in the calorimeter will equalize the temperature in the tank. Refrigerant will lose its enthalpy to water and it will lose its enthalpy to water and it will evaporate. Water temperature will be reduced. The heater will offset the cooling effect and maintain the temperature of the bath practically constant
9. Adjust the heater load with the help of dimmer such that the temperature remains constant
10. Record the time required for 10 pulses of compressor and heater energy meters. Here heater load is equal to refrigeration effect.
11. Record all the readings as per the observation table
12. Allow at least half hours running time for correct result
13. Calculate the results as per the procedure mentioned

Caution:

1. Always start the machine only after ensuring adequate water level in the tank. There is a small submersible pump in the tank. It should never be run dry. Otherwise it will overheat and go out of order
2. Do not switch ON the heater in the dry tank
3. When not in use for more than, week remove all the water from the tank and keep it dry
4. Do not hamper with the temperature as well as the pressure setting.

Observation Table :

Vapour compression Refrigeration cycle Tutor observation Table

	TIME HRS.	REFRIGERANT TEMPERATURES				WATER TEMP °C.	ENERGY METER (WITHOUT) COMP.	ENERGY METER (WITH) HEATER	REFRIGERANT PRESSURE PSIg		REFRIGERANT MASS FLOW
		AFTER EVAPORATOR	AFTER COMPRESSOR (DISCHARGE)	AFTER COND	AFTER EXPN. VALVE		Es-Time For 10 Pulses	Es-Time For 10 Pulses	SUCTION P_1	DISCHARGE P_2	LPH.
1)	11.40 AM 19/8/2020	18	63	31	10	-	37.36	16.56	35	170	8.5
2)	11.50 AM 19/02/2020	15	66	31	10		37.1	25.23	38	172	8.5

Calculations :

Actual COP :

Refrigerating Effect = Heater Load.

1) Power consumed for heating [Heater]

Time for 10 blinks of Energy meter & Heater = 16.56

Energy Meter const = 3200 Pulse/KW/hr.

10 blinks = 11.25 KJ

$\therefore$ Heater load = $\frac{11.25}{\text{time}} = \frac{11.25}{16.56}$

= 0.6793 KW.

MCQ's:

Pre-Test:

I. Which is/are the following power consuming devices in the set up
   A. Evaporator
   B. Expander
   C. Heater
   D. Compressor
   E. Both C and D

II. Identify the expected areas of maximum pressure losses from the following
   A. Evaporator inlet
   B. Compressor inlet

III. Describe "A" for flow measurement formula of rotameter Q=K.A.(g.h)2?
   A. Cross sectional area of connecting pipe
   B. Annular area between float and pipe

IV. Give examples of power measurement devices
   A. Inputs of voltmeter & ammeter
   B. Inputs of energy meter
   C. Both

V. Capillary tube is the expansion valve used in refrigeration and Air Conditioning units of cooling capacity
   A. >3 tons
   B. <10 tons
   C. <3 tons

Post Test:

I. Increase in work of compression indicates
   A. Pressure losses in overall system
   B. leakages in the system
   C. none
   D. Both A and B

II. Actual Compressor work can be calculated from

A. enthalpy difference in Compressor
B. energy meter reading
C. voltmeter & ammeter
D. Both B and C

III. Predict the correct inference of Actual & theoretical COP of the system?
A. COPact > COPTh
B. COPact = COPTh
C. COPact < COPTh

IV. What are the effects of superheating and subcooling on COP of the cycle?
A. Increase in COP
B. No effect
C. Decrease in COP

V. Superheating of the vapor takes place
A. At constant pressure
B. At Constant entropy
C. At constant volume