DRONACHARYA GROUP OF INSTITUTIONS

LABORATORY MANUAL

REFRIGERATION AND AIR CONDITIONING LAB

SUBJECT CODE: KME-651

B.TECH. (ME) SEMESTER - VI

Academic Session: 2022-23, Even Semester

Student Name:	
Roll. No.:	
Branch/Section:	

Dronacharya Group of Institutions
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Lucknow, Uttar Pradesh 226031

Table of Contents

Vision and Mission of the Institute

Vision:

“Dronacharya Group of Institutions, Greater Noida aims to become an Institution of excellence in imparting quality Outcome Based Education that empowers the young generation with Knowledge, Skills, Research, Aptitude and Ethical values to solve Contemporary Challenging Problems”

Mission:

We, at Dronacharya Group of Institutions, are absolutely committed to serve the society and improve the mode of life by imparting high quality education in the field of Engineering and Management catering to the explicit needs of the students, society, humanity, and industry. ‘Shiksha evam Sahayata’ i.e. Education and help are the two words etched on our banner soaring higher year after year.

Vision and Mission of the Department

Vision:

“To become a Centre of Excellence in teaching and research in Mechanical Engineering for producing skilled professionals having a zeal to serve society”

Mission:

M1: To create an environment where students can be equipped with strong fundamental concepts.

M2: To provide an exposure to emerging technologies by providing hands on experience for generating competent professionals.

M3: To promote Research and Development in the frontier areas of Mechanical Engineering and encourage students for pursuing higher education

M4: To inculcate in students ethics, professional values, team work and leadership skills**.**

Program Educational Objectives (PEOs)

PEO 1. Engineers will practice the profession of engineering using a systems perspective and analyze, design, develop, optimize & implement engineering solutions and work productively as engineers, including supportive and leadership roles on multidisciplinary teams.

PEO 2. Continue their education in leading graduate programs in engineering & interdisciplinary areas to emerge as researchers, experts, educators & entrepreneurs and recognize the need for, and an ability to engage in continuing professional development and life-long learning.

PEO 3. Engineers, guided by the principles of sustainable development and global interconnectedness, will understand how engineering projects affect society and the environment.

PEO 4. Promote Design, Research, and implementation of products and services in the field of Engineering through Strong Communication and Entrepreneurial Skills.

PEO 5. Re-learn and innovate in ever-changing global economic and technological environments of the 21st century.

Program Outcomes (POs)

PO1: Engineering knowledge: Apply knowledge of mathematics, science, and engineering in Mechanical Engineering.

PO2: Problem analysis: Design and conduct experiments, as well as to analyze and interpret data.

PO3: Design/development of solutions: To design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.

PO4: Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5: Modern tool usage: Apply principles of engineering, basic science, and mathematics to design and realize physical systems, components, or processes.

Use the techniques, skills, and modern engineering tools necessary for engineering practice like AUTOCAD.

PO6: The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7: Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice.

PO9: Individual and teamwork: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10: Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11: Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one’s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12: Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes (PSOs)

PSO 1: Graduates of the program will achieve excellence in product design, thermal engineering and manufacturing system by acquiring knowledge in mathematics, science and designing principles.

PSO 2: Graduate will be able to analyze, interpret and provide solutions to the real life mechanical engineering problems.

PSO 3: Graduate will develop an approach to solve multidisciplinary problems of manufacturing and allied industries.

University Syllabus

1. Experiment on refrigeration test rig and calculation of various performance parameters.
2. Experiment on air-conditioning test rig & calculation of various performance parameters.
3. Study of Psychrometer and determination of humidity of air using Sling Psychrometer.
4. To study and perform experiment on vapour absorption apparatus.
5. To study the air washer and perform different psychometric processes on air washer.
6. Study of desert coolers and determine the change in temperature and humidity of ambient air.
7. Handling, use and familiarization with refrigeration tools and accessories such as: Tube cutter; Tube bender [spring type]; Flaring tool; Swaging tool; Pinch off etc.
8. Study of window air conditioner.
9. Study of Hermetically sealed compressor.
10. To study basic components and control devices of refrigeration and air-conditioning system.
11. Experiment on Ice-plant and calculation of various performance parameters.
12. Visit of a central air conditioning plant and its detailed study.
13. Visit of cold-storage and its detailed study.

Course Outcomes

CO 1	Determine the performance of different refrigeration and air-conditioning systems.
CO 2	Apply the concept of psychrometry on different air cooling systems.
CO 3	Interpret the use of different components, control systems and tools used in RAC Systems

CO-PO Mapping

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO 1	1		1		3			2	3	1	3	1
CO 2	1		3		3			2	3	1	3	1
CO 3	1		3		3			2	3	1	3	1
CO	**1**		**2.2**		**3**			**2**	**3**	**1**	**3**	**1**

CO-PSO Mapping

	PSO1	PSO2	PSO3
CO 1	2		2
CO 2	2		2
CO 3	2		2
CO	**2**		**2**

Course Overview

By following the guidelines outlined in this manual and conducting experiments in the laboratory, the following objectives can be accomplished:.

1. Evaluate the performance of refrigeration and air-conditioning systems using various performance parameters.
2. Diagnose faults in refrigeration and air-conditioning systems.
3. Undertake repair and maintenance tasks for such systems.
4. Perform trials on refrigeration and air-conditioning equipment.
5. Familiarize oneself with the latest advancements in the field of refrigeration.
6. Develop a logical approach to analyze and interpret data.

List of Experiments mapped with COs

S. No	Aim of the Experiment	COs
1.	Experiment on refrigeration test rig and calculation of various performance parameters.	**CO 1**
2.	To study and perform experiment on vapour absorption apparatus.	**CO 4**
3.	To study different types of expansion devices used in refrigeration system.	**CO 3**
4.	To study different types of evaporators used in refrigeration system.	**CO 3**
5.	To study basic components of air-conditioning system.	**CO 3**
6.	Experiment on air-conditioning test rig & calculation of various performance parameters.	**CO 1**
7.	Experiment on Ice-plant.	**CO 4**
8.	Study of window air conditioner.	**CO 4**
9.	Study of hermetically sealed compressor.	**CO 3**
10.	Study of parts and operation of a cold Storage plant and Ice bank	**CO 2**

DOs and DON'Ts

DOs

1. Student must carry record and observation.
2. Take signature of lab in charge after completion of observation and record.
3. If any equipment fails in the experiment report it to the supervisor immediately.
4. Students should come to the lab with thorough theoretical knowledge.
5. Put your bags in the designated area.

DON'Ts

1. Don't touch the equipment without instructions from lab supervisor.
2. Don't crowd around the experiment and behave in-disciplinary.
3. Using the mobile phone in the laboratory is strictly prohibited.

General Safety Precautions

Precautions (In case of Injury or Electric Shock)

1. To break the victim with live electric source, use an insulator such as firewood or plastic to break the contact. Do not touch the victim with bare hands to avoid the risk of electrifying yourself.
2. Unplug the risk of faulty equipment. If the main circuit breaker is accessible, turn the circuit off.
3. If the victim is unconscious, start resuscitation immediately, use your hands to press the chest in and out to continue breathing function. Use mouth-to-mouth resuscitation if necessary.

Precautions (In case of Fire)

1. Turn the equipment off. If the power switch is not immediately accessible, take plug off.
2. If fire continues, try to curb the fire if possible, by using the fire extinguisher or by covering it with a heavy cloth if possible isolate the burning equipment from the other surrounding equipment.
3. Sound the fire alarm by activating the nearest alarm switch located in the hallway.

Guidelines to Students for Report Preparation

All students are required to maintain a record of the experiments conducted by them. Guidelines for its preparation are as follows:-

1) All files must contain a title page followed by an index page. ***The files will not be signed by the faculty without an entry in the index page.***

2) Student's Name, Roll number and date of conduction of experiment must be written on all pages.

3) For each experiment, the record must contain the following

(i) Aim/Objective of the experiment

(ii) Pre-experiment work (as given by the faculty)

(iii) Lab assignment questions and their solutions

(iv) Test cases (if applicable to the course)

(v) Results/ output

Note:

1. Students must bring their lab record along with them whenever they come for the lab.

2. Students must ensure that their lab record is regularly evaluated.

Lab Assessment Criteria

An estimated 10 lab classes are conducted in a semester for each lab course. These lab classes are assessed continuously. Each lab experiment is evaluated based on 5 assessment criteria as shown in following table. Assessed performance in each experiment is used to compute CO attainment aswell as internal marks in the lab course.

Grading Criteria	Exemplary (4)	Competent (3)	Needs Improvement (2)	Poor (1)
AC1: Pre-Lab written work (this may be assessed through viva)	Complete procedure with underlined concept is properly written	Underlined concept is written but procedure is incomplete	Not able to write concept and procedure	Underlined concept is not clearly understood
AC2: Program Writing/ Modeling	Assigned problem is properly analyzed, correct solution designed, appropriate language constructs/ tools are applied, Program/solution written is readable	Assigned problem is properly analyzed, correct solution designed, appropriate language constructs/ tools are applied	Assigned problem is properly analyzed & correct solution designed	Assigned problem is properly analyzed
AC3: Identification & Removal of errors/ bugs	Able to identify errors/ bugs and remove them	Able to identify errors/ bugs and remove them with little bit of guidance	Is dependent totally on someone for identification of errors/ bugs and their removal	Unable to understand the reason for errors/ bugs even after they are explicitly pointed out
AC4:Execution & Demonstration	All variants of input /output are tested, Solution is well demonstrated and implemented concept is clearly explained	All variants of input /output are not tested, However, solution is well demonstrated and implemented concept is clearly explained	Only few variants of input /output are tested, Solution is well demonstrated but implemented concept is not clearly explained	Solution is not well demonstrated and implemented concept is not clearly explained
AC5:Lab Record Assessment	All assigned problems are well recorded with objective, design constructs and solution along with Performance analysis using all variants of input and output	More than 70 % of the assigned problems are well recorded with objective, design contracts and solution along with Performance analysis is done with all variants of input and output	Less than 70 % of the assigned problems are well recorded with objective, design contracts and solution along with Performance analysis is done with all variants of input and output	Less than 40 % of the assigned problems are well recorded with objective, design contracts and solution along with Performance analysis is done with all variants of input and output

LAB EXPERIMENTS

EXPERIMENT NO. 1

OBJECTIVE:
Experiment on refrigeration test rig and calculation of various performance parameters.

PRE-REQUISITES:
Students are required to have understanding of the following basics to enable better understanding of the practical:

1. Knowledge of refrigeration cycle.
2. Basic understanding of coefficient of performance (COP) of cycle and tonnage capacity.
3. Knowledge of calculations related to COP and tonnage capacity.

Test Rig Specification

Compressor	ISI hermetically sealed.
Condenser	Air Cooled Condenser.
Evaporator	Calorimeter type. Inner chamber is made up of stainless steel. The immersion type cooling coil is provided inside the calorimeter chamber.
Refrigerant	Freon, R-22
Control Panel	➢ Glass tube rotameter to measure the flow of liquid refrigerant. ➢ Expansion device (capillary tube & expansion valve). ➢ Drier. ➢ Thermostat for heating and cooling. ➢ Pressure gauges. ➢ Main switch, digital type voltmeter, ampere meter, energy meter. ➢ Digital temperature Indicator fitted with RTD thermocouple.
Voltage	Single phase, 220 V, 50 Hz AC supply.

THEORY:
The coefficient of performance of refrigeration plant is given by the ratio of heat absorbed, by the refrigerant when passing through the evaporator or the system,

to the working input to the compressor to compress the refrigeration. Co-efficient of refrigeration cycle is given by the ratio of net refrigeration effect to the power required to run the compressor.

COP(cycle) = Net refrigerant effect in unit time / Power input in unit time
= $m\ C_p\ \Delta T$ / kWh
where

C_p = Specific heat of refrigerant
ΔT = Temperature difference ($T_1 - T_3$)
kWh = Kilowatt hours energy meter reading (1 kWh = 3600 Joule)

$$= m\, C_p\, \Delta T / 3.88$$

PROCEDURE:

Switch on the compressor and let it run for considerable period of time. Fill the measured amount of water in cooling chamber. Measure initial temperature of water. Note down the temperature of water after 20 minutes, note down the power consumed by the compressor.

OBSERVATIONS:

S. no.	Energy meter reading (kWh)			Mass of water (Kg)	Temperature of chilling water final ΔT (°C)
	Initial (a)	Final (b)	C = (b - a)		
1					
2					
3					
4					
5					

RESULT:

The COP and tonnage capacity are calculated for different cases and is found out to be ……

PRECAUTIONS:

1. Keep the instrument clean and away from dust.
2. Move the equipment carefully.
3. Take the readings carefully under steady-state conditions.

EXPERIMENT NO. 2

OBJECTIVE:
To study and perform experiment on vapour absorption apparatus.

SYSTEM COMPONENTS:

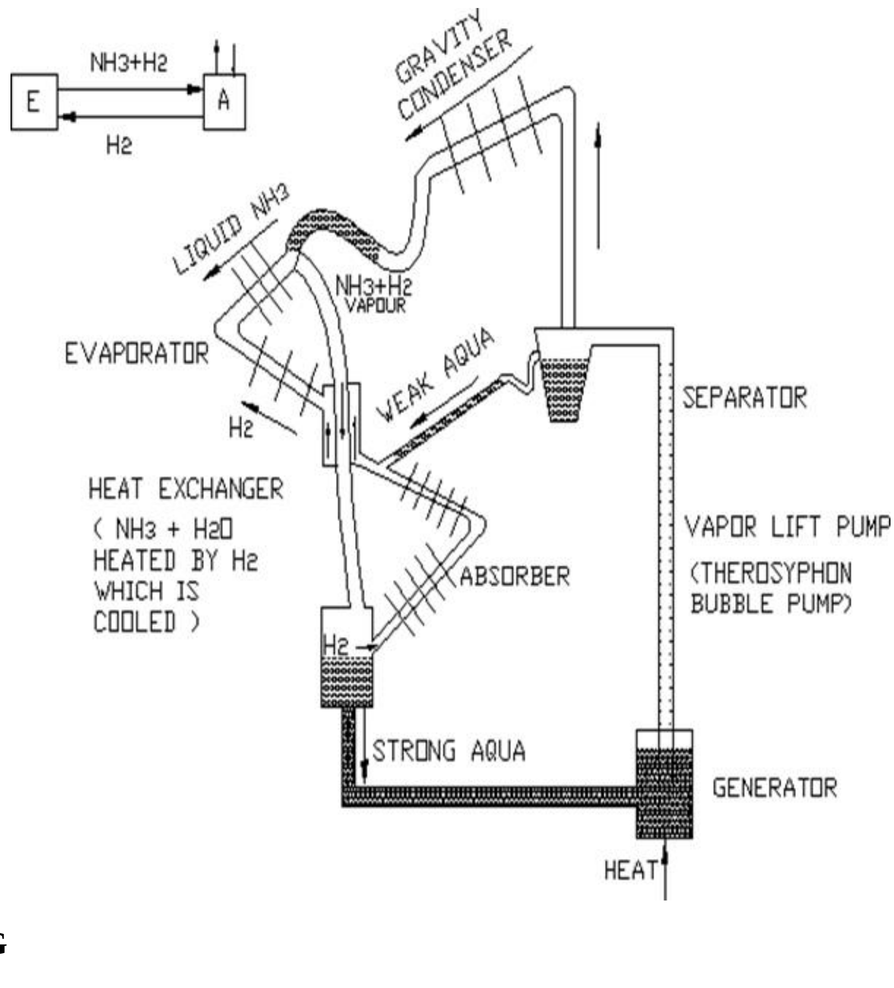
- Electrolux refrigerator
- Bulb
- Voltmeter
- Ammeter
- Temp indicator with pt 100 sensors
- Wattmeter
- Dimmer

THEORY

Simple Electrolux System: This system was invented by two Swedish engineers Carl Munters and Baltzer Von Platen developed the domestic absorption type refrigerator from an invention. The main purpose of this system is to eliminate the pump so that in the absence of moving parts, the machine becomes noise-less. Ammonia is used as a refrigerant. The operation of this system is based on the concept of Dalton’s Law. The ammonia vapor in the condenser is condensed to liquid and flows to evaporator by gravity. The whole plant is charged to a pressure of about 15 bars. In the evaporator the liquid ammonia meets an atmosphere of hydrogen at about 12 bars. Thus the partial pressure of ammonia falls to about 3 bar, keeping the same total pressure, and the temperature falls to about - 100c. The vaporization of ammonia at this temperature produces refrigeration. Water is used as a solvent for ammonia. It absorbs ammonia readily. If liquid ammonia is introduced at the top of the system it passes on to the evaporator and vaporizes. Hydrogen flows upwards in the evaporator counter - flows to liquid ammonia that falls from the top. The ammonia vapor and hydrogen leave the top of the evaporator and flow through the gas heat exchange getting warmed by the warmer hydrogen flowing through the evaporator. Both the gases flow to the absorber. Weak aqua ammonia solution enters at the top of the absorber and absorbs ammonia gas as it passes counter flow through the absorber. The hydrogen is not soluble in weak aqua ammonia solution and gets separated and flows up to the evaporator through the heat exchanger. Strong aqua ammonia solution leaves the bottom of the absorber and passes on the generator.

Heat is supplied to the generator from external source by gas burner etc., expelling ammonia vapor out from the strong solution. Here the problem is to raise the elevation of week solution of ammonia also so that it can pass to the separator and flow back to the absorber. Principle of bubble pump is used here. The delivery tube from the generator is immersed below the liquid level in the generator. Thus as ammonia vaporizes in the tube, they carry slugs of week solution also into the separating vessel. From the separating vessel, weak solution flows to the absorber and ammonia vapor passes on to the condenser.

Thus cycle is completed. The total pressure in the condenser is approximately the same as in evaporator. Since, in the condenser there is pure ammonia, the vapor pressure there is more or less same as the total pressure. In the evaporator, there exists a mixture of ammonia vapor and hydrogen gas. Thus ammonia vapor pressure is much less, this being equal to total pressure minus the partial pressure of hydrogen. Being at a pressure below saturation pressure, the ammonia readily evaporates in the evaporator and refrigerates. Thus temperature equal to the saturation temperature of ammonia at its partial pressure is theoretically obtained in the evaporator.

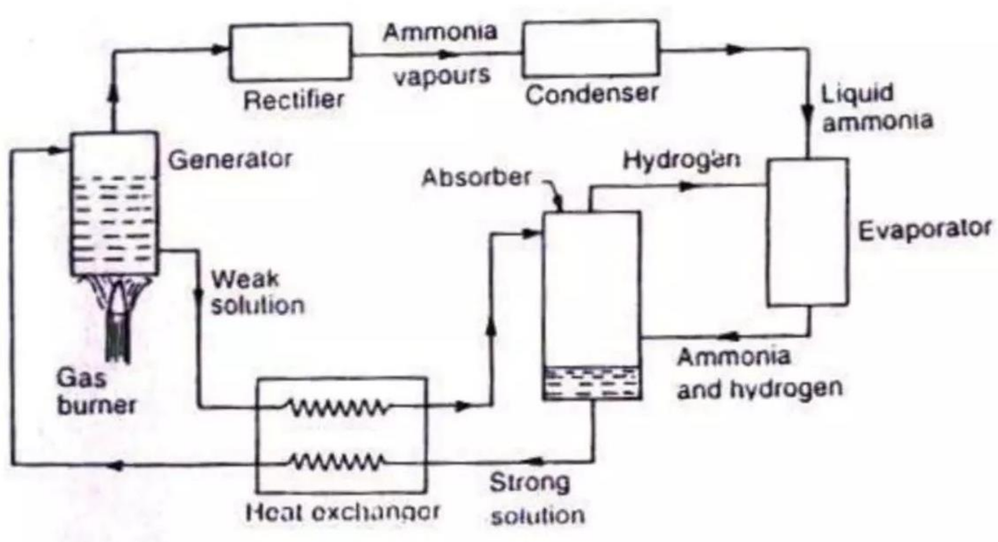


WORKING

1. The arrangement of the components of the system is as shown above figure.
2. This type of refrigerator is known as three fluid absorption system in which refrigerant is ammonia, solution used is aqua ammonia and third fluid used in evaporator is hydrogen gas. The solution circulation pump is taken out of the system and test-rig is made

noiseless.

3. Circulation of system is achieved by providing high pressure in condenser and generator and low pressure in evaporator and absorber.
4. The liquid ammonia flows under gravity into evaporator. As soon as ammonia liquid enters the evaporator the partial pressure of ammonia decreases to 2 bars due to presence of hydrogen and by absorbing latent heat ammonia converts into vapor.
5. The heavy mixture of ammonia vapor and hydrogen vapor coming out of evaporator is passed to absorber. The weak solution of aqua ammonia is sprayed into the absorber where it absorbs ammonia vapors and gets converted into strong solution of aqua ammonia. The hydrogen left is recirculated into evaporator.



6. The strong solution of aqua ammonia from the absorber again enters into generator through heat exchanger. The purpose of heat exchanger is to transfer the heat of weak aqua ammonia solution to strong aqua ammonia solution to improve the overall performance of system.
7. The strong aqua ammonia solution is heated in generator by electric heater. Due to addition of heat ammonia vapors are released and strong solution gets converted into weak solution, which is passed to absorber. Analyzer and rectifier remove moisture in ammonia vapor and dehydrated ammonia vapors are passed to condenser.
8. The chief advantage of Electrolux refrigerator is that it has no moving parts. As no compressor or pump is required it is very quiet in operation.

Experimental Procedure:

1. Switch ON the supply to the trainer and switch ON the main switch to start the trainer.
2. Check all the temperatures (i.e. 1,2,3,4,5,6)
3. Let the system run for some period (till the temperature in the evaporator tank starts decreasing)
4. Now note down the readings as per the observation table.
5. When cabinet temperature (T6) reaches around 15˚C, switch on dimmer. Adjust the load between 75 – 100 Volts. Ensure that the cabinet temperature does not increase when bulb is switched on.
6. If T6 increases, reduce the power supplied to bulb.
7. Note down 5 – 6 readings at interval of 10 minutes.
8. Calculate the results as per the calculation procedure.

SPECIFICATION & OBSERVATION TABLE

SR. NO.	**T1 (ºC)**	**T2 (ºC)**	**T3 (ºC)**	**T4 (ºC)**	**T5 (ºC)**	**T6 (ºC)**	**V (V)**	**I (A)**	**POWER (watt)**	**TIME DURATION**

Where,

T1: temperature before generator.

T2: temperature after generator

T3: evaporator temperature

T4: condenser temperature

T5: temperature before absorber

T6: cabinet temperature

CALCULATION & RESULT TABLE

1) **COP** (Theoretical) = T3 (T2 – T5) / T2 (T5 – T3)

Where

T2: temperature after generator

T3: evaporator temperature

T5: temperature before absorber

2) COP (actual) = load applied / Heat supplied to generator

RESULT TABLE:

Sr. No.	C. O. P. (Th)	C.O.P.(Actual)
1		

RESULT:

The COP and tonnage capacity are calculated for different cases. And is found out to be ……

PRECAUTIONS:

1. Keep the instrument clean and away from dust.
2. Move the equipment carefully.
3. Take the readings carefully under steady-state conditions

EXPERIMENT NO. 3

OBJECTIVE:

To study different types of expansion devices used in refrigeration system.

PREREQUISITES:

Students are required to have understanding of the following basics to enable better understanding of the practical:

"Expansion Device", is the term usually used in industry, for any device that meters or regulates the flow of liquid refrigerant to an evaporator. It has two purposes:

1. To reduce the pressure of the liquid refrigerant.
2. To regulate the flow of refrigerant to the evaporator.

It, thus divides the high-pressure side from the low-pressure side of the system.

HAND EXPANSION VALVE:

A hand expansion valve is a hand operated needle valve. The rate of liquid flow through the valve depends on the pressure differential across the valve orifice and on the degree of valve opening, the latter being manually adjustable.

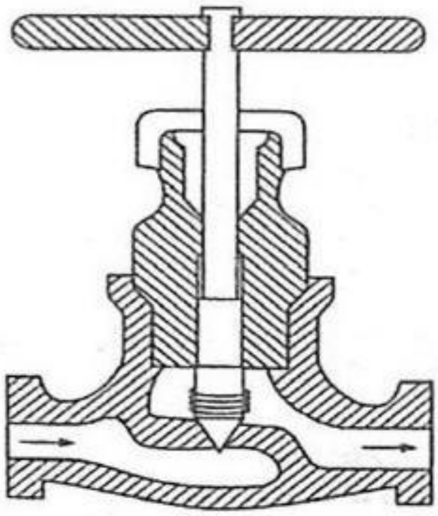


Fig. 1 Hand expansion valve.

This is suitable for use only on large systems where an operator is on duty and where the load on the system is relatively constant (e.g., ice making plants and cold storages).

The main advantages of a hand expansion valve are its simplicity and low initial cost. Also, because of its simple construction there is very little that can get out of order. The principle disadvantage is that an operator must be available at all times to make the necessary adjustment to meet the changing load conditions.

AUTOMATIC EXPANSION VALVE

The automatic expansion valve is a pressure-reducing device. It is activated by the evaporator pressure which it keeps constant since the pressure of the refrigerant in the evaporator determines evaporator temperature.

Fig. 2 shows a schematic sketch of an automatic expansion valve. It is a diaphragm-or bellows operated valve with the evaporator pressure acting on the lower side of the diaphragm and atmospheric pressure plus adjustable spring pressure acting on the upper side. As the compressor operates to remove the gas from the evaporator, reducing the pressure in the evaporator and under the diaphragm, the adjusting spring pressure pushes diaphragm down. This motion is transmitted through push rods (or by needle valve seat) to the valve needle, opening it enough to allow more refrigerant to flow to the evaporator. As more Refrigerant in liquid enters the evaporator, the pressure increases forcing the diaphragm upward and allowing the valve to close. A properly sized valve will pass enough liquid refrigerant to maintain constant temperature and pressure conditions.

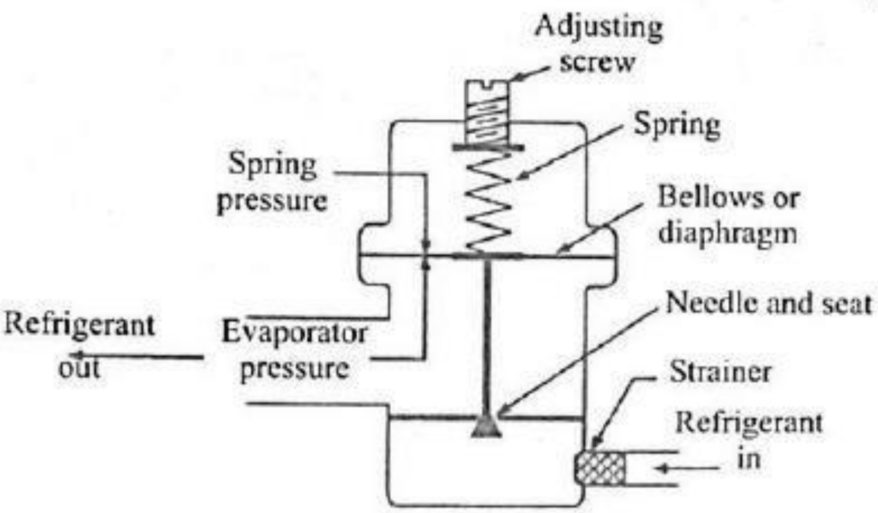


Fig. 2. Automatic expansion valve.

An automatic expansion valve must be set to prevent over feeding on low-load conditions and therefore cannot feed enough on high-load conditions. If the heat load drops off quickly, the evaporator pressure drops suddenly, opening the valve wide again in trying to raise evaporator pressure to the pressure setting of the valve. As a result the liquid refrigerant can flood back to the compressor and cause much damages. If the heat load increases suddenly, the evaporator pressure will increase rapidly, forcing the diaphragm up and allowing the valve to close. This `starves' the evaporator until the compressor can reduce the pressure and allow more refrigerant to pass into the evaporator.

The automatic expansion valves find their greatest use in the systems with relatively constant loads and in systems with only one evaporator coil.

THERMOSTATIC EXPANSION VALVE

A thermostatic expansion valve is a throttling device which works automatically, maintaining proper and correct liquid flow as per the requirements of the load on the evaporator.

This valve finds a wide application because of its adaptability to any type of dry expansion application, automatic operation, high efficiency and ability to prevent liquid flood backs.

A thermostatic expansion valve performs the following functions:

(i) Reduces the pressure of liquid from the condenser pressure to evaporator pressure.
(ii) Keeps the evaporator fully active.
(iii) Modulates the flow of liquid to the evaporator according to the load requirement of the evaporator so as to prevent flood back of liquid refrigerant to the compressor.

Fig. 3 shows a thermostatic expansion valve. The following are the important parts of the valve:

1. Power element with a feeler bulb
2. Valve seat and needle
3. Adjustment spring
4. Bellows or diaphragm.

The remote bulb charged with fluid which is open on one side of the diaphragm through a capacity tube is clamped firmly to the evaporator outlet. The temperature of the saturated liquid in vapour mixture is the same as the temperature of the superheat gas leaving the evaporator at the location. The pressure of the liquid in the bulb (P3) tends to open the valve. This pressure is balanced by pressure due to spring (P2) plus pressure in the evaporator (P1).

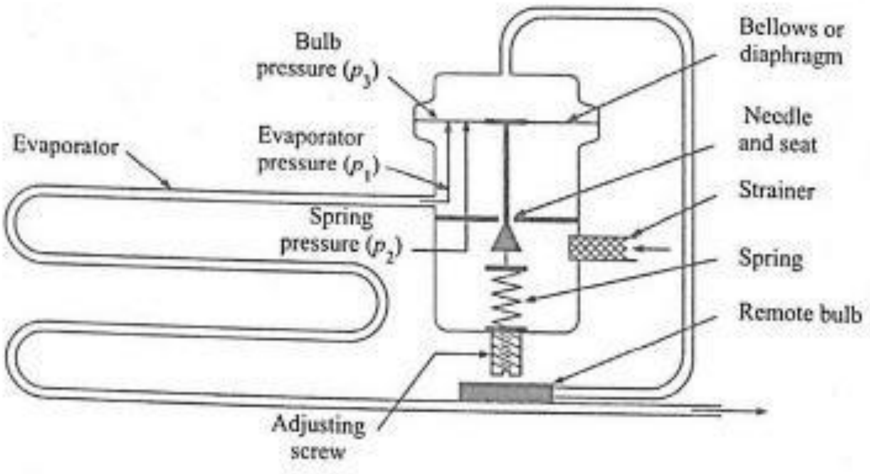


Fig. 3. Thermostatic expansion valve.

The performance characteristics of thermostatic-expansion valves are most suitable for application in air-conditioning and refrigerant plants. When the cooling load 'increases', the refrigerant evaporates at a faster rate in the evaporator than the compressor can suck. As a result the pressure and degree of superheat in the evaporator increase. The increase in superheat causes the valve to open more and to allow more refrigerant to enter the evaporator. At the same time, the increase in suction pressure also enables the compressor to delivery increased refrigerating capacity. When the cooling load 'decreases' the refrigerant evaporates at a slower rate than the compressor can suck. As a result, the evaporator pressure drops and the degree of superheat decreases. The valve tends to close and the compressor delivers less refrigerating capacity at a decreased suction pressure. Thus the thermostatic-expansion valve, as opposed to the automatic expansion valve, is capable of meeting varying load requirement.

Most thermostatic expansion valves are set for 5°C of superheat and are usually rated in tonnes of refrigeration.

CAPILLARY TUBE

A capillary tube is a fixed restriction-type device. It is the simplest of the refrigerant flow controls, consisting merely of a fixed length (from 0.5 m to 5 m) of small diameter (0.5 mm to 2.25 mm) tubing installed between the condenser and the evaporator, usually in place of the conventional liquid line.

The pressure drop through the capillary tube is due to the following two factors:

(i) Friction, due to fluid viscosity, resulting in 'frictional pressure drop'.
(ii) Acceleration, due to the flashing, of the liquid refrigerant into vapour resulting 'momentum pressure drop'.

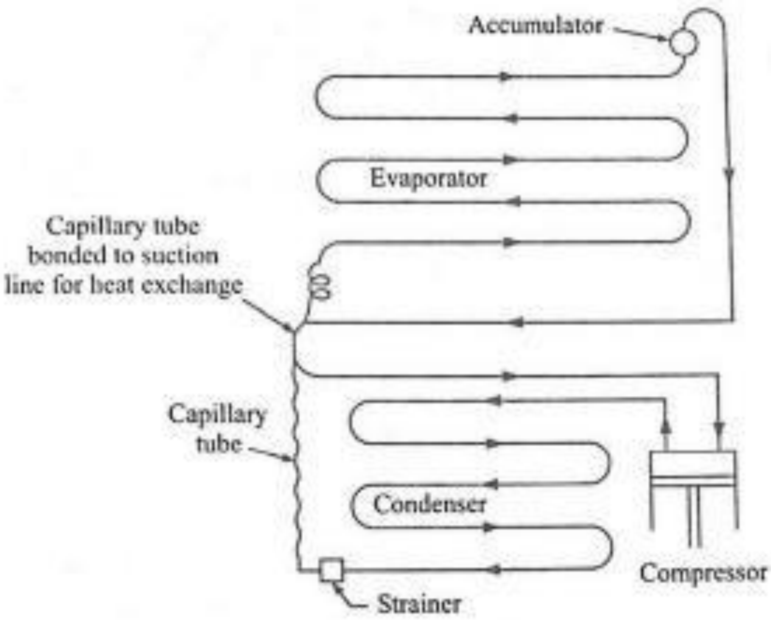


Fig. 4. Capillary tube.

The cumulative pressure drop must be equal to the difference in pressures at the two ends of the tube. The flow through the capillary tube will, therefore, adjust so that the pressure drop through the tube just equals the difference in pressures between the condenser and evaporator. For a given state of the refrigerant, the pressure drop is directly proportional to the length and inversely proportional to the bore diameter of the tube.

To obtain the desired flow and pressure drop a number of combinations of length and bore are possible for a capillary tube. However, once a capillary tube has been selected, it will be suitable only for design pressure drop. It cannot satisfy the flow requirements with changing condenser and evaporator pressures. Even then the capillary tube is most commonly used in small refrigerators, window type air-conditioners, water-coolers, etc.

Advantages:

Capillary tube claims the following advantages:

1. Simplicity.
2. Low cost.
3. Absence of moving parts.
4. It is found most advantageous with on-off control because of its unloading characteristics.

EXPERIMENT NO. 4

OBJECTIVE:

To study different types of evaporators used in refrigeration system.

PREREQUISITES:

Students are required to have understanding of the following basics to enable better understanding of the practical:

1. Basic concepts of Thermodynamics and Heat Transfer.

INTRODUCTION

An evaporator is any heat transfer surface in which a volatile liquid is vapourised for the purpose of removing heat from a refrigerated space or product and also cooling its own coils. Evaporator is also called chiller, freezer or cooling coil depending upon its application. An evaporator must fulfil following three main requirements:

(i) It must have enough surface to absorb the required heat without excessive temperature difference between the refrigerant and the substance to be cooled.

(ii) It must provide sufficient space for the liquid refrigerant and also adequate space for the refrigerant vapour to separate from the liquid.

(iii) It must provide space for circulation of the refrigerant without excessive pressure drop between the intel and outlet.

Classification of Evaporators

Evaporators may be classified as follows:

(a) On the basis of operating conditions:
  1. Flooded type evaporators.
  2. Dry or direct expansion type evaporators.

(b) On the basis of construction of the surfaces:
  1. Bare-tube evaporator
  2. Plate-surface evaporator
  3. Finned-tube evaporator.

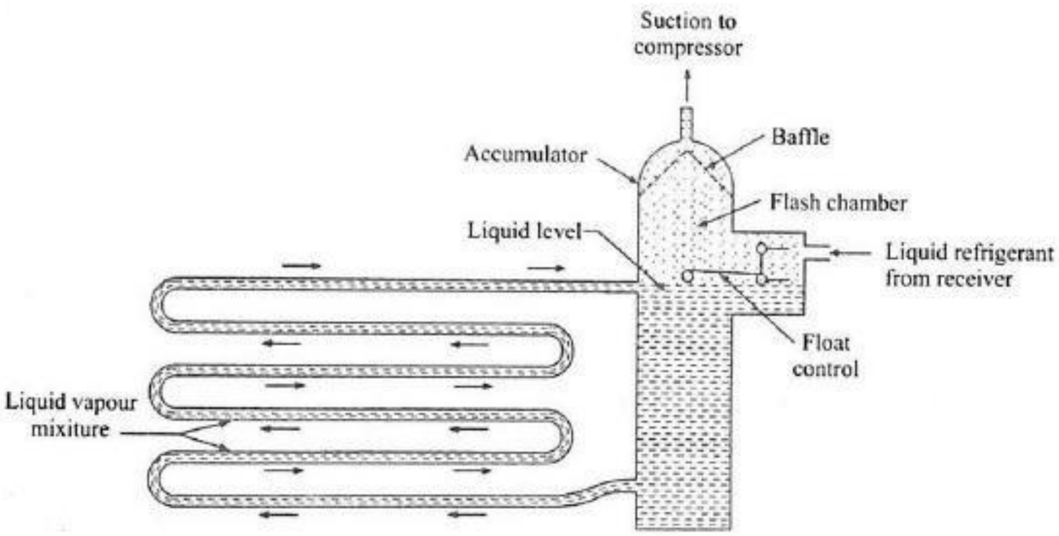
The above mentioned evaporators are discussed in the following articles.

Flooded Type Evaporators

A flooded or overfeed evaporator is one wherein the amount of liquid refrigerant circulated through the evaporator is considerably in excess of that which can be vaporised. Here a constant refrigerant liquid level is maintained. A float valve is used as the throttling device which maintains a constant liquid level in the evaporator. Due to the heat supplied by the substance to be cooled, the liquid refrigerant is vaporised and so the liquid level falls down. The float valve opens to admit more liquid and thus maintains a constant liquid level. As a result the evaporator is always filled with liquid to the level determined by the float adjustment and the inside surface is wetted with the liquid. Thus this type is called flooded evaporator. To prevent liquid carry over to compressor, accumulator is generally used with a flooded evaporator. Accumulator also serves as the chamber for the liquid level float valve. The evaporator coil is connected to the accumulator and the liquid flow from the accumulator to the evaporator coil is generally by gravity. The vapour formed by the vaporising of the liquid in the coil being lighter, rises up and passes on to the top of the accumulator from where it enters the suction line. Sometime liquid eliminators are provided in the accumulator top to prevent the possible carryover of the liquid particles from the accumulator to the suction line.

These evaporators give high rate of heat transfer as the whole surface of the evaporator coil remains in contact with liquid refrigerant. These are bulky in construction and require large amount of refrigerant for their working.

The flooded evaporators are used in large installations, especially in chemical and food processing industries.

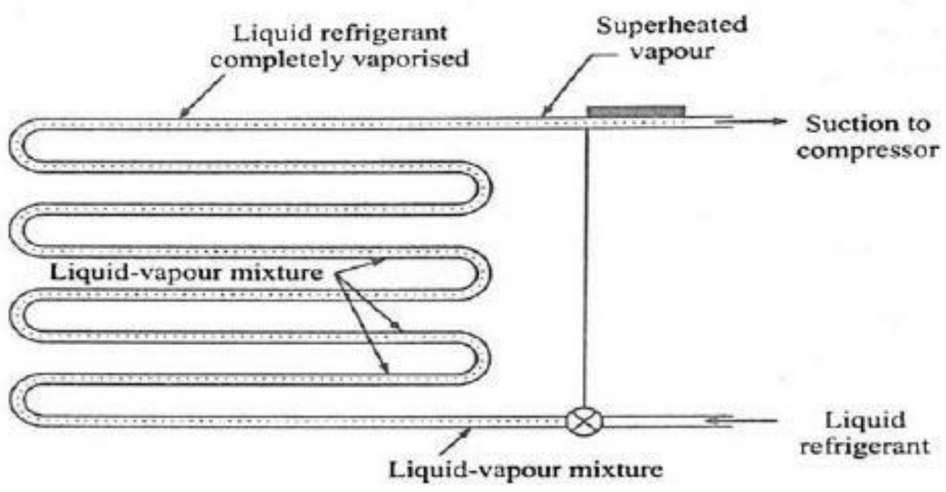


Flooded type evaporator.

Dry Expansion Evaporator

In a dry expansion evaporator the amount of liquid refrigerant fed into the evaporator is limited to that which can be completely vaporised by the time it reaches the end of the evaporator. The expansion device feeds the evaporator at such a rate that whole of the refrigerant gets gradually vaporised by the time it reaches the end of the coil. Feeler bulb of the expansion valve controls the rate of flow through the orifice of the flow control.

Such an evaporator is one of the most widely used devices for producing refrigeration and is used on systems having capacity below 150 tonnes of refrigeration.



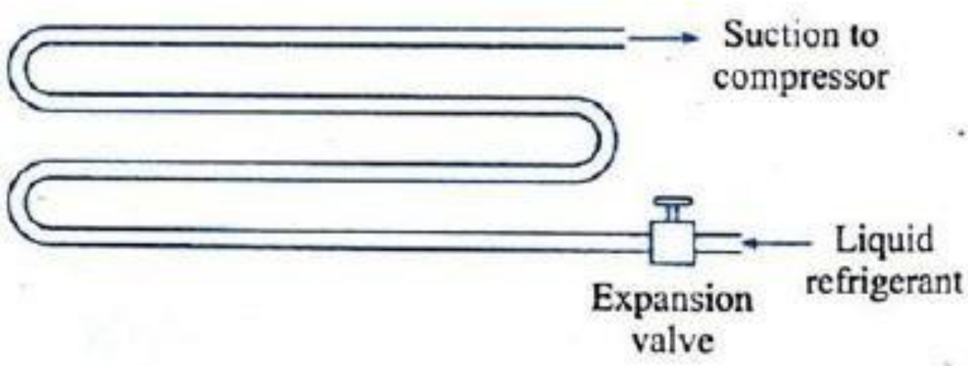
Dry expansion evaporator.

Bare Tube Evaporator

These evaporators are usually constructed of either steel pipe or copper tubing. Copper tubing is used in small evaporators using Freon as refrigerant whereas steel pipe is employed with large evaporators using ammonia as refrigerant. Bare-tube coils are available in a number of sizes, shapes and designs, and are usually bare tube evaporator and are usually custom made to the individual application.

Its use is limited to applications where the box temperatures are under 0°C and in liquid cooling, because the accumulation of ice or frost on these evaporators has less effect on the heat transfer than on those equipped with fins.

Since these, evaporators are easier to clean. They are also extensively used in household refrigerators.



Bare tube evaporator.

Plate Surface Evaporator

These evaporators are made in different designs. In some cases tubing is attached to the plates whereas in other cases two sheets may be pressed together to provide a path for refrigerant flow between them. • Such evaporators are used in domestic refrigerators or frozen food industry.

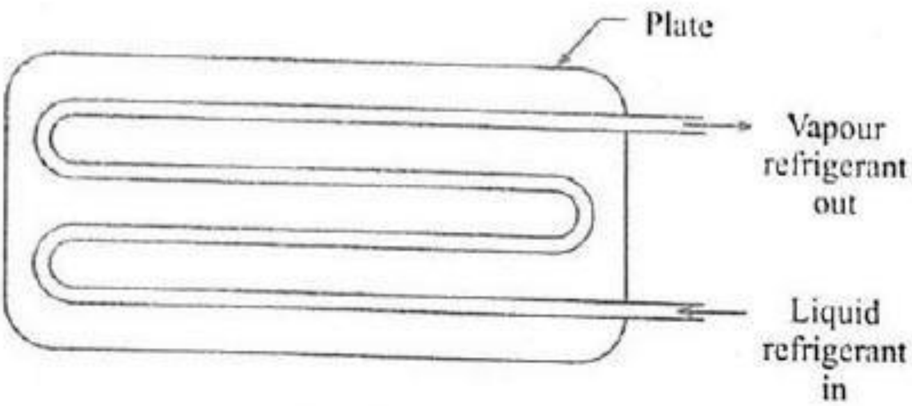
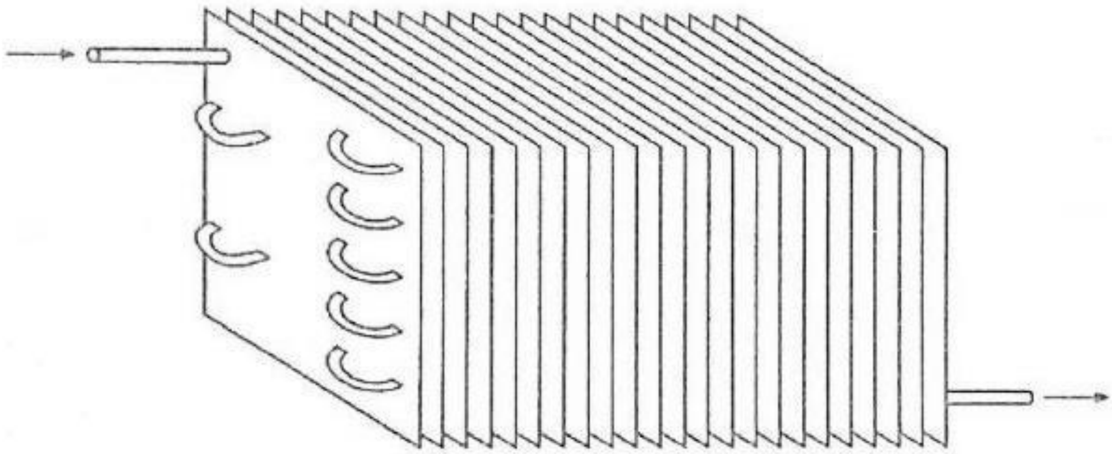


Plate surface evaporator.

Finned Tube Evaporator

Finned coils are bare-tube coils upon which metal plates or fins have been installed. The fins increase the surface area of evaporator which means increased hear transfer and capacity. The size and spacing of fins depends upon the type of application. Such evaporators have always a direct expansion feed of liquid refrigerant.

Finned tube evaporators are best suited for window type air-conditioners and other air cooling application where temperature is maintained above I °C. For such an application the capacity of evaporator is further increased by adding a fan to the finned evaporator.



Finned tube evaporator.

EXPERIMENT NO. 5

OBJECTIVE:
To study basic components of air-conditioning system.

PREREQUISITES:
Students are required to have understanding of the following basics to enable better understanding of the practical:

1. Basic concepts of Thermodynamics, Heat Transfer and psychrometry.

The purpose of an air conditioner is to maintain a comfortable indoor environment. The comfort is determined by a combination of 3 factors:

- Temperature.
- Humidity.
- Air Distribution.

For this reason, the main purposes of air conditioners are to:

- Control room temperatures (cooling/heating).
- Control room humidity levels (drying, humidifying).
- Optimise air flow (circulation, distribution).
- Clean the air (filtration).

An Air Conditioner Consists of Four Main Sections:

Refrigerant circuit components: Circulation of the refrigerant and radiation of heat. (Compressor, evaporator, condenser, capillary tube, etc.).

Ventilation System: Distribution of air (indoor) Heat dissipation (outdoor). (Fan, filter, duct etc.).

Electrical parts: Climate control (Starting relay, over load protector, thermostat, and motor).

Other: Unit casing, etc.

Refrigerant circuit components

Compressor: Compresses the refrigerant from low pressure (low temperature) to high pressure (high temperature). This conversion raises the boiling point to higher temperature levels, facilitating elimination of the heat brought by the outdoor air.

Condenser: This component receives gas at high pressure and high temperature from the compressor. In air-cooled condensers, the metallic surfaces cool the gas which changes status and turns to liquid. In the case of water-cooled condensers, it is the circulation of the water that produces the same cooling effect.

Evaporator: After expansion refrigerant enters in to evaporator it absorbs heat from the surrounding air and produces cooled air.

Expansion Device: A narrowing of a tube connected along the line between the condenser and the evaporator with diameters ranging from 1 to 2 mm. and lengths ranging between 1 and 2 m.

Ventilation System:

Fan: following two types of fans may be used for the transmission of air:

1. Centrifugal fan:
   Centrifugal fan may have following three types of blades:
   a. Radial or straight blades.
   b. Forward curved blades.
   c. Backward curved blades.
2. Axial flow fan:
   Axial fans are divided into following three groups:
   a. Propeller fan.
   b. Tube axial fan.
   c. Vane axial fan.

Electrical System:

1. Starting Relay: It is used to provide necessary starting torque required to start the motor.
2. Overload Protector: It is used to protect the compressor motor winding from damage due to excessive current, in the event of overloading due to some fault.
3. Thermostat: A thermostat is used to control the temperature in the refrigerator. The bulb of the thermostat is clamped to the evaporator.

EXPERIMENT NO. 6

OBJECTIVE:
Experiment on air-conditioning test rig & calculation of various performance parameters.

PREREQUISITES:
Students are required to have understanding of the following basics to enable better understanding of the practical:
1. Basic concepts of Thermodynamics, Heat Transfer and psychrometry.
2. Understanding of refrigeration cycle.

Test Rig Specification:

Compressor	ISI, hermetically sealed, reciprocating compressor
Condenser	Fin tube type air cooled condenser with variable speed fan
Evaporator	Fin & Tube (copper) type
Refrigerant	Freon, R-22
Fan Blower Set	Standard Make
Control Panel	➢ Suction pressure gauge for low pressure measurement ➢ Discharge pressure gauge for High pressure measurement ➢ Expansion Device ➢ Filter/Drier ➢ High pressure cutout ➢ Main switch, digital type voltmeter, ampere meter, energy meter. ➢ Digital temperature Indicator fitted with RTD thermocouple.
Voltage	Single phase, 220 V, 50 Hz AC supply.

THEORY:
The performance of Air-Conditioning system is expressed in terms of COP. The COP of air conditioning system is given by:

$$C.O.P. = HR/\text{Power Input}$$

where,

HR is heat removed = $m.C_P.\Delta T$

m = mass of air supplied /sec

C_p = specific heat of air

$\Delta T = T_1 - T_2$

T_1 = surrounding air temperature.

T_2 = duct air temperature.

$m = V_a/V_{sa}$

V_a = quantity of air supplied m^3/sec

V_{sa} = area of duct × velocity of air

$$= L \times B\sqrt{2(Pstag - Pstat)/\rho}$$

P_{stag} = Stagnation or Total Pressure

P_{stat} = Static Pressure

Power Input: measured from energy meter.

PROCEDURE:

Switch on the power supply to system i.e. start the compressor simultaneously start fan blower motor also. Now compressed refrigerant passing through the condenser and after condensing. It goes to evaporator, where due to cooling effect air, which is sucked by blower cools.

After few minute the air at the outlet of air duct will become cool at that time. And also measure the static and total pressure by using V-tube manometer and pilot tube.

OBSERVATION TABLE:

S.No.	T1	T2	Pstag	Pstat	Energy meter reading (kWh)		
					Initial (a)	Final (b)	C = (b a)
1							
2							
3							
4							

CALCULATIONS:

RESULT:

PRECAUTIONS:

1. Run the system for quite some time before taking readings.
2. Note down number of revolutions of energy meter carefully with the help of stop watch.
3. Insure considerable cooled air output from air duct.
4. The system should not switch OFF immediately after once switched ON.
5. The control valve of pressure and compound gauge should open partly; when it is required to measure pressure otherwise valves must be closed.

6. Do not twist any pipe line and handle all switches valves very carefully only as and when required.

EXPERIMENT NO. 7

OBJECTIVE:

Experiment on Ice-plant.

PREREQUISITES:

Students are required to have understanding of the following basics to enable better understanding of the practical:

1. Basic concepts of Thermodynamics, Heat Transfer and psychrometry.
2. Understanding of refrigeration cycle.

Test Rig Specification:

Compressor	ISI hermetically sealed reciprocating type.
Condenser	Air Cooled- Standard make.
Ice Plant Tank	Mild Steel (Thermally Insulated)
Cooling Coil	Water Immersed type
Ice Cans	Made of G.I. Sheet.
Primary refrigerant	Freon, R-22
Secondary Refrigerant	Brine.
Control Panel	➢ Expansion device (Thermostatic Expansion Valve). ➢ Drier. ➢ Pressure gauges. ➢ Main switch, digital type voltmeter, ampere meter, energy meter. ➢ Digital temperature Indicator fitted with RTD thermocouple.
Voltage	Single phase, 220 V, 50 Hz AC supply.

THEORY:

The ratio of heat removed to work input is called the co-efficient of performance of a refrigerating machine.

$$COP = \text{Heat output} / \text{Power input}$$

$$= m.\ Cp\Delta T / Kwh$$

where

m = Mass of water is ice cane in kg.

Cp = Specific heat of water = 4.18

ΔT = Temperature (in K) drop of ice cane water in unit time.

kWh = Power consumed by the compressor in unit time.

PROCEDURE:

Fill the water in ice canes. The measured quantity of water should be filled. And keep the ice canes in brine tank and close the door. Switch on the power supply to compressor, at the time of starting note down the initial temperature of ice cane water and energy meter reading. Also switch on the stop on the stop watch take the readings of ice cane temperature and energy meter at the interval of 5 minutes. Take enough set of readings for considerable difference in temperature. Finally, Switch off the compressor and drain the ice can water.

OBSERVATION TABLE:

S.No.	Mass of Water (Kg)	Temperature			Energy Meter reading		Time (sec)
		Initial (T_1)	Final (T_2)	ΔT	Initial	Final	
1							
2							
3							
4							

CALCULATIONS:

RESULT:

PRECAUTIONS:

1. Run the system for quite some time before taking readings.
2. Note down number of revolutions of energy meter carefully with the help of stop watch.
3. Do not open the door of Ice Box.
4. Measure time precisely.
5. Once experiment is over, drain water from Ice canes.
6. Do not twist any pipe line and handle all switches, valves carefully, when required.

EXPERIMENT NO. 8

OBJECTIVE:

Study of window air conditioner.

PREREQUISITES:

Students are required to have understanding of the following basics to enable better understanding of the practical:

1. Basic concepts of Thermodynamics, Heat Transfer and psychrometry.

Window air conditioner is sometimes referred to as room air conditioner as well. It is the simplest form of an air conditioning system and is mounted on windows or walls. It is a single unit that is assembled in a casing where all the components are located.

This unit has a double shaft fan motor with fans mounted on both sides of the motor. One at the evaporator side and the other at the condenser side.

The evaporator side is located facing the room for cooling of the space and the condenser side outdoor for heat rejection. There is an insulated partition separating this two sides within the same casing.

THEORY:

Front Panel

The front panel is the one that is seen by the user from inside the room where it is installed and has a user interfaced control be it electronically or mechanically. Older unit usually are of mechanical control type with rotary knobs to control the temperature and fan speed of the air conditioner. The newer units come with electronic control system where the functions are controlled using remote control and touch panel with digital display. The front panel has adjustable horizontal and vertical (some models) louvers where the direction of air flow are adjustable to suit the comfort of the users. The fresh intake of air called VENT (ventilation) is provided at the panel in the event that user would like to have a certain amount of fresh air from the outside.

Indoor Side Components

The indoor parts of a window air conditioner include:

Cooling Coil with an air filter mounted on it. The cooling coil is where the heat exchange happens between the refrigerant in the system and the air in the room. **Fan Blower** is a centrifugal evaporator blower to discharge the cool air to the room.

Capillary Tube is used as an expansion device. It can be noisy during operation if installed too near the evaporator.

Operation Panel is used to control the temperature and speed of the blower fan. A thermostat is used to sense the return air temperature and another one to monitor the temperature of the coil. Type of control can be mechanical or electronic type.

Filter Drier is used to remove the moisture from the refrigerant.

Drain Pan is used to contain the water that condensate from the cooling coil and is discharged out to the outdoor by gravity.

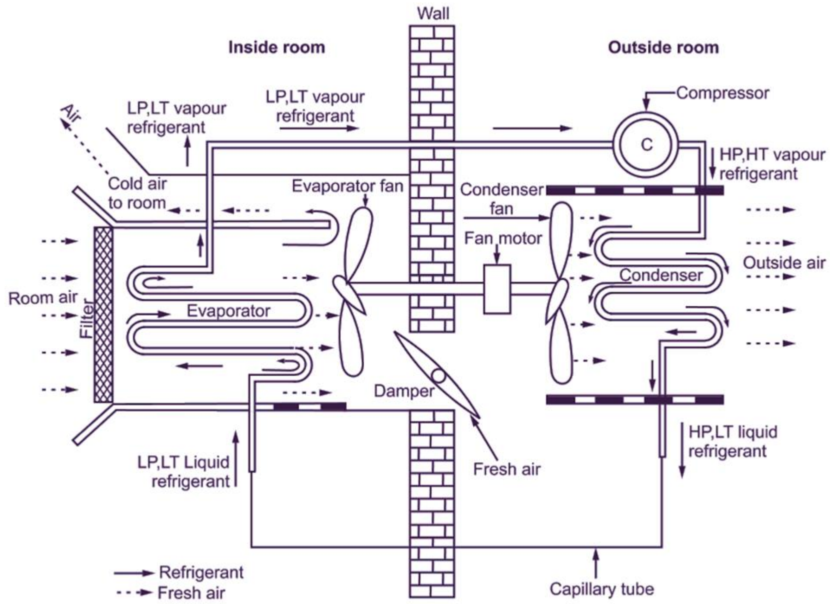
Outdoor Side Components

The outdoor side parts include:

Compressor is used to compress the refrigerant.

Condenser Coil is used to reject heat from the refrigerant to the outside air. **Propeller Fan** is used in air-cooled condenser to help move the air molecules over the surface of the condensing coil.

Fan Motor is located here. It has a double shaft where the indoor blower and outdoor propeller fan are connected together.



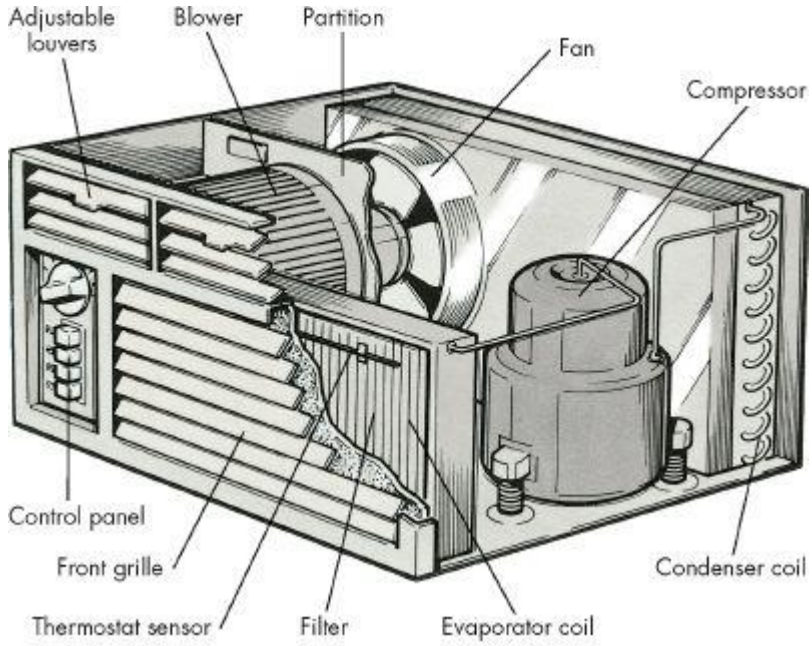
Operations

During operation, a thermostat is mounted on the return air of the unit. This temperature is used to control the on or off of the compressor. Once the room temperature has been achieved, the compressor cuts off. Usually, it has to be off for at least 3 minutes before turning on again to prevent it from being damaged. For mechanical control type, there is usually a caution to turn on the unit after the unit has turned off for at least 3 minutes. For electronic control, there is usually a timer to automatically control the cut-in and cut-out of compressor.

The evaporator blower fan will suck the air from the room to be conditioned through the air filter and the cooling coil. Air that has been conditioned is then discharge to deliver the cool and dehumidified air back to the room. This air mixes with the room air to bring down the temperature and humidity level of the room. The introduction of fresh air from outside the room is done through the damper which is then mixed with the return air from the room before passing it over the air filter and the cooling coil. The air filter which is mounted in front of the evaporator acts as a filter to keep the cooling coil clean to obtain good heat- transfer from the coil. Hence, regular washing and cleaning of the air filter is a good practice to ensure efficient operation of the air conditioner.

Heat Pump Window Air Conditioner

In temperate countries, heating of the room is required. A heat pump window air conditioner unit is able to cool the room during summer and heat the room during winter. A reversing valve (also known as 4-Way-Valve) is used to accomplish this. During heating operation, it reverses the flow of the refrigerant which results in the evaporator to act as a condenser and the condenser as evaporator.



EXPERIMENT NO. 9

OBJECTIVE:

Study of hermetically sealed compressor.

PREREQUISITES:

Students are required to have understanding of the following basics to enable better understanding of the practical:
Compressor function in refrigeration cycle, types of compressor, hermetically sealed compressor.

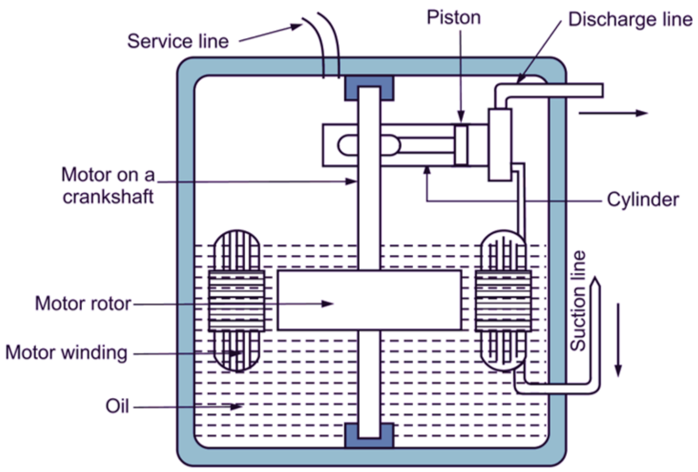
Hermetically Sealed Compressor:

A hermetic or sealed type compressor are directly connected on electric motor, the motor and compressor operates on the same shaft and are enclosed in common casing. Compact units of this type are used almost exclusively in domestic refrigeration and also in home cold storage plants, drinking fountains, ice cream and food displayed cabinets. They are made to operate on either the reciprocating or rotary principle and may be mounted with the shaft in either in the vertical or horizontal position. The rpm is same for compressor and motor. The one- piece housing provides for quietness and minimum of vibration. In addition, the seal and compiling are eliminated. The motor operates in an ideal atmosphere. As it is entirely enclosed no airborne dust can reach it. Important sub-systems in hermetically sealed compressor are as under.

a. **Suction & discharge of refrigerant:** Service valves are used for suction, discharge refrigerant to compressor. It is also used to connect pressure gauge. For filling refrigerant to compressor initially, charging valve is also present.

b. **Cooling:** suction gas at 10 to 15 degree C cools the motor and shell. Also the compressor has oil-cooling tube, which cools the lubricating oil in compressor & placed in the form of a loop at the bottom. Refrigerant & cooling through this tube takes heat from lubricant & dissipate in oil cooler placed just above the tubing.

c. **Anti-slug device:** An anti-slug device consisting basically of two assemblies. One is the centrifuge, press fitted on the crankshaft, rotates at the speed of compressor. The refrigerant is drawn in through the h in the top. Any liquid or oil is expelled through the slots on the side by centrifugal force & the gas being lighten is drawn through the slots in the hub. The second assembly collects the gas and directs it to the cylinder heads.



Power transmission mechanism: a 230-v electric power supply is given to the stator through relay. The rotor which has crank shaft generally rotates. The crankshaft through e reciprocates. The refrigerant is sucked & discharged through suction read & flapper valve plate.

d. **Lubrication system:** The lubricating oil along with refrigerant is discharged during compression. Lubricating oil travels on high-pressure side up to capillary tube only and from here major lubricating oil return back to compressor. Oil separated by oil separator is collected at lower part of the compressor in sump from where it is led to piston - cylinder assembly and other moving parts by splash lubrication. Care should be taken to use the standard, directed lubricating oil only for particular type of refrigerant, otherwise it may form sludge, wax when mixed with the refrigerant.

1. Take out the oil from the dome of the compressor through suction or charging line.
2. Cut the welding of dome with the help of hacksaw and separate the two halves of the dome.
3. Clean the dome properly.
4. Take out the compressor motor assembly from the dome by removing spring attached to the dome.
5. Remove the suction and discharge mufflers and study their function.
6. Open the valve assembly.
7. Note the construction of suction valve.
8. Note the construction of discharge valve and retainer and spring for discharge valve.
9. Study the working of both valves.
10. Rotate the crankshaft and note how the motion is transferred from crankshaft to the piston.

11. Also note the type of crankshaft used.
12. Dismantle the crankshaft and connecting rod.
13. Also separate the piston from the connecting rod by taking out the piston pin.
14. Note whether the piston rings are available or not.
15. Note the material of each part and their functions.
16. See if there is any defect with any part and note it.
17. Remove the defect by repairing or changing the part if required.
18. See if there is any defect in electric motor with the help of a multi meter and note it.
19. Get it rectified from the electrician if there is any defect. Now assemble the parts in correct sequence using the proper size gaskets.

EXPERIMENT NO. 10

OBJECTIVE:

Study of parts and Operation of a cold Storage plant and Ice bank

INTRODUCTION:

The cold storage is a highly essential part in a dairy industry for safe storage of dairy products. In the cold storage, favorable conditions of temperature and humidity are maintained so as to retard spoilage and preserve the freshness and eatable quality of dairy products. It may be of varying size depending on the quantity of products to be stored and also the storage time. It is an insulated room used as a storage cabin in which low temperature/ cold is maintained with the help of a refrigeration system. The evaporator or evaporating coil of refrigeration system is situated inside the cold room to maintain cold conditions. All other components, i.e., compressor, condenser, expansion valves etc. are situated outside the cold room. When refrigeration plant is run, the evaporating coil situated inside cold storage produces cooling around it. To spread this cooling of evaporator in whole inside space of cold storage, an air diffusing system is used. In this system, a fan or blower force the room air to flow over the cooling coil and then spread it in the whole room thus increasing heat transfer. As the plant is continuously run, it pumps out the inside heat of cold room and of products stored within. By pumping out the heat and preventing the natural inflow of heat from outside by insulation, the temperature inside the cold storage falls down, making the safe environment for stored products.

An ice-bank unit is also commonly used in a large size dairy plant. An ice-bank unit is nothing but a large size tank filled with chilled water and ice. Here also the normal water filled in tank can be chilled or formed to ice by the application of a refrigeration system. The evaporating coil of refrigeration system is directly dipped in water where it absorbs heat from water and converts it to ice. This ice-bank unit can supply a large amount of chilled water for various applications in plant. Ice-bank unit is generally operated by the same refrigeration system by taking a part of compressed and condensed refrigerant and expanding it in the cooling coil dipped in water. Thus there is no need to install separate compressing and condensing unit. This combination of one or more cold storage and an ice-bank unit run by a common refrigeration system is usually kept in dairy industry. Our purpose here is to visit a working refrigeration plant and study of its different parts and their operation.

EXPERIMENTS

i. Principle

The principle of production of cooling is same as of vapour compression refrigeration system. However, different methods are used to spread this cooling from evaporator to dairy products in a cold storage and from evaporator to water in an ice-bank unit. In a cold storage an air diffusing system is used which force the room air to flow over cooling evaporator coil and diffuse this cold air in the whole space. In an ice bank system, an agitator is generally used to spread cooling in all directions in water thus increasing the rate of ice formation.

ii. Requirement of Machinery/ Instrument and Materials

1. A cold storage plant in working condition.
2. An ice-bank unit in working condition.

iii. Procedure

1. Study of cold storage plant:
2. Visit to a working cold storage plant after taking legal permission of authority.
3. Inquire and note down the capacity of plant and refrigerant being used. Also note the horsepower of compressor motors.
4. Identify the various components and sub-components of cold storage and its refrigeration system.
5. See the pipe connections between components and draw a refrigerant flow diagram of the plant showing different components.
6. Enter the cold room and study the air diffusing system. Also check the type of insulation around the cold room.
7. Understand the procedure of loading and unloading in cold store.
8. Note down the reading of different indicating devices, indicating pressure and temperature at various points.

iv. Study of Ice-Bank Unit:-

1. Visit an ice-bank unit of dairy plant after taking legal permission of concerned authority.
2. Identify the various components and sub-components of ice-bank unit and its refrigeration system.
3. Inquire and note down the capacity of ice-bank unit. Also the capacity of compressor motors in horsepower or KW.
4. Identify the pipe connections between components, and draw a refrigerant flow diagram (line-diagram) showing all the major components.
5. See the working of agitator and the circulation of chilled water within the icebank tank. Also note the HP of agitator motor.
6. Note down the specifications of chilled water supplying pumps and their positions near the ice-bank.

OBSERVATIONS

1. Observe and understand the flow of refrigerant through refrigeration system and the change in its conditions while flowing through different components by reading the various indicating devices positioned at various points.
2. Observe the air diffusion/ circulation system within the cold storage.
3. Observe the process of ice-formation in ice-bank unit and importance of circulation of water by agitator motor.
4. Finally observe and understand completely the whole operation of cold storage and ice-bank unit in a dairy plant.

RESULTS

The students will be able to know the:

1. Actual size, shape and physical appearance of various components of cold storage and ice-bank unit.
2. Need and importance of various indicating/ control devices fitted in the cold storage and ice-bank unit.
3. Importance of the effectiveness of heat exchange processes occurring in condenser and evaporator.
4. Importance of providing insulation around cold room, ice-bank tank and also pipes carrying low temperature refrigerant.
5. Type and method of insulation provided.
6. How the cold storage is useful in safe storage of dairy products.
7. How an ice-bank unit is useful in a dairy plant and how it can maintain supply of chilled water by melting of ice formed around cooling coil even when refrigeration plant is not working

PRECAUTIONS

1. Study of refrigeration plans should be undertaken in the presence of Instructor/ Practical Teacher and under his guidance.
2. Don't touch and disturb any part in the plant of your own.
3. Listen carefully the instructions of practical teacher and follow them accordingly.
4. Do not dismantle any part without the permission of operator/ plant in charge.

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