Department of Mechanical and Production Engineering
Ahsanullah University of Science and Technology (AUST)

Lab Manual on **ME 4202**

Applied Thermodynamics Sessional

Credit Hours: 0.75

General Guidelines:

1. Students shall not be allowed to perform any experiment without apron and shoes.
2. Students must be prepared for the experiment prior to the class.
3. Report of an experiment must be submitted in the next class.
4. Viva for each experiment will be taken on the next day with the report.

5. The report should include the following:
    - Top sheet with necessary information
    - Main objectives
    - Work material/machine/tool/equipment used (with their specifications)
    - Experimental procedures
    - Experimental results and discussions (Experimental setup, Experimental conditions, Data, Graph, calculation etc.)
    - Conclusions
    - Acknowledgements
    - References
6. A quiz will be taken on the experiments at the end of the semester.
7. Marks distribution:

	Total Marks = 100		
Attendance	*Report*	*Viva Voce*	*Final Quiz*
10	30	20	40

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Experiment No: 01

To study the working and function of mountings and accessories in boilers

Boiler: A steam boiler is a closed vessel in which steam is produced from water by combustion of fuel.

Classification of Boiler:

Boilers are classified on the basis of following-

1. According to contents in the Tube:

a) Fire tube boiler: In fire tube boilers, the flue gases pass through the tube and water surround them. Vertical tubular, Lancashire, Cochran, Cornish, Locomotive fire box, Scotch marine etc are some fire tube boilers.

b).Water tube boiler: In water tube boiler, water flows inside the tubes and the hot flue gases flow outside the tubes. Babcock and Wilcox boiler, Stirling boiler, La-mont boiler, Benson boiler, Loeffler boiler etc are some of water tube boilers.

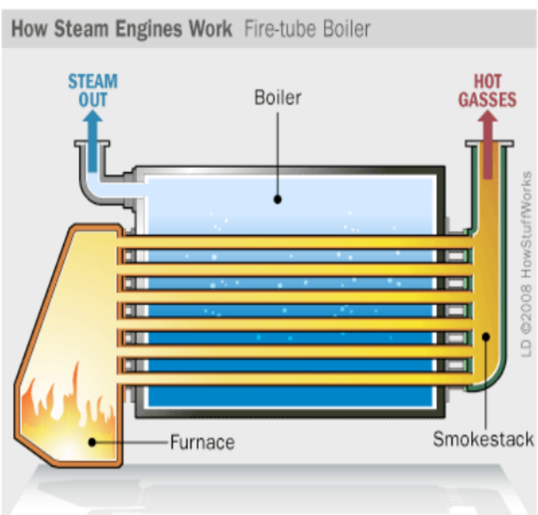

Fig.: Schematic Diagram of a fire Tube Boiler

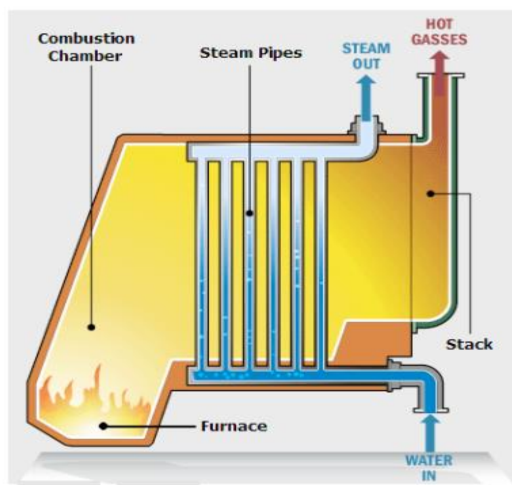

Fig.: Schematic Diagram of a Water Tube Boiler

2. According to the pressure of steam:

a) Low pressure boiler: A boiler which generates steam at a pressure of below 80 bars is called low pressure boiler. Examples: Cochran boiler, Lancashire boiler etc.

b) High pressure boiler: A boiler which generates steam at a pressure higher than 80 bar is called high pressure boiler. Example- Babcock and Wilcox boiler, La Mont Boiler etc.

Boiler Mountings:

Boiler mountings are the machine components that are mounted over the body of the boiler itself for the safety of the boiler and for complete control of the process of steam generation. Various boiler **mountings** are as under:

1) Pressure gauge
2) Water Level Indicator
3) Fusible plug
4) Safety Valve
5) Steam stop valve
6) Feed check valve
7) Blow-off cock
8) Man and Mud hole

1. ***Bourdon's pressure gauge***:

Function:
To record the steam pressure at which the steam is generated in the boiler.
2. A bourdon pressure gauge in its simplest form consists of elliptical elastic tube bent into an arc of a circle
3. This bent up tube is called as BOURDON'S tube.
4. One end of tube gauge is fixed and connected to the steam space in the boiler.
The other end is connected to a sector through a link

2. ***Water Level Indicator***:

Function:

- The function of water level indicator is to indicate the level of water in the boiler constantly.
- It is also called water gauge.
- Normally two water level indicators are fitted at the front end of every boiler

3. ***Fusible plug***:

Function:

- To extinguish fire in the event of water level in the boiler shell falling below certain specified limit.
- It protects fire tubes from burning when the level of the water in the water shell falls abnormally low and the fire tube or crown plate which is normally submerged in the water, gets exposed to steam space which may not be able to keep it cool.
- It is installed below boiler's water level.

4. Safety Valve:

Function: The function of safety valve is to release the excess steam when the pressure of steam inside the boiler exceeds the rated pressure.

There are 4 types of safety valves:

i) Lever Safety Valve:

The disadvantage of this valve is that it admits of being tempered with, and the effect of a small addition to the weight is magnified considerably in its action on the value.

ii) Spring Loaded safety Valve:

For locomotives and marine engines both the lever and dead weight types are unsuitable for obvious reasons and the valve must be spring loaded, as such valve is unaffected by vibration or deviation from the vertical.

Disadvantage**:**

- One disadvantage of this valve is that the load on the valve increases as the valve lifts, so that pressure required just to lift the valve is less than that required to open it fully.

iii) Dead Weight Safety Valve**:**

It is mainly used for low pressures, low capacity, stationary boilers of the Cornish and Lancashire types.

• **Merits:**

1) Simplicity of design
2) Gives quite a satisfactory performance during operation.
3) It cannot be easily tempered from the pressure adjustment view.

• **Demerits:**

1) Unsuitable for use on any boiler where extensive vibration and movement are experienced (e.g. locomotive and marine work).
2) It is not suitable for high pressure boilers because a large amount of weight is required to balance the steam pressure.

iv) High steam and low water safety valve

It serves the following purposes.

(i) The steam automatically escapes out when the level of water falls below a certain level.

(ii) It automatically discharges the excess steam when the pressure of the steam rises above a certain pressure.

Use: It is generally used on Lancashire or Cornish boiler. It cannot used in mobile boilers.

5. Steam Stop Valve:

• This valve is a device that regulates the flow of a fluid (gases, fluidized solids, slurries, or liquids) by opening, closing, or partially obstructing various passageways.

Function:

• To shut off or regulate the flow of steam from the boiler to the steam pipe or steam from the steam pipe to the engine.

• When the hand wheel is turned, the spindle which is screwed through the nut is raised or lowered depending upon the sense of rotation of wheel. The passage for flow of steam is set on opening of the valve.

6. Feed Check Valve:

Function: The function of a feed check valve is to control the supply of water to the boiler and to prevent the escaping of water from the boiler when the pump pressure is less or pump is stopped.

i) To allow the feed water to pass into the boiler.

ii) To prevent the back flow of water from the boiler in the event of the failure of the feed pump.

The feed check valve is fitted in the water space of the boiler slightly below the normal level of the water.

7. Blow off Cock:

Function: To drain out the water from the boiler for internal cleaning, inspection, repair or other purposes.

• It may discharge a portion of water when the boiler is in operation to blow out mud, scale or sediments, periodically.

• It is fitted on the boiler shell directly or to a short branch pipe at the lowest part of the water space.

8. Manhole and mud box:

Function: Manhole provides opening for cleaning, inspection and maintenance purpose. Mud box is a collection chamber (as shown in Babcock and Wilcox boiler) for collecting the Mud.

Boiler Accessories:

Boiler Accessories:
Boiler accessories are those components which are installed either inside or outside the boiler to increase the efficiency of the plant and to help in the proper working of the plant. Various boiler accessories are:

1) Air Preheater
2) Economizer
3) Super-heater
4) Feed Pump

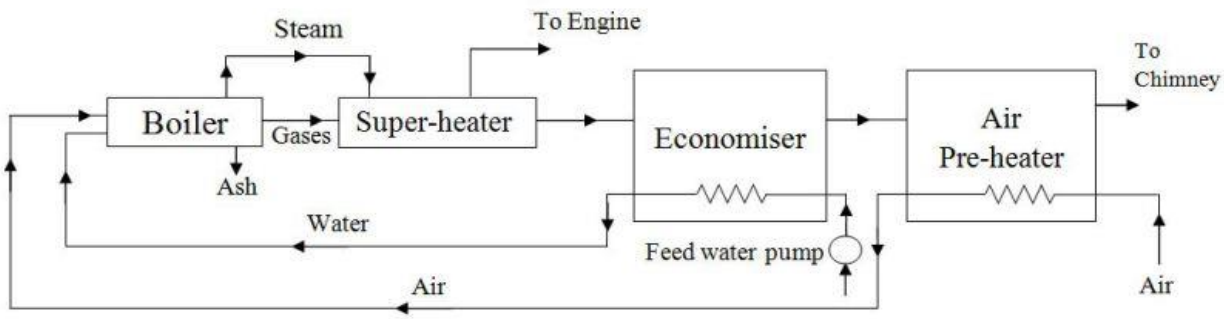

Fig- Schematic diagram of a boiler plant

1) **Air Preheater:**
   There are three types of air pre-heaters :
   i. Tubular type, ii. Plate type, iii. Storage type.

   • Waste heat recovery device in which the air to on its way to the furnace is heated utilizing the heat of exhaust gases
   • The function of air pre-heater is to increase the temperature of air before enters the furnace.
   • It is generally placed after the economizer; so the flue gases passes through the economizer and then to the air preheater.
   • An air-preheater consists of plates or tubes with hot gases on one side and air on the other
2) **Economizer:**
   <u>Function:</u>
   • It is a device in which the waste heat of the flue gases is utilsed for heating the feed water.
   • To recover some of the heat being carried over by exhaust gases.This heat is used to raise the temperature of feed water supplied to the boiler.

Advantages:

i) The temperature range between various parts of the boiler is reduced which results in reduction of stresses due to unequal expansion.
ii) If the boiler is fed with cold water it may result in chilling the boiler metal.
iii) Evaporative capacity of the boiler is increased.
iv) Overall efficiency of the plant is increased.

3) Superheater:

- The function of super heater is to increase the temperature of the steam above its saturation point.
- To superheat the steam generated by boiler.
- Super heaters are heat exchangers in which heat is transferred to the saturated steam to increase its temperature.

Superheated steam has the following advantages :

Advantages:

i) Steam consumption of the engine or turbine is reduced.
ii) Losses due to condensation in the cylinders and the steam pipes are reduced.
iii) Erosion of turbine blade is eliminated.
iv) Efficiency of steam plant is increased.

4) Feed Pump:

- The feed pump is a pump which is used to deliver feed water to the boiler.
- Double feed pump is commonly employed for medium size boilers.
- The reciprocating pump are continuously run by steam from the same boiler to which water is to be fed.
- Rotary feed pumps are of centrifugal type and are commonly run either by a small steam turbine or by an electric motor.

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Experiment No:02

Performance Test of a Forced draft Wet Cross flow Cooling Tower

Introduction:

A cooling tower is a specialized heat exchanger in which air and water are brought into direct contact with each other in order to reduce the water's temperature. As this occurs, a small volume of water is evaporated, reducing the temperature of the water being circulated through the tower.

Classification:

a) **According to construction**:

- ***Package type***: These types of cooling towers are factory preassembled, and can be simply transported on trucks, as they are compact machines. The capacity of package type towers is limited.
- ***Field Erected type***: Field erected towers are usually much larger in size compared to the package type cooling towers. Facilities such as power plants, steel processing plants, petroleum refineries, or petrochemical plants usually install field erected type cooling towers due to their greater capacity for heat rejection

b) **On the basis of heat transfer method**:

- ***Dry cooling towers***: Separates the working fluid from ambient air, such as in a tube to air heat exchanger, utilizing convective heat transfer. No evaporation occurs.
- ***Wet cooling towers***: Operate on the principle of evaporative cooling. The working fluid and the evaporated fluid (usually water) are one and the same.
- ***Fluid coolers***: Hybrids that pass the working fluid through a tube bundle, upon which clean water is sprayed and a fan-induced draft applied.

c) According to air flow generation method:

- ***Natural draft***: Air or flue gases flow due to the difference in density of the hot flue gases and cooler ambient gases.
- ***Mechanical draft***: Air is circulated inside the tower mechanically instead of natural circulation. Propeller fans or centrifugal fans may be used.

Again, according to the location of the fan, mechanical drafts are further classified as:

i) *Forced draft* cooling towers
ii) *Induced draft* cooling towers

d) **On the basis of Air to Water flow**:

- ***Cross flow***: Crossflow is a design in which the air flow is directed perpendicular to the water flow.
- ***Counter flow***: In a counterflow design, the air flow is directly opposite to the water flow.

Data Table:

Table 01: Data taken from the experiment with corrugated tin sheet fill.

Barometric Pressure: 101.325 kPa

Serial no	Volumetric flow rate of hot water inlet $m_{vw}(m^3/s)$	Tower inlet dry bulb temp. T_{dbt}℃	Tower inlet wet bulb temp. T_{wbt} ℃	Tower inlet hot water temp. T_1℃	Tower outlet cold water temp. T_2℃	Tower outlet dry bulb temp. ℃	Tower outlet wet bulb temp. ℃	Velocity of Air V_a (m/s)
1								
2								
3								
5								
5								

Calculation Table 01: Calculate the value for experiment with corrugated tin sheet fill.

Serial No.	Range R= $(T_1 - T_2)$ ℃	Approach A= $(T_2 - T_{wbt})$ ℃	Effectiveness $\in = \frac{T_1 - T_2}{(T_1 - T_{wbt})}$	Cooling capacity, $Q = m_w c_p R\ (kW)$	Inlet relative humidity	Inlet absolute humidity ratio (ω_{ai})	Inlet enthalpy of air $h_1\ (\frac{kj}{kg})$
1							
2							
3							
4							
5							

Calculation Table 02: Calculate the value for experiment with corrugated tin sheet fill.

Serial no.	Outlet relative humidity	Outlet absolute humidity ratio ω_{ao}	Outlet enthalpy of air $h_2\ (\frac{kj}{kg})$	Energy given by hot water (kW)	Energy taken by air (kW)	Energy taken by the wall (kW)	Evaporation rate (kg/s)	L/G ratio
1								
2								
3								
4								
5								

Sample Calculation:

Range: $R = (T_1 - T_2)$ °C

Approach: $A = (T_2 - T_{wbt})$ °C

Effectiveness: $\in = [(T_1 - T_2)/(T_1 - T_{wbt})]$

Cooling capacity, $Q = m_{hw} C_p R$

where, m_{hw} = mass flow rate of hot water (kg/s)

C_p = specific heat of water = 4.120 kJ/kg-K

***Calculation of mass flow rate of dry air*:**

Here, exhaust fan area $A_e = 0.074 m^2$

Discharge of air $Q_e = A_e \times V_a$

Now, density of air, $\rho_a = \frac{P_{atm}}{RT_{atm}}$

Mass flow rate of air, $m_a = Q_e (m^3/s) \times \rho_a\ (kg/m^3)$

Mass flow rate of dry air, $m_{da} = \frac{m_a}{1+\omega_{ao}}$

Liquid/Gas (L/G) ratio:

$$L/_G = Mass\ flow\ rate\ of\ hot\ water/\ Mass\ \ flow\ rate\ of\ dry\ air = \frac{m_{hw}}{m_{da}}$$

Energy Balance Equation:

Energy given by hot water (kW) $=$ Energy taken by air (kW) + Energy taken by the wall (kW)

$$m_{hw}c_p(T_1 - T_2) = m_{da}(h_2 - h_1) + m_{da}(\omega_{ao} - \omega_{ai})h_g$$

here, $h_g = Enthalpy\ of\ water\ vapour\ at\ Room\ temperature\ (use\ saturated\ steam\ table)$

Evaporation Rate Calculation:

Evaporation Rate in cooling tower is calculated by the following empirical equation.

E = 0.00085 x R x 1.8 x C

E = Evaporation loss (kg/s)

R = Range

C = Circulating Cooling water (kg/s)

Graphs:

- Range vs mass flow rate of hot water
- Approach vs mass flow rate of hot water
- Effectiveness vs mass flow rate of hot water
- Cooling capacity vs mass flow rate of hot water
- Evaporation rate vs mass flow rate of hot water

Experiment No: 03

Investigation of the Effect of Condenser Pressure on Refrigeration System Performance

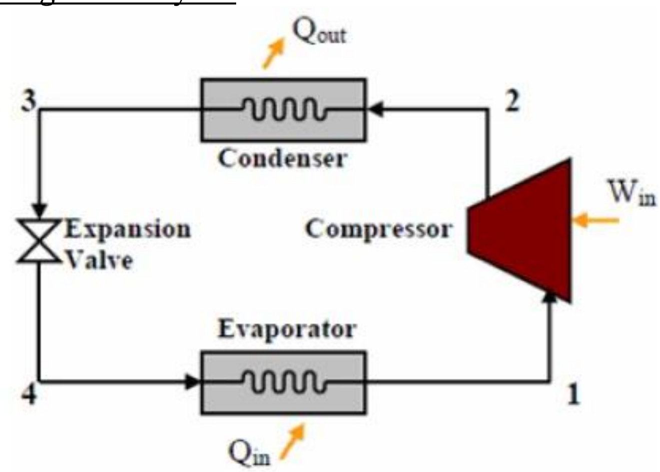
Objectives:

1. Refrigeration cycle demonstration.
2. Generation of refrigeration cycle on Pressure –enthalpy (P-h) diagram.
3. To find the effect of condenser pressure on Refrigeration cycle.

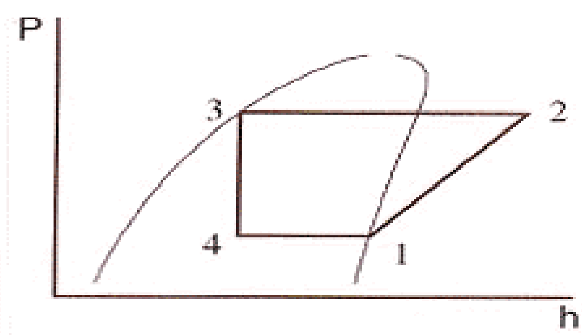
Specification:

Refrigerant: SES 36 [Pentaflurobutane + Perfluropolyether + azeotrope]
Condenser Water Coil surface area = 0.066 m^2
Evaporator Water coil surface area = 0.068 m^2

Refrigeration cycle:
Vapour Compression Refrigeration Cycle:



Vapor Compression Cycle



Pressure enthalpy diagram

NORMAL OPERATION

To start the unit first turn on the cooling water supply and the mains supply to the unit.

Open the valves indicated in Figure 2 on Page 2 for Normal Operation.

This allows vapour to be drawn from the evaporator by the compressor and for condensed liquid to return to the evaporator from the condenser.

Turn on the water supply to the unit and adjust the control valves on the evaporator water flowmeter and condenser water flowmeter to give approximately 10 – 12 g s^{-1} and 20 – 30 g s^{-1} flow rates respectively.

Open the expansion valve on the refrigerant flow meter to give an indicated flow of approximately 0.9 — 1.5 g s^{-1}. The actual flow required to balance the rate of condensation will vary depending upon operating conditions. Adjustment will be necessary if the refrigerant level in the condenser either rises or falls significantly.

Turn on the main switch and the compressor will start and the two internal lamps will light.

If the optional temperature indicator is fitted then the display on this will also illuminate.

AIR VENTING

A vent valve is situated on the top of the condenser and this allows air that has been admitted to the system to be safely vented into the void inside the instrument panel.

Air that enters the system usually from the charging valve as part of an experiment will be swept into the compressor by the flow of vapour from the evaporator and from here to the condenser where it will collect around the condenser coils. The air will remain in this area and effectively present an insulating barrier to vapour transfer, condensation and hence heat transfer. The nett result will be a chamber pressure that is far greater than should be the case for the condensing temperature t_6 indicated.

Unless demonstrating the effects of air in a condenser it will be necessary to vent the air from the system. The oil utilised in the compressor is hygroscopic and air admitted to the system is likely to bring with it water vapour. This should therefore be vented from the system.

To vent air from the condenser it is necessary to increase the condenser pressure to approximately 50kN m^{-2} above atmospheric pressure.

With the unit running normally, close the control valve on the condenser water flowmeter. This will cause the condenser pressure to rise. The time taken to reach 50kN m^{-2} above atmospheric pressure will depend upon the local ambient temperature and the amount of time that the unit has been running.

Once 50kN m^{-2} is reached the vent valve should be briefly opened and gas will be heard to enter the void inside the panel. Close the valve well before the gauge pressure reaches 0 kN m^{-2}.

Data Table:

Local atmospheric Pressure = 101 kN/m²

Test No.	1	2	3
Condenser pressure, P_c (kN/m²)			
Refrigerant flow rate, m_r (g/s)			
Compressor Power Input, W (watts)			
Condenser Inlet temperature (Refrigerant), (°C)			
Condenser Outlet Temperature (Refrigerant), (°C)			
Condenser Inlet water temperature,(°C)			
Condenser Outlet water Temperature, (°C)			
Evaporator Pressure, P_e (kN/m²)			
Evaporator Inlet temperature (Refrigerant), (°C)			
Evaporator Outlet Temperature (Refrigerant),(°C)			
Evaporator Inlet water temperature,(°C)			
Evaporator Outlet water Temperature, (°C)			

Calculation:

$COP = \frac{RE}{W_{in}}$ [RE =Refrigeration effect, W_{in} = work input]

$$= \frac{h_1 - h_4}{h_2 - h_1}$$

Condenser Temperature	COP

Graphs:

1. Draw Refrigeration cycle on pressure enthalpy diagram for different Condenser Pressure.
2. COP vs Condenser Temperature
3. Refrigerant flow rate vs Condenser Temperature.

Experiment No: 04

Investigation of the Effect of Compressor Pressure ratio on Refrigeration System Performance

Objectives:

- To observe the effect of increasing the condensing temperature for a constant given evaporating temperature to increase the compression ratio P_c/P_e.
- To observe the the effect of the compressor pressure ratio P_c/P_eon Evaporator and Condenser heat transfer.

Apparatus:

- Refrigeration cycle demonstration unit R-634

Procedure:

- Start the refrigeration unit for normal operation and ensure that the unit is air free by venting air from the condenser as described under air venting.
- Once air free increase the condenser cooling water flow to the flow-meter to maximum. The pressure at which the condenser stabilizes will depend upon the water inlet temperature.
- Set the evaporator water flow to approximately 30 g/s and allow the unit to run for approximately 15-20 minutes. The time taken to stabilize will depend upon the local ambient conditions and the cooling water inlet temperature.
- Record all the system parameters as illustrated in the data table.
- Reduce the condenser cooling water flow rate until the condenser pressure increases by approximately 5-10 kN/m². Allow the unit to stabilize and again record the parameters.
- Repeat the increasing condenser pressures to the minimum readable value on the condenser water flow-meter is reached or the condenser pressure reaches 200 kN/m² gauge pressure.

Data Table:

Local Atmospheric Pressure = 101.325 kN/m²

Test No.	1	2	3	4	5
Evaporator Gauge Pressure, P_e (kN/m²)					
Absolute Evaporator Pressure, P_e (kN/m²)					
Evaporator Temperature, T_5 (°C)					
Evaporator Water Flow Rate, m_e (g/s)					
Evaporator Water Inlet Temp. T_1 (°C)					
Evaporator Water Outlet Temp. T_2 (°C)					
Condenser Gauge Pressure, P_c (kN/m²)					
Absolute Condenser Pressure, P_c (kN/m²)					
Condenser Temperature, T_6 (°C)					
Condenser Water Flow Rate, m_c (g/s)					
Condenser Water Inlet Temp. T_4 (°C)					
Condenser Water Outlet Temp. T_5 (°C)					
Refrigerant Flow Rate, m_r (g/s)					

Calculation Procedure:

Evaporator: Rate of heat transfer to water in evaporator,

$$Q_{E} = m_e.C_p.(T_1 - T_2)$$

Condenser: Rate of heat transfer to water in condenser,

$$Q_{c} = m_c.C_p.(T_3 - T_4)$$

Compressor: Delivered pressure ratio = $\frac{P_c}{P_e}$

Derived Result:

Compressor Pressure Ratio, P_C/P_e					
Heat Transfer in Evaporator, Q_E (W)					
Heat Transfer in Condenser, Q_C (W)					

Graph:

- Heat Transfer Rates in the Condenser and Evaporator vs Compressor Pressure Ratio.

Experiment No: 05

Determination of Overall Heat Transfer Between SES-36 and Water in the Evaporator and Condenser

Objectives:

- To determine the rate of heat transfer to water in Evaporator
- To determine the overall heat transfer co-efficient in Evaporator
- To determine the rate of heat transfer to water in Condenser
- To determine the overall heat transfer co-efficient in Condenser

Apparatus:

- Refrigeration cycle demonstration unit R-634

Procedure:

- ➢ Start the unit for normal operation as shown in the diagram provided and ensure that the unit is air free by venting air from the condenser as described under air venting.
- ➢ Once air free increase the condenser cooling water flow to a mid-range value. The pressure at which the condenser stabilizes will depend upon the water inlet temperature.
- ➢ Set the evaporator water flow to a mid-range value and allow the unit to run for approximately 15-20 minutes. The time taken to stabilize will depend upon the local ambient conditions and the cooling water inlet temperature.
- ➢ Record all the system parameters as illustrated in the data table.

Data Table:

Local atmospheric pressure = 101 kN/m²

Test No.	**1**	**2**	**3**	**4**
Evaporator Gauge Pressure, P_e (kN/m²)				
Absolute Evaporator Pressure, P_e(kN/m²)				
Evaporator Temperature, T_5 (°C)				
Evaporator Water Flow Rate, m_e (g/s)				
Evaporator Water Inlet Temp.T_1 (°C)				
Evaporator Water Outlet Temp.T_2 (°C)				
Condenser Gauge Pressure, P_c (kN/m²)				
Absolute Condenser Pressure, P_c (kN/m²)				
Condenser Temperature, T_6 (°C)				
Condenser Water Flow Rate,m_c (g/s)				
Condenser Water Inlet Temp.T_4 (°C)				
Condenser Water Outlet Temp.T_5 (°C)				
Refrigerant Flow Rate, m_r (g/s)				

<u>Calculation Procedure</u>:

<u>For the Evaporator:</u>

<u>Rate of heat transfer to water in evaporator</u>:

$$Q_E = m_e.C_p.(T_1 - T_2)$$

- $\Theta_{inlet} = T_1 - T_5$
- $\Theta_{outlet} = T_2 - T_5$
- $\Theta_{mean} = \frac{\Theta_{inlet} - \Theta_{outlet}}{\ln \frac{\Theta_{inlet}}{\Theta_{outlet}}}$

The heat transfer rate, U = $\frac{Q_E}{A_e.\Theta_{mean}}$

For the Condenser:

Rate of heat transfer to water in condenser:

$$Q_{C} = m_c . C_p . (T_1 - T_2)$$

- $\Theta_{inlet} = T_6 - T_4$
- $\Theta_{outlet} = T_6 - T_3$
- $\Theta_{mean} = \frac{\Theta_{inlet} - \Theta_{outlet}}{\ln \frac{\Theta_{inlet}}{\Theta_{outlet}}}$

The heat transfer rate, U = $\frac{Q_C}{A_c . \Theta_{mean}}$

Experiment No: 06

Problem Solving Class on Power Plant Economy

Problem 01: The load on a power plant with respect to time for 24 hours is given as follows:

Time (Hrs)	0-6	6-8	8-12	12-14	14-18	18-22	22-24
Load (MW)	40	50	70	60	80	100	60

(a) Draw the load curve
(b) Draw load duration curve
(c) Calculate load factor
(d) Calculate the capacity factor and the plant capacity factor
(e) Select suitable generation unit to supply the load

Problem 02: A power station of 30 MW has the maximum annual demand of 25 MW. It supplies loads having maximum demands of 15 MW, 10 MW, 8 MW and 5 MW. The annual load factor is 45%. Estimate:

(i) The average load
(ii) The energy supplied per year
(iii) The diversity factor and
(iv) The demand factor

Problem 03: A power plant with 250 MW of installed capacity has the following particulars:

Capital cost = 20000 taka/kw installed
Interest and depriciation = 12%
Annual load factor = 60%
Annual capacity factor = 55%
Annual running charge = 250 x 10^6 taka
Energy consumed by power plant auxiliaries = 8%

Calculate: **(i) the cost of power generation per kW/hr** and
(ii) the reserved capacity

Problem 04:

The following data pertain to a power plant:

Installed capacity = 200 MW

Capital cost = 4000x10^6 taka

Rate of interest = 10% of the capital

Energy used in running the plant auxiliaries = 4% of the units generated

Rate of depreciation = 8% of the capital

Annual cost of fuel,taxes and salaries = 600x10^6 taka

Annual load factor = 65%

Capacity factor = 55%

Determine: **a) the reserve capacity and**

b) the cost of power generation

Problem 05:

A central power station has annual load factor, capacity factor and use factor as 65%, 50% and 60% respectively. The maximum demand is 20 MW. Estimate:

- **(i) The annual energy production and revenue earned if the cost of energy is taka 1.00 per kWhr.**
- **(ii) The reserve capacity over and above the peak load.**
- **(iii) The hours per year the station is not in service.**