# K.L.N. College of Engineering

**(An Autonomous Institution Affiliated to Anna University, Chennai)**

**Accredited by National Assessment and Accreditation Council (NAAC)**
**Pottapalayam – 630612. (11 km From Madurai City )TamilNadu, India.**

***Department of Mechanical Engineering***

**Accredited by NBA, New Delhi**
**Approved Research Center by Anna University, Chennai**

## Regulations – KLNCE-2020

## *20ME4L2*
## *THERMAL ENGINEERING LABORATORY MANUAL*

**Lab In charge**

***Mr. T.Samynathan AP2 / Mech.,***


**Prepared by**
***Dr. M.R.Thansekhar, Professor / Mech.***
***Dr.C.Anbumeenakshi, ASP / Mech***
***Mr. T.Samynathan AP2 / Mech.***

**Approved by**
***Dr. P. Udhayakumar***
***HOD / Mech. Engg.***

## DEPARTMENT OF MECHANICAL ENGINEERING

### VISION

**To become a Centre of excellence for Education and Research in Mechanical Engineering.**

### MISSION

- **Attaining academic excellence through effective teaching learning process and state of the art infrastructure.**
- **Providing research culture through academic and applied research.**
- **Inculcating social consciousness and ethical values through co-curricular and extra-curricular activities.**

## PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

| | |
|---|---|
| **PEO I** | **Graduates will have successful career in Mechanical Engineering and service industries.** |
| **PEO II** | **Graduates will contribute towards technological development through academic research and industrial practices.** |
| **PEO III** | **Graduates will practice their profession with good communication, leadership, ethics and social responsibility.** |
| **PEO IV** | **Graduates will adapt to evolving technologies through lifelong learning.** |

## PROGRAM SPECIFIC OUTCOMES (PSOs)

| | |
|---|---|
| **PSO1** | **Derive technical knowledge and skills in the design, develop, analyze and manufacture of mechanical systems with sustainable energy, by the use of modern tools and techniques and applying research based knowledge.** |
| **PSO 2** | **Acquire technical competency to face continuous technological changes in the field of mechanical engineering and provide creative, innovative and sustainable solutions to complex engineering problems.** |
| **PSO 3** | **Attain academic and professional skills for successful career and to serve the society needs in local and global environment.** |

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***Mr. T.Samynathan AP2 / Mech.,***

***Name :*** ***Roll No. :***

***Year / Sem. / Sec :*** ***Reg. No :***

# General Instructions for Laboratory Classes

- Students must attend the lab classes with **ID cards**
- Enter Lab with **CLOSED FOOTWEAR**
- Boys should **"TUCK IN"** the shirts
- Students should wear **uniform only**
- **LONG HAIR** should be protected
- Any other machines / equipment's **should not be operated** other than the prescribed one for that day.
- POWER SUPPLY to your test table should be obtained only through the **LAB TECHNICIAN**
- Do not **LEAN** and do not be **CLOSE** to the machine components.
- **TOOLS, APPARATUS & GUAGE** Sets are to be returned before leaving the Lab.
- **Any damage** to any of the equipment/instrument/machine caused due to carelessness, the **cost** will be fully recovered from the individual (or) group of students.

## University Examination

**The examination will be conducted for 100 marks. Then the marks will be calculated to 80 marks.**

## Split up of Practical Examination Marks

| ***Aim and Apparatus Required*** | ***Tabulation & Calculation*** | ***Procedure*** | ***Results*** | ***Graph*** | ***Viva*** | ***Total*** |
|---|---|---|---|---|---|---|
| *15* | *30* | *15* | *20* | *10* | *10* | *100* |

## *Contents*

***Name: …………………………………….………  Batch……………………..………….***

***Roll No.:……………  Year ……..…  Semester……..…  Section: ……….....***

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| S. No. | Date | Name of the Experiment | Page | Marks | Staff Signature |
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| 15. | | | | | |

**Completed date:**

**Average Mark:**  **Staff - in – charge**

**K.L.N. COLLEGE OF ENGINEERING, POTTAPALAYAM – 630 612**
**(An Autonomous Institution Affiliated to Anna University, Chennai)**

**20ME4L2 THERMAL ENGINEERING LABORATORY L T P C**
**0 0 3 1.5**

**OBJECTIVES:**

- To understand the construction, working and performance of I.C.Engines.
- To measure viscosity of lubricants
- To measure performance characteristics of refrigerator.
- To determine COP of an air conditioner.
- To gain practical knowledge about the working of air compressor.

**PREREQUISITE: NIL**

**LIST OF EXPERIMENTS**

1. Valve Timing diagrams of four stroke diesel engines and Port Timing diagrams of two Stroke petrol engine.
2. Determination of Flash Point and Fire Point of various fuels / lubricants.
3. Determination of viscosity of a lubricant.
4. Determination of p-v diagram of IC engine using Data acquisition system.
5. Performance Test on 4 – stroke Diesel Engine.
6. Heat Balance Test on 4 – stroke Diesel Engine.
7. Retardation Test on a Diesel Engine.
8. Morse Test on Multi-cylinder Petrol Engine.
9. Determination of COP of a refrigeration system.
10. Performance test in a HC Refrigeration System.
11. Determination of COP of an air conditioning system.
12. Performance test on a reciprocating air compressor.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

**AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:**

- Conduct tests on I.C Engine – 2 stroke and 4 stroke model and Calculate Valve Timing and Port Timing Values.
- Conduct tests on Flash and Fire Point apparatus and determine the value of Flash and Fire Point of fossil fuels and Lubricants.
- Conduct Performance tests on Diesel and Petrol engine Test rigs and analyze the performance Parameters of different engines.
- Conduct tests on refrigeration test rigs and determine the COP of refrigeration test rigs.
- Conduct tests on air conditioning test rigs and determine the COP of air conditioning test rigs.
- Conduct tests on reciprocating air compressor test rigs and determine the volumetric efficiency of reciprocating air compressor test rigs.

**LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:**

| S.No. | NAME OF THE EQUIPMENT | Qty. |
|---|---|---|
| 1 | I.C Engine – 2 stroke and 4 stroke model | 1 set |
| 2 | Apparatus for Flash and Fire Point | 1 No. |
| 3 | Viscometer | 1 No |
| 4 | 4-stroke Diesel Engine with mechanical loading. | 1 No. |
| 5 | 4-stroke Diesel Engine with hydraulic loading. | 1 No. |
| 6 | 4-stroke Diesel Engine with electrical loading. | 1 No. |
| 7 | Multi-cylinder Petrol Engine | 1 No. |
| 8 | Refrigeration test rig. | 1 No. |
| 9 | Air-conditioning test rig. | 1 No. |
| 10 | Reciprocating air compressor. | 1 No. |
| 11 | Refrigeration test rig with HC as the Refrigerant. | 1 No. |

***Ex No:1a*** ***Date :***

## *Valve Timing Diagram of Four Stroke Diesel Engine*

***Aim:***

To draw the actual valve timing diagram of the four stroke Diesel engine and to find the angle of overlap.

***Accessories required:***

1. 4 – Stroke cycle Diesel Engine
2. Measuring Tape / Thread
3. Scale

***Formula:***

$$Required\ angle(\theta) = Distance\ X \frac{360}{Circumference of Flywheel}$$

Where,

Distance = Distance of the valve opening or closing position marked on flywheel with respect to their dead Centre

***Introduction:***

Valve timing diagram is a system used to measure valve operation in relation to crankshaft position (in degrees), specifically the points when the valves open, how long they remain open, and the points when they close. In internal combustion engines, valves behavior (lift and timing) is one of the most important parameters which have a major effect on the engine operation and emission. The intake and exhaust valves must open and close at the right time. Otherwise, the performance of the engine will be poor. The valves in four-stroke cycle engines are almost universally of a poppet type which are spring loaded toward a valve-closed position and opened against that spring bias by cam on rotating camshaft with the camshaft being synchronized by the engine crankshaft.

***Tabulation:***

Circumference of the flywheel = cm.

| ***S. No.*** | ***Valve Position*** | ***Position with respect to nearest dead centre TDC / BDC (cm)*** | ***Distance (or) Arc length to nearest dead center (cm)*** | ***Angle (Deg.)*** |
|---|---|---|---|---|
| **1.** | | | | |
| **2.** | | | | |
| **3.** | | | | |
| **4.** | | | | |
| **5.** | | | | |
| **6.** | | | | |

***Calculation:***

$$Required\ angle(\theta) = Distance\ X \frac{360}{Circunference of Flywheel}$$

***Procedure:***

1. First the TDC and BDC of the engine are found correctly by rotating the flywheel and the positions are marked on the flywheel.
2. Now the circumference of the flywheel is found by using the measuring tape.
3. The flywheel is rotated and the point at which the inlet valve starts opening is found out and its position is marked on the flywheel.
4. Similarly the position at which it closes is also found out.
5. The distances are measured by using thread with respect to their dead centre and converted into angles.
6. The same procedure is repeated for the exhaust valves also.

***Valve Timing Diagram:***

***Inference:***

- Understand Valve Overlapping. The time during which both the valves (inlet and exhaust) remain open at the same instant.
- In four stroke CI Engines(compression ignition engine), both the valves do not open and close exactly at dead center positions, rather operate at some degree on either side in terms of the crank angles from the dead center positions. The injection of the fuel is also timed to occur earlier.

***Application:***

- Four stroke diesel engine or four stroke petrol engines.
- Automobile vehicle which are used four stroke engine.

***Result:***

The actual valve timing diagram of four stroke diesel engine was drawn.

Inlet valve opens =

Inlet valve closes =

Exhaust valve opens =

Exhaust valve closes =

***Ex No: 1b*** ***Date :***

## *Port Timing Diagram of Two Stroke Petrol Engine*

***Aim:***

To draw the port timing diagram of two stroke cycle petrol engine.

***Accessories Required:***

1. Two stroke cycle petrol engine
2. Measuring Tape
3. Thread and scale

***Formula:***

$$Required\ Angle\ (\theta) = \frac{Distance x\ 360}{Circumference\ of\ Fly\ wheel}$$

Where,

Distance = Distance of the valve opening or closing position marked on flywheel with respect to their dead centre

***Introduction:***

The port timing diagram gives an idea about how various operations are taking place in an engine cycle. The two stroke engines have inlet and transfer ports to transfer the combustible air fuel mixture and an exhaust port to transfer exhaust gas after combustion. The sequence of events such as opening and closing of ports are controlled by the movements of piston as it moves from TDC to BDC and vice versa. As the cycle of operation is completed in two strokes, one power stroke is obtained for every crankshaft revolution. Two operations are performed for each stroke both above the piston (in the cylinder) and below the piston (crank case). When compression is going on top side of the piston, the charge enters to the crank case through inlet port. During the downward motion, power stroke takes place in the cylinder and at the same time, charge in the crank case is compressed and taken to the cylinder through the transfer port.

***Tabulation:***

Circumference of the flywheel = cm.

| *S. No.* | *Port Position* | *Position with respect to nearest dead centre TDC /BDC (cm)* | *Distance (or) Arc length to nearest dead centre (cm)* | *Angle (Deg.)* |
|---|---|---|---|---|
| 1. | | | | |
| 2. | | | | |
| 3. | | | | |
| 4. | | | | |
| 5. | | | | |
| 6. | | | | |

During this period exhaust port is also opened and the fresh charge drives away the exhaust which is known scavenging. As the timing plays major role in exhaust and transfer of the charge, it is important to study the events in detail. The pictorial representation of the timing enables us to know the duration and instants of opening and closing of all the ports. Since one cycle is completed in one revolution i.e. 360 degrees of crank revolution, various positions are shown in a single circle of suitable diameter.

***Standard positions of port:***

***Inlet port:***

It is uncovered 45º to 50º in advance of TDC.

It is covered 40º to 45º after the TDC

***Exhaust port:***

It is uncovered 40º to 55º in advance of the BDC.

It is covered 40º to 55º after the BDC.

***Transfer Port***

Uncovered – 35º – 45º

Covered – 35º – 45º

***Procedure:***

1. Remove the ports cover and identify the three ports.
2. Mark the TDC and BDC position of the fly wheel. To mark this position follow the same procedure as followed in valve timing diagram.
3. Rotate the flywheel slowly in usual direction (usually clockwise) and observe the
4. Movement of the piston.
5. When the piston moves from BDC to TDC observe when the bottom edge of the
6. Piston, Just uncover the bottom end of the inlet port. This is the inlet port opening
7. (IPO) condition, make the mark on the flywheel and measure the distance from TDC
8. When piston moves from TDC to BDC observe when the bottom edge of the piston completely covers the inlet port. This is the inlet port closing (IPC) condition. Make on the flywheel and measure the distance from TDC.
9. When the piston moves from TDC to BDC observe, when the top edge of the piston just uncover the exhaust port. This is the exhaust port opening [EPO] condition. Make the mark on the flywheel and measure the distance from BDC.

10. When the piston moves from BDC to TDC observe, when the piston completely Cover the exhaust port. This is the exhaust port closing condition [EPC]. Make the mark on the flywheel and measure the distance from BDC.
11. When the piston moves from TDC to BDC observe, when the top edge of the piston just uncover the transfer port. This is the transfer port opening [TPO] condition. Make the mark on the flywheel and measure the distance from BDC
12. When the piston moves from BDC to TDC, observe, when the piston completely
13. Covers the transfer port. This is the transfer port closing [TPC] condition. Make the Mark on the flywheel and measure the distance from BDC.

***Calculation:***

$$Diameter\ of\ Fly\ Wheel\ (D) = \quad mm$$

$$Circumference\ of\ Flywheel\ (X) = \pi D = \quad mm$$

$$Required\ Angle\ (\Theta) = \frac{Distance x\ 360}{Circumference\ of\ Fly\ wheel}$$

***Port Timing Diagram:***

***Inference:***

- Understand the use of transfer port in two stroke engine.
- Know about Purpose of scavenging in two stroke engine.
- Understand cylinder head shape in two stroke engines.

***Application:***

- Automobile vehicles in two stroke engine.

***Result:***

The port timing diagram of two stroke petrol engine was drawn.

1. Inlet port opens =
2. Inlet port closes =
3. Transfer port opens =
4. Transfer port closes =
5. Exhaust Port opens =
6. Exhaust port closes =

***Ex No: 2a*** ***Date :***

## *Determination of Flash Point and Fire Point of various fuels / lubricants (Pensky Martens Apparatus)*

***Aim:***

To find the flash & fire point from the given sample of oil using closed cup apparatus.

***Application:***

It is used to test the fuel oils, lubricating oils, viscous materials and suspension of solids. This method is not applicable to solvent type liquid waxes or cut-back asphalts.

***Apparatus required:***

1. Closed cup apparatus,
2. Thermometer,
3. Electric heater.

***Theory:***

***Flash point:***

It is the lowest temperature at which the fuel will flash when an external source of fire is brought in contact with the vapors over its surface.

***Fire point:***

Fire point is the lowest temperature at which the formation of combustible gases from the oil is enough to maintain a steady combustible gas fire after it is ignited.

***Precautions:***

Using a rheostat regulate the heating range to sufficiently low rate to avoid errors. Provide adequate heating.

***Procedure:***

1. Fill the given oil to the apparatus up to the marking.
2. Let the thermometer be placed in the holder without touching the surface.
3. The sample is heated in a test cup at a slow and constant rate with continuous stirring.
4. A small test flame is directed in to the cup at regular intervals with simultaneous interruption of stirring.

5. The flash point is taken at the lowest temperature at which the application of the test flame causes the vapor above the sample to ignite momentarily.
6. Apply the test flame by operating the mechanisms on the cover which controls the shutter. Do not stir the sample while applying the
7. Record as the flash point the temperature read on the thermometer at the time and test flame application causes a distinct flash in the interior of the cup. Do not confuse the true flash point with the bluish halo that sometimes surroundings the test flame at applications preceding the one that cause the actual flash.
8. After attaining the flash point continue the heating until the oil lights and continuous to burn for 5 sec. Record the temperature of the oil when this occurs as the fire point.
9. Results of duplicate tests shall not differ by more than the following amounts.

***Closed cup:***

EXPERIMENTAL SETUP:

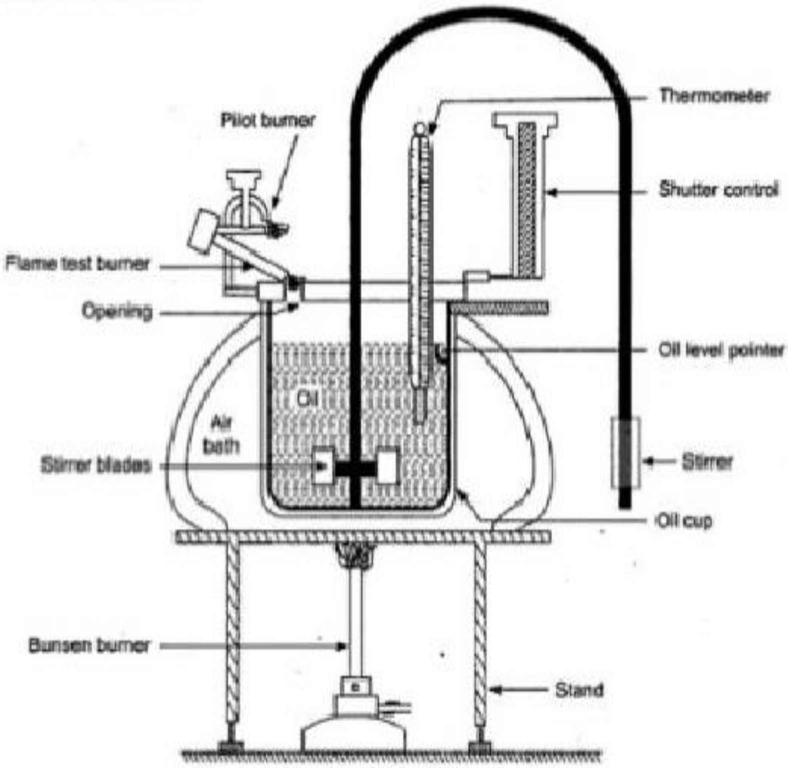



Figure: Pensky Martens apparatus

***Tabulation:***

| ***S.No.*** | ***Name of The Oil Sample*** | ***Temperature °C*** | ***Observation*** |
|---|---|---|---|
| 1. | | | |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| 7. | | | |
| 8. | | | |
| 9. | | | |
| 10. | | | |

***Inference:***

- Know about viscosity
- Know about flash and fire point.
- Understanding Lubrication.

***Application:***

- I.C engines, Bearings.
- All type of Industry involving moving parts.

***Result:***

Thus the flash & fire point from the given sample of oil using closed cup apparatus was done.

***Ex No: 2 b*** ***Date :***

## *Determination of Flash Point and Fire Point of various fuels / lubricants (Cleveland Apparatus)*

***Aim:***

To determine the flash and fire point the given sample oil with open cup apparatus.

***Apparatus required:***

1. Open cup apparatus
2. Thermometer
3. Electric heater

***Theory:***

***Flash Point:***

It is the lowest temperature at which the fuel will flash when an external source of fire is brought in contact with the vapor over its surface.

***Fire point:***

Fire point is the lowest temperature at which the formation of combustible gases from the oil is enough to maintain a steady combustible gas fire after it is ignited.

***Description:***

This apparatus consist of standard size cylindrical cup. It is held in the metallic holder, which is heated by means of an electrical heater. A provision is made on the top Edge of the cup to hold the mercury glass thermometer in correct position.

A permanent mark is in scribbled on the inner surface of the cup .the oil sample is filled up to this mark.

***Precautions:***

1. Using a rheostat regulate the heating range to sufficiently low rate to avoid errors.
2. Provide adequate heating

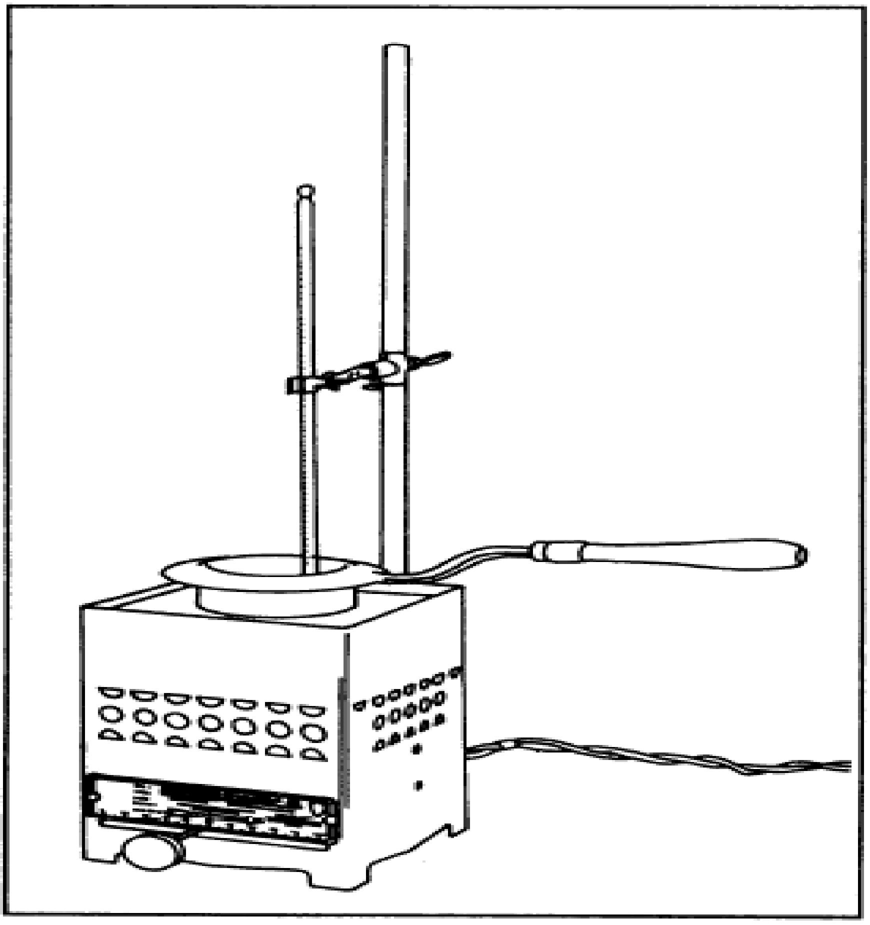
***Procedure:***

1. Fill the given oil to the apparatus upto the marking.
2. Let the thermometer be placed in the holder without touching the surface.
3. The sample is heated in a test cup at a slow and constant rate with continuous stirring.
4. A small test flame is directed in to the cup at regular intervals with simultaneous interruption of stirring.

5. The flash point is taken at the lowest temperature at which the application of the test flame causes the vapor above the sample to ignite momentarily.
6. Apply the test flame by operating the mechanisms on the cover which controls the shutter. Do not stir the sample while applying the
7. Record as the flash point the temperature read on the thermometer at the time and test flame application causes a distinct flash in the interior of the cup. Do not confuse the true flash point with the bluish halo that sometimes surroundings the test flame at applications preceding the one that cause the actual flash.
8. After attaining the flash point continue the heating until the oil lights and continuous to burn for 5 sec. Record the temperature of the oil when this occurs as the fire point.

***Closed cup:***

***EXPERINMENT SETUP:***



***Tabulation:***

| S. No. | Name of the Oil Sample | Temperature °C | Observation |
|---|---|---|---|
| 1. | | | |
| 2. | Sample Oil ( ) | | |
| 3. | | | |
| 4. | | | |
| 5. | Sample Oil ( ) | | |
| 6. | | | |
| 7. | | | |
| 8. | Sample Oil ( ) | | |
| 9. | | | |

***Inference:***

- Know about viscosity
- Know about flash and fire point.
- Understanding Lubrication.

***Application:***

- I.C engines, Bearings.
- All type of Industry involving moving parts.

***Result:***

Thus the flash & fire point from the given sample of oil using open cup apparatus was done.

***Ex No: 3*** ***Date :***

## *Determination of viscosity of a lubricant (Redwood Viscometer)*

***Aim:***

To determine the kinematic viscosity of the given oil sample at various temperatures and to draw the following graph.

1. Redwoods viscosity Vs temperature.
2. Kinematics' viscosity Vs temperature

***Apparatus required:***

a. Redwood viscometer
b. Thermometers - 2 Nos.
c. Stop watch
d. 50 cc collecting flask.

***Theory:***

***Viscosity:***

Viscosity is defined as the property of a fluid which offers resistance to the movement of one layer of fluid over another adjacent layer of the fluid

***Kinematic viscosity:***

It is defined as the ratio between the dynamic viscosity and the density of the fluid. It is denoted by ( $\mu$).

***Description:***

1. The redwood viscometer consists of a cylindrical oil cup and it has an orifice at the centre of its base. The orifice can be opened and closed by a ball valve.
2. A hook pointing upward serves as a guide for the oil in the cup, the cup is place inside a water bath, which can be heated electrically. A stirrer with radial vanes is provided to keep the temperature uniform. Thermometers are held in the holders provided for reading the temperature of water bath and oil.

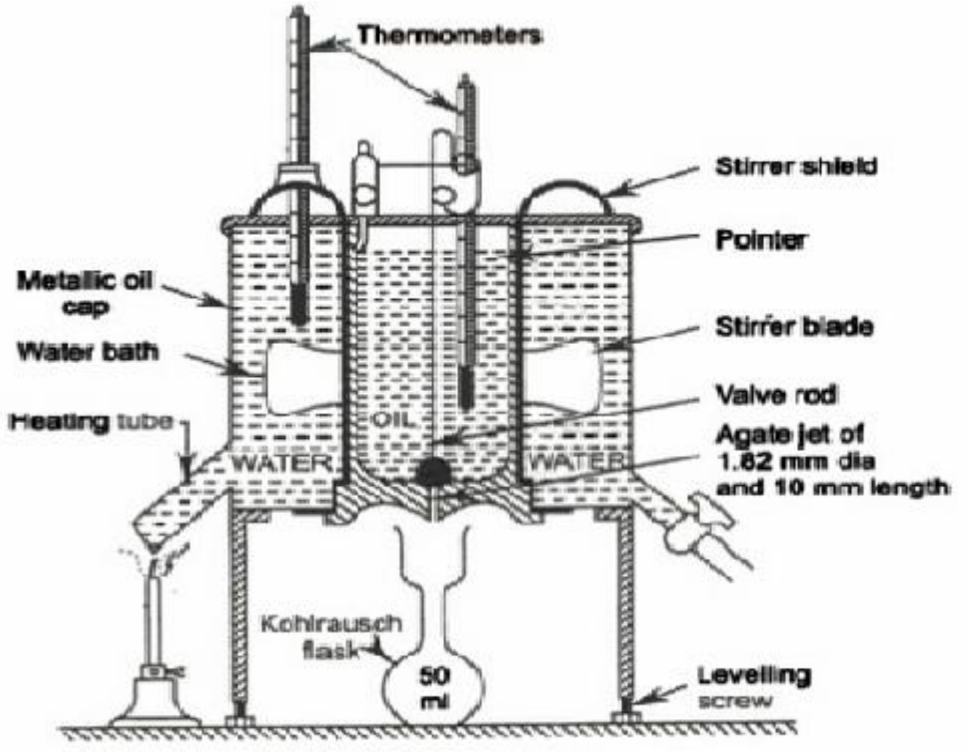


Figure: Experimental Setup

***Tabulation:***

| *S. No.* | *Temperature of water ℃* | *Temperature of oil ℃* | *Time taken for 60 ml (sec)* | $\nu = At - \frac{B}{t}$ *Centistokes* |
|---|---|---|---|---|
| 1. | | | | |
| 2. | | | | |
| 3. | | | | |
| 4. | | | | |
| 5. | | | | |
| 6. | | | | |
| 7. | | | | |
| 8. | | | | |
| 9. | | | | |
| 10. | | | | |

***Formula:***

Dynamic viscosity = A t - (B/ t) centistokes.

Where

A & B are constant, A = 0.26, B = 170.5. t = time taken to collect 50 cc of oil in the flask in seconds.

Kinematics viscosity = dynamic viscosity / density

***Procedure:***

1. Clean the cup and move the jet is free from distance close to the orifice with help of ball valve and fill the cup with the given oil up to the tip of the hook gauge.
2. Insert the thermometer in the holder, one in oil cup and other in the stirrer mouth and read the room temperature of oil.
3. Place the cleaned standard collecting flask of 50cc capacity just below the opening of the orifice and adjust the flask such that the stream oil coming out of orifice strikes the mouth of the flask.
4. The oil is heated by switching on the heater and the water is stirred continuously .the input to the heater is varied by adjusting the rheostat regulator. Ensure the temperature reading is same in the oil and water before opening the ball vale.
5. Opening the ball valve and then the time taken for collecting 50cc oil is measured by stop watch. After collecting 50 cc of oil in the flask close the ball valve.
6. Repeat the experiment different temperature. And tabulate the reading

***Graph***

1. Temperature Vs Redwood seconds.
2. Temperature Vs Kinematic viscosity

***Inference:***

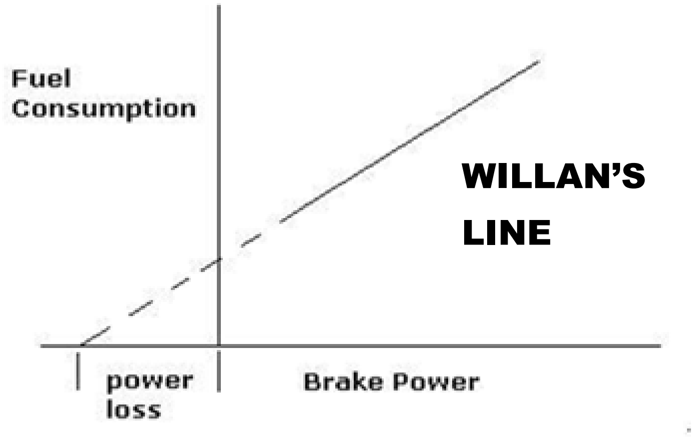
1. Know about viscosity
2. Know about flash and fire point.
3. Understand Lubrication and its functions.
4. Understand Lubricating oil grades.

***Application:***

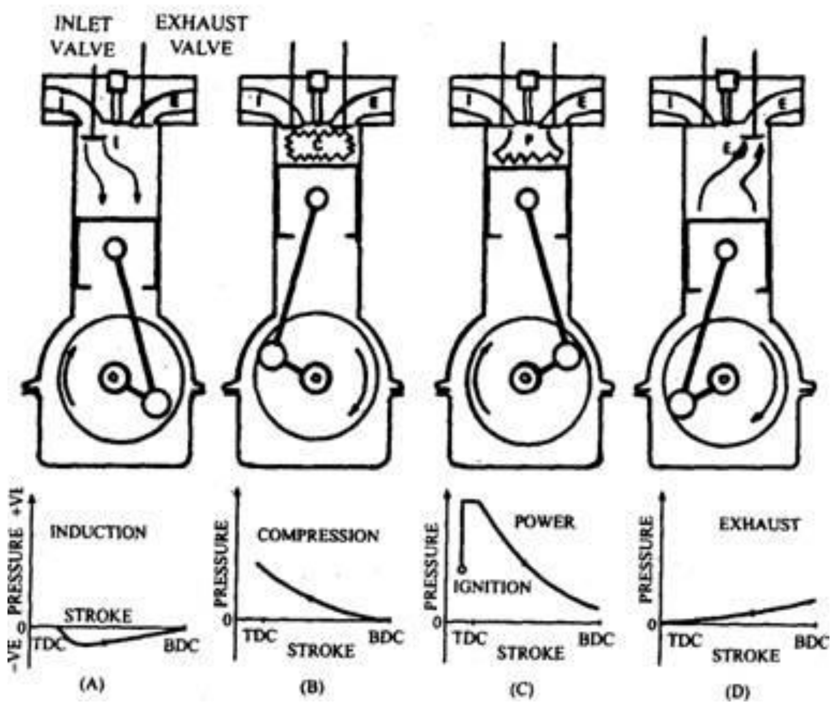
- I.C engines, Bearings.
- Industry

***Result:***

The kinematics viscosity of the given sample was determined for the different temperatures. The temperature Vs kinematics viscosity graphs were drawn.




*Model 4 stroke diesel engine working:*



***Ex No:4*** ***Date :***

## *Determination of p-v diagram of IC engine using Data acquisition system.*

***Aim:***

To draw the Actual P V diagram of single cylinder 4 - stroke diesel engine.

***Accessories Required:***

1. Four stroke single cylinder diesel engine
2. Dynamometer.
3. Stop watch
4. Manometer

***Specifications:***

| ***S. No*** | ***Name*** | ***Details*** |
|---|---|---|
| 1. | Type | 4-Stroke, 2-Cylinder Diesel Engine (Water Cooled), Compression Ignition. |
| 2. | Make | Maxwell |
| 3. | Rated Power Output | 10 HP, 1500 RPM. |
| 4. | Bore & Stroke | 80mm x 88.9mm. |
| 5. | Compression' Ratio | 17.5 : 1 |
| 6. | Starting | By Hand Cranking |

***Introduction***

A machine, which uses heat energy obtained from combustion of fuel and converts it into mechanical energy, is known as a Heat Engine. They are classified as External and Internal Combustion Engine. In an External Combustion Engine, combustion takes place outside the cylinder and the heat generated from the combustion of the fuel is transferred to the working fluid which is then expanded to develop the power. An Internal Combustion Engine is one where combustion of the fuel takes place inside the cylinder and converts heat energy into mechanical energy. IC engines may be classified based on the working cycle, thermodynamic cycle, speed, fuel, cooling, method of ignition, mounting of engine cylinder and application.

Diesel Engine is an internal combustion engine, which uses heavy oil or diesel oil as a fuel and operates on two or four stroke. In a 4-stroke Diesel engine, the working cycle takes place in two revolutions of the crankshaft or 4 strokes of the piston. In this engine, pure air is sucked to the engine and the fuel is injected with the combustion taking place at the end of the compression stroke. The power developed and the performance of the engine depends on the condition of operation. So it is necessary to test an engine for different conditions based on the requirement.

***Experimental setup:***

The compact and simple engine test rig consisting of a four stroke double cylinder, water cooled, constant speed diesel engine coupled with flywheel and mechanical loading arrangement. The engine is started by hand cranking using the handle by employing the decompression lever. The engine is loaded using weight through weight load. The loading arrangement consists of a set of weights on the spring balance. A spring balance is used to record the load on the engine flywheel. A burette is connected with the fuel tank through a control valve for fuel flow measurement. Provision is made to circulate water continuously through the engine jacket.

***Starting the Engine:***

1. Keep the decompression lever in the vertical position
2. Insert the starting handle in the shaft and rotate it
3. When the flywheel picks up speed bring the decompression lever into horizontal position and remove the handle immediately.
4. Now the engine will pick up.

***Stopping the Engine:***

Cut off the fuel supply by keeping the fuel governor lever in the other extreme position.

T = Load X radius of flywheel

Max. Load =

Half Load =

75% Load =

***Procedure:***

1. Start the engine at no load and allow idling for some time till the engine warm up.
2. Note down the time taken for 10cc of fuel consumption using stopwatch and fuel measuring burette.
3. After taking the readings open the fuel line to fill burette and supply fuel to run the engine from the fuel tank again.
4. Now load the engine gradually to the desired valve. This may be done by switching on the load switches.
5. Allow the engine to run at this load for some time in order to reach steady state condition and note down the time taken for 10 cc of fuel consumption.
6. Note down the voltmeter and ammeter readings for the above conditions.
7. Repeat the experiment by switch ON additional load switches.
8. Release the load by switching OFF the load switches slowly one by one and stop the engine.
9. Tabulated the reading as shown and calculate the result.

***Graphs:***

B.P. Vs T.F.C.

B.P. Vs S.F.C.

B.P. Vs Mechanical efficiency

B.P. Vs Brake Thermal efficiency

**Inference:**

- Understanding single cylinder four stroke diesel engine.
- Measuring the performance of the engine at constant speed.
- Drawing Willan's line and obtaining friction power and mechanical efficiency.

**Application:**

- Used in Diesel engine pump set.
- Used in Diesel engine concrete mixer machine etc.,

***Result:***

Thus the Actual PV diagram and performance characteristic curves are drawn.

***Ex No: 5*** ***Date:***

## *Performance Test on Four Stroke Diesel Engine with Electrical Load*

***Aim:***

To conduct the performance test on single cylinder 4 - stroke diesel engine with electrical load.

***Accessories Required:***

1. Four stroke single cylinder diesel engine
2. AC generator with resistance bank load.
3. Stop watch
4. Manometer

| *S. No* | *Name* | *Details* |
|---|---|---|
| 1. | Type | 4-Stroke, 2-Cylinder Diesel Engine (Water Cooled), Compression Ignition. |
| 2. | Make | Field marshal |
| 3. | Rated Power Output | 5 H.P, 1500 rpm. |
| 4. | Bore & Stroke | 80 mm, 110 mm. |
| 5. | Compression' Ratio | 17.5 : 1 |
| 6. | Starting | By Hand Cranking |

***Introduction:***

The diesel engine is a type of internal combustion engine; more specifically, it is a compression ignition engine. The fuel in a diesel engine is ignited by suddenly exposing it to the high temperature and pressure of a compressed gas containing oxygen (usually atmospheric air), rather than a separate source of ignition energy (such as a spark plug). This process is known as the diesel cycle after Rudolf Diesel, who invented it in 1892. While traditional diesel engine generators may not fit into our definition of 'alternative energy' sources, they are still a valuable addition to a remote power or grid back-up system. Diesel generators are designed to meet the needs of small and medium-sized businesses apart from heavy usage in industries.

***Tabulation I:***

***Observation:***

| S. No | Applied Electrical Load (KW) | Time Taken for 10 Cc Of Fuel (Sec) |
|---|---|---|
| 1 | | |
| 2 | | |
| 3 | | |
| 4 | | |
| 5 | | |
| 6 | | |
| 7 | | |

***Tabulation:***

| S. No | BP KW | IP KW | Time Taken for 10 Cc Fuel Consumed Sec | Heat Supplied H.S $\frac{kJ}{sec}$ | SFC $\frac{kJ}{sec}$ | TFC $\frac{kJ}{sec}$ | $\eta_{BTH}$ % | $\eta_{ITH}$ % | $\eta_{Mech}$ % |
|---|---|---|---|---|---|---|---|---|---|
| 1. | | | | | | | | | |
| 2. | | | | | | | | | |
| 3. | | | | | | | | | |
| 4. | | | | | | | | | |
| 5. | | | | | | | | | |
| 6. | | | | | | | | | |
| 7. | | | | | | | | | |

A generator is a revolutionary product that brings clean and affordable standby power within the reach of millions of enterprises, homes and small businesses. Reducing the cost of backup power and making generators easy to install is becoming the norm these days.

Most modern generators are engineered to meet emergency power needs. These units continuously monitor the electrical current and automatically start up if power is interrupted and shut off when utility service is returned. In industries, during critical processes, generators can supply emergency power to all vital and selected loads as desired. This quality leads to widespread use of diesel-powered generators across recreational, residential, commercial, communication, and industrial applications. Today, most state-of-the-art-hospitals, five star hotels, business process outsourcing centers, manufacturing plants, telecommunications organizations, commercial buildings, data centers, emergency facilities, large industries, and mining companies require uninterrupted power and have backup diesel engine generators.

***Experimental Setup:***

The compact and simple engine test rig consisting of a four stroke single cylinder, water cooled, and constant speed diesel engine coupled with flywheel and AC generator with resistance bank loading arrangement. The engine is started by hand cranking using the handle by employing the decompression lever. The engine is loaded using set of resistance bank. Give load by selecting suitable resistance bank and measure the reading by looking ammeter. A burette is connected with the fuel tank through a control valve for fuel flow measurement. Provision is made to circulate water continuously through the engine jacket.

***Procedure:***

1. Fill the fuel tank with diesel, provide engine jacket water connection.
2. Open the 3way cock. In this position the fuel flows from the tank to the engine filling the burette. To remove air block in the hose, remove the hose from the engine and hold it vertically up. Now connect the hose back to the engine and open the air bleed screw to allow the fuel to freely flow through the screw. Tighten the screw. Put the decompression lever up.
3. Crank the engine to hear the fuel injection creek sound and put the decompression lever down and the engine starts. Care to be taken to remove the handle immediately on starting of the engine.
4. The voltmeter indicates the voltage output from the generator.
5. Switch on the resistance bank load. Select a suitable load by looking at the ammeter

reading.

6. Note the voltmeter and ammeter reading.
7. Note the time for the fuel consumption from the burette by closing the cock for 10cc.
8. Note the manometer reading.
9. Note the temperatures from T1 to T6.
10. Note the time for 1 liter water flow through the engine jacket.
11. Repeat the procedure for other loads.
12. It is preferred to take readings in the ascending order of loads.

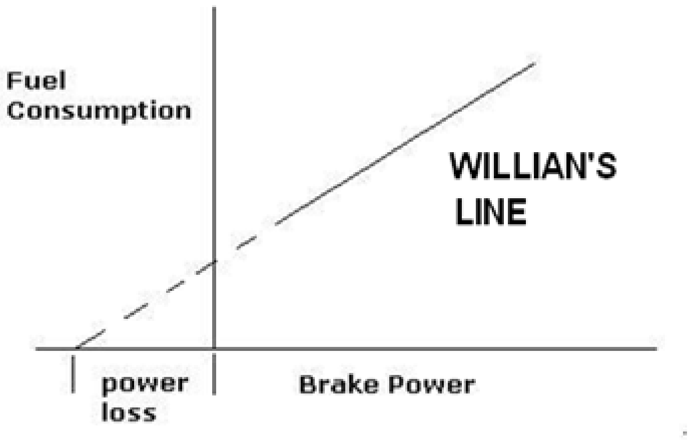
***Formula:***

1. Break power = V X A in W
2. Total fuel consumptions (TFC) = $\frac{10cc \ X \ 0.8 \ X \ 3600}{t \ X \ 1000} \frac{kg}{hr}$

Where t is time for 10cc fuel from burette in seconds.

3. Specific fuel consumption (SFC) = $\frac{TFC}{BP} \frac{kg}{kWhr}$
4. IP = BP – FP in W

William's line,



***Maximum load calculation:***

1. Break power = V X A = in W

2. Total fuel consumptions (TFC) = $\frac{10cc\ X\ 0.8\ X\ 3600}{t\ X\ 1000} =$ $in\ \frac{kg}{hr}$

3. Specific fuel consumption (SFC) $= \frac{TFC}{BP} =$ $in\ \frac{kg}{kWhr}$

4. IP = BP – FP = in W

5. Break thermal efficiency = $\frac{BP\ X\ 3600\ X\ 100}{TFC\ X\ C.V} =$ $in$ in %

6. Mechanical efficiency $= \frac{BP}{IP}\ X\ 100 =$ $in\ \%$

7. Indicated thermal efficiency = $\frac{IP\ X\ 3600\ X\ 100}{TFC\ X\ C.V} =$ in %

8. Volumetric efficiency $= \frac{V\ actual}{V\ theoretical}\ X\ 100 =$ $in\ \%$

9. $V_{theoretical} = \frac{LAN}{60} =$ $in\ \frac{m^3}{sec}$

The BP vs. TFC curve is drawn and produced to meet the negative BP axis which gives FP.

5. Break thermal efficiency = $\frac{BP \ X \ 3600 \ X \ 100}{TFC \ X \ C.V}$ in %
6. Mechanical efficiency = $\frac{BP}{IP} \ X \ 100 \ in \ \%$
7. Indicated thermal efficiency = $\frac{IP \ X \ 3600 \ X \ 100}{TFC \ X \ C.V}$ in %
8. Volumetric efficiency = $\frac{V \ actual}{V \ theoretical} \ X \ 100 \ in \ \%$
9. $V_{theoretical} = \frac{LAN}{60}$

Where,

L = Stroke length

A = Area of the piston

N = speed in rpm.

***Graphs:***

B.P. Vs T.F.C.

B.P. Vs S.F.C.

B.P. Vs Mechanical efficiency

B.P. Vs Brake Thermal efficiency

***Inference:***

- Understanding single cylinder four stroke diesel engine.
- Measuring the performance of the engine at constant speed.
- Understanding electrical resistant load.

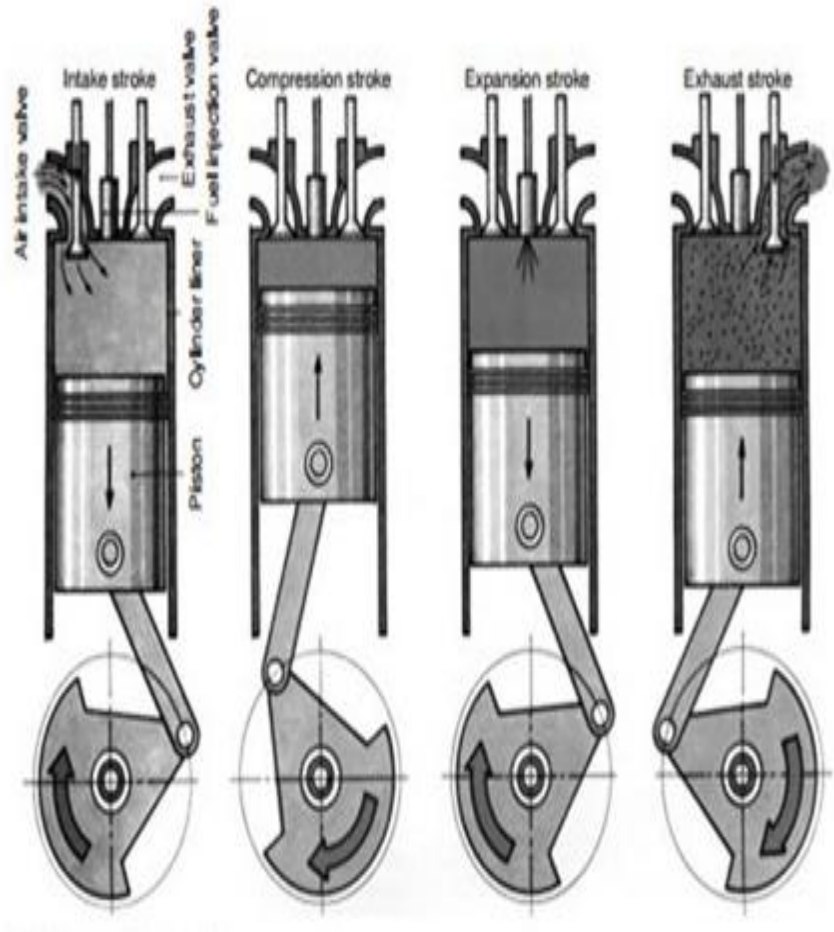
***Application:***

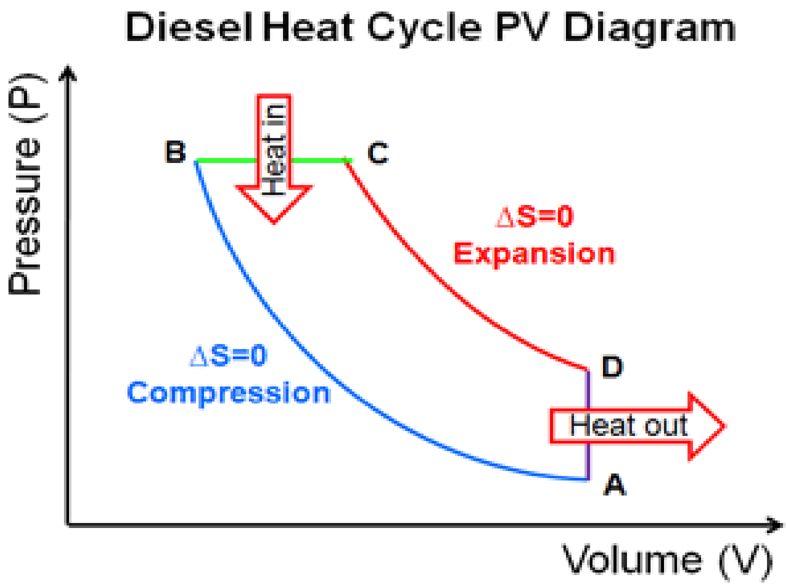
- Used in Diesel engine generators.
- Diesel power plant.

***Result:***

Load test and Heat Balance test on the given engine is performed and performance characteristic curves are drawn. From the graph drawn between B.P and T.F.C, friction power is calculated by William's line method.

*Model four stroke diesel engine working*



***Ex No:6*** ***Date:***

## *Heat Balance Test on Four Stroke Diesel Engine*

***Aim:***

To perform a heat balance test on the given single cylinder four stroke C.I engine and to prepare the heat balance sheet at various Mechanical loads.

***Accessories required:***

1. Engine coupled with a dynamometer,
2. Rota meter for water flow measurement,
3. Stop watch,
4. Tachometer,
5. Temperature Indicator.

***Specifications***

| ***S. No*** | ***Name*** | ***Details*** |
|---|---|---|
| 1. | Type | 4-Stroke, single Cylinder Diesel Engine (Water Cooled), Compression Ignition. |
| 2. | Make | Kirloskar. |
| 3. | Rated Power Output | 3.68KW @ 1500 RPM |
| 4. | Bore & Stroke | 80mm x 110mm. |
| 5. | Compression' Ratio | 17.5 : 1 |
| 6. | Starting | Hand cranking |

***Introduction:***

From the law of conservation of energy, the total energy entering the engine in various ways in a given time must be equal to the energy leaving the engine during the same time, neglecting other form energy such as the enthalpy of air and fuel. The energy input to the engine is essentially the heat released in the engine cylinder by the combustion of the fuel. The heat input is partly converted into useful work output, partly carried away by exhaust gases, partly carried away by cooling water circulated and the direct radiation to the surroundings. In a heat balance test all these values are calculated and converted to percentage with respect to the input and are presented in a chart at various loads.

***Observation:***

| ***S. No.*** | ***Observation*** | ***Unit*** | ***$W_2$ (kg)*** | ***$W_1$ (kg)*** | ***W (kN)*** |
|---|---|---|---|---|---|
| 1. | | | | | |
| 2. | | | | | |
| 3. | | | | | |
| 4. | | | | | |
| 5. | | | | | |

***Experimental setup:***

The compact and simple engine test rig consisting of a four stroke single cylinder, water cooled, constant speed diesel engine coupled to a rope brake dynamometer. The engine is started by hand cranking using the handle by employing the decompression lever. Air from atmosphere enters the inlet manifold through the air box. An orifice meter connected with an inclined manometer is used for air flow measurement. A digital temperature indicator is used to measure temperature of exhaust gas. A burette is connected with the fuel tank through a control valve for fuel flow measurement. Provision is made to circulate water continuously through the engine jacket. Rota meter is provided to measure the flow rate of cooling water. Thermometers are provided to measure the temperature of cooling water passing through the jacket.

**Starting the Engine:**

- Keep the decompression lever in the vertical position
- Insert the starting handle in the shaft and rotate it
- When the flywheel picks up speed bring the decompression lever into horizontal position and remove the handle immediately.
- Now the engine will pick up.

**Stopping the Engine:**

- Cut off the fuel supply by keeping the fuel governor lever in the other extreme position.

***Formula:***

1. Load = $\frac{W1 - W2}{1000} X9.81\ kN$

2.

$W_1 - W_2 =$ Initial reading in spring balance – final reading in spring balance.

3. T.F.C. $= \frac{10}{t} X \frac{3600}{1000} X\ specific\ gravity\ of\ diesel\ \frac{kg}{kW}$

t = Time taken for 10 cc fuel consumption.

4. Heat supplied ($Q_S$) = $\frac{T.F.C\ x\ CV}{3600}\ kW$

5. SFC = $\frac{TFC}{BP}$

Calorific value for diesel = 44100 $\frac{kJ}{kg}$

B.P = $\frac{2\pi NT}{60}$

T = w = $\frac{T}{R}$ =

***For cooling water:***

1. Mass flow rate ($M_{CW}$) = $\frac{10}{t} X \frac{3600}{1000} \frac{kg}{hr}$

   t = time taken for 10cc of fuel consumption in sec.

2. Heat taken by cooling water ($Q_{CW}$) = $M_{CW} X cp_w \; X(T_O - T_i) \frac{kJ}{hr}$

   $M_{CW}$ = Mass of cooling water Circulated in kg

   $c_{pW}$ = Specific heat of water at constant pressure in $\frac{kJ}{kgK}$

   $c_{pW}$ = 4.186 J/g °C

   $T_O$ = Outlet temperature of water in ºC

   $T_i$ = Inlet temperature of water in ºC

3. Percentage of heat loss by cooling water = $\frac{Q_{CW}}{Q_S} X100\%$

   $Q_{CW}$= Heat taken by cooling water in $\frac{kJ}{hr}$

   $Q_S$ = Total heat supplied in $\frac{kJ}{hr}$

***Useful work:***

1. Brake power B.P= $\frac{2\pi N R_W}{60}$ $in\ W$

   N = Speed in rpm.

   $R_W$ = Load in kg.

2. $R_W$ = $\frac{W_1 \sim W_2}{1000}$ $X\ 9.81\ kN$

   3. Percentage of useful work = $\frac{B.P.X\ 3600}{Q_S}$ $X\ 100\%$

   B.P.= Brake power in kW

   $Q_S$ = Heat input in $\frac{kJ}{hr}$

***Exhaust gas:***

1. $Air\ Fuel\ Ratio = \frac{Q_a\ \rho_a}{TFC}$

   $Q_a$ = Actual discharge of air in $\frac{m^3}{hr}$

   $\rho_a$ = Density of air in $\frac{kg}{m^3}$

   TFC = Total fuel consumption in $\frac{kg}{hr}$

2. $C_d X\ A\ X \sqrt{2gha}\ X\ 3600 =$ $\frac{m^3}{hr}$

   $C_d$ = Co-efficient of discharge.

   A = Area of orifice in $m^2$.

   $h_a$ = Head of air in m

3. $h_a = \frac{\rho_w\ h_w}{\rho_a}$ m of air

   $\rho_w$ = Density of water = 1000 in $\frac{kg}{m^3}$

   $h_w$ = head of water in m.

   $\rho_a$ = Density of air = 1.275 in $\frac{kg}{m^3}$

4. Mass flow rate = $\left(1 + \frac{A}{F}\right) X\ TFC\ \frac{kg}{hr}$

5. Heat loss in exhaust gas = $m_C X cp\ X (T_C - T_a)\ \frac{kJ}{hr}$

   $m_C$ = Mass flow rate of exhaust gas in $\frac{kg}{hr}$

   $C_p$ = Specific heat of Exhaust gas at constant pressure= 1.090 in $\frac{kJ}{kgK}$

6. Percentage of heat in exhaust gas = $\frac{Q_C}{Q_S}$ X 100

***Calculation detail:***

| | | |
|---|---|---|
| Specific gravity of diesel | = | 0.88 |
| Density of water | = | 1000 $\frac{kg}{m^3}$ |
| $R_a$ | = | 0.287 $\frac{kJ}{kgK}$ |
| $C_P$ for water | = | 4.186 $\frac{J}{g^0C}$ |
| $C_P$ for air | = | 1.006 $\frac{kJ}{kgK}$ |
| Diameter of orifice | = | m |

***Procedure:***

1. Start the engine at no load and allow idling for some time till the engine warm up.
2. At no load condition, note down the readings as per the observation table.
3. Note down the time taken for 10cc of fuel consumption using stopwatch and fuel measuring burette.
4. After taking the readings open the fuel line to fill burette and supply fuel to run the engine from the fuel tank again.
5. Now load the engine gradually to the desired valve.
6. Allow the engine to run at this load for some time in order to reach steady state condition.
7. Note down the readings as per the observation table.
8. Repeat the experiment for different loads.
9. Release the load slowly and stop the engine.

***Inference:***

- Understand performance of diesel engine.
- Measure and check the Major Loss in internal combustion engine.
- Know about heat supplied, utilized and wasted in internal combustion engine.
- Draw the heat balance sheet with help of pie chart.

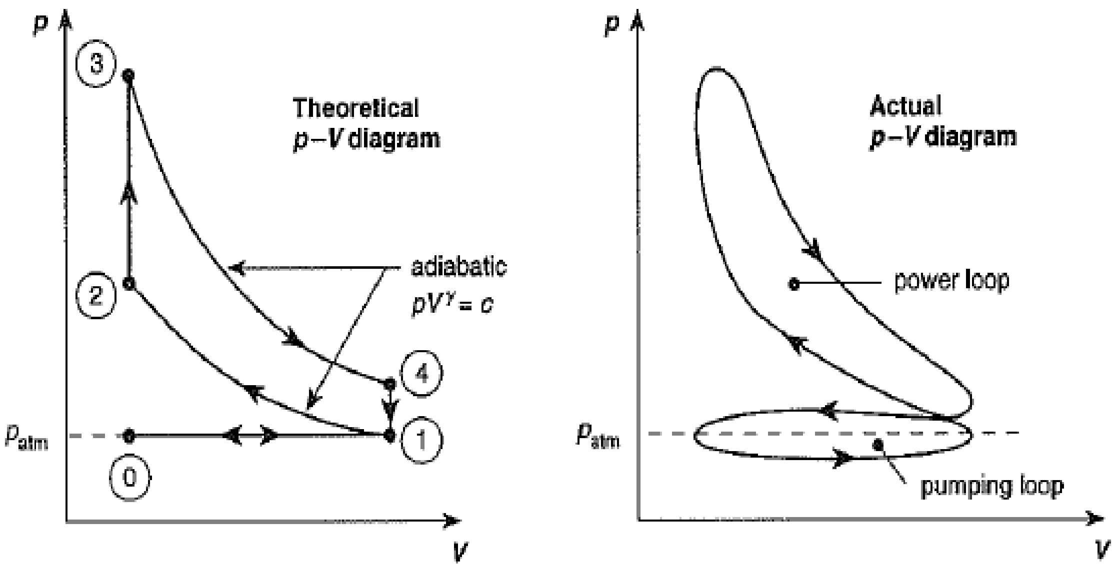
***Application:***

- Internal combustion engine.
- Steam power plant.
- Diesel power plant.

***Result:***

The heat balance test is conducted in the given diesel engine to draw up the heat balance sheet at various loads.

***Model of Single Cylinder Petrol Engine:***



**Ex No:7** **Date :**

## Retardation Test on Diesel Engine

### Aim:

To find the Frictional power and mechanical efficiency of single cylinder diesel engine by retardation test.

### Accessories required:

1. Single cylinder diesel engine
2. Stop watch
3. Tachometer

### Formula:

1. $Torque = \frac{W\ X\ R\ 9.81}{1000}\ \frac{kN}{m}$
2. $Frictional\ Torque = \frac{T_b\ X\ t_b}{T_b - t_b}\ \frac{kN}{m}$
3. $Brake\ Power = \frac{2\pi N T_b}{60}\ kW$
4. $Frictional\ Power = \frac{2\pi N T_f}{60}\ kW$
5. $Mechanical\ efficiency = \frac{BP}{BP + FP}\ X\ 100\ \%$

### Maximum load calculation:

1. $P = \frac{2\pi NT}{60}\quad W$
2. $T = Effective\ Radious\ X\ W\ X\ 9.81\ \frac{N}{m}$

### Procedure:

1. The precautions are checked and the engine is started.
2. The fuel supply is adjusted to run the engine at rated speed (ex: 700 rpm). The fuel supply is cut and the time taken is noted for the speed to full down from 700 rpm to 600 rpm at no load condition. The procedure is repeated for 4 times and the observations are tabulated.
3. Approximately 50% of load is applied and the time taken is found for the speed to full down. From 700 rpm to 600 rpm. The procedure is repeated and the observation as tabulated.
4. The load is released and the engine is stopped.

***Specifications***

| ***S. No*** | ***Name*** | ***Details*** |
|---|---|---|
| 1. | Type | 4-Stroke, single Cylinder Diesel Engine (Water Cooled), Compression Ignition. |
| 2. | Make | Kirloskar. |
| 3. | Rated Power Output | 3.68KW @ 1500 RPM.. |
| 4. | Bore & Stroke | 80mm x 110mm. |
| 5. | Compression' Ratio | 17.5 : 1 |
| 6. | Loading Device | Rope Brake dynamometer |
| 7. | Starting | By Hand Cranking |

***Observation:***

| ***Speed Reduction*** | ***Time in (Sec.)*** | | | | ***Average*** |
|---|---|---|---|---|---|
| | ***1*** | ***2*** | ***3*** | ***4*** | |
| No load condition 700 rpm to 600 rpm | | | | | |
| 50% of load 700 rpm to 600 rpm | | | | | |

Time taken to reduce at no load condition =

Time taken to reduce at 50% load condition =

***Graph:***

Time Vs Drop in speed for various loads

***Inference:***

- Understand performance of diesel engine.
- Know about Frictional torque and Frictional power.
- Find out mechanical efficiency.

***Application:***

Automobile vehicles.

***Result:***

The retardation test was conducted and mechanical efficiency was found.

***Ex No:8*** ***Date :***

## *Morse Test on Multi Cylinder Petrol Engine*

***Aim:***

To perform the test on multi cylinder petrol engine and draw its characteristic curves.

***Accessories required:***

1. Multi cylinder petrol engine
2. Stop watch
3. Tachometer

***Specifications***

| S. No | Name | Details |
|---|---|---|
| 1. | Type | 4-Stroke, single Cylinder Diesel Engine (Water Cooled), Spark Ignition.. |
| 2. | Make | Ambassador |
| 3. | Rated Power Output | 10 HP,@1500 RPM. |
| 4. | Bore & Stroke | 73.02mm x 88.9mm. |
| 5. | No. of Cylinder | 4 |
| 6. | Loading Device | Hydraulic Dynamometer |
| 7. | Starting | Self-Starting with help of 24 V Battery |

***Theory***

Morse Test is used to find a close estimate of Indicated Power (IP) of a Multi cylinder Engine. In this test, the engine is coupled to a suitable dynamometer and the brake power is determined by running the engine at the required speed. The fuel flow in first cylinder is now cut off by closing the fuel injector of the first cylinder in the diesel engine.

A 4 - Stroke 4 - Cylinder petrol engine consist of carburetor fitted at the top of the inlet manifold through which the air fuel mixture is taken in. The air fuel mixture taken into the cylinder must be used for combustion under the stroke of initiation by a spark created at the end of compression stroke. The fire order of the engine is vary for the different engines. According to their order the cylinder will produce power. The firing order will be change slightly due to the distributor provided for the contact type breaking system is affected.

***Observation:***

| *S. No.* | *Load in Kg.* | *Time for 10 cc of fuel consumption (sec.)* | *RPM* |
|---|---|---|---|
| 1. | | | |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |

***Maximum Load Calculation:***

Brake power = $\frac{W}{2000}$ in H.P

***Tabulation:***

| *S. No.* | *TSFC (kg/hr.)* | *B.P. (kW)* | *IP (kW)* | *SFC (kg/kWhr.)* | *Heat Supplied (kW)* | $\eta_{B.P.}$ % | $\eta_{I.P.}$ % | $\eta_{mech.}$ % |
|---|---|---|---|---|---|---|---|---|
| 1. | | | | | | | | |
| 2. | | | | | | | | |
| 3. | | | | | | | | |
| 4. | | | | | | | | |
| 5. | | | | | | | | |
| 6. | | | | | | | | |
| 7. | | | | | | | | |

As a result of cutting out the first cylinder, the engine speed will drop. Load on the engine is now removed so that the original speed is attained. The brake power under this load is determined and recorded (BP1). The first cylinder operation is restricted normal and the second cylinder is fuel injector is cut-out. The engine speed will again vary. By adjusting the load on the engine, speed brought to original speed and the new BP is recorded (BP2).

***Procedure:***

1. Start the engine without any loading
2. Then put a certain % of maximum load, which is already calculated.
3. Take the readings of fuel for 10cc consumption at the speed of 1500 rpm.
4. Again the load is increased and the speed of the engine is adjusted to 1500 rpm and take the time for 10cc consumption of fuel.
5. Procedure is repeated upto the maximum load of the engine

***Model Calculation :***

1. B.P $= \frac{WN}{2000} X \frac{735.5}{1000}$ = kW
2. TFC $= \frac{10}{t} X\, 3600\, X 10^{-3}\ X\, S_g =$ $\frac{kJ}{hr}$

Where, Sg = Specific gravity of petrol = 0.785

3. S.F.C. = $\frac{TFC}{BP}$ = $\frac{kg}{kWhr}$

I.P. = B.P. + F.P = kW

$IP_1 + IP_2 + IP_3 + IP_4 = BP_{1234} + fP$ ------------- (1)

1st cylinder is cut –off, it will not produce any power but it will have friction, then

$IP_2 + IP_3 + IP_4 = BP_{1234} + fP$ ------------------ (2) Then

sub equ. - (2) From equ. (1)

$IP_1 = BP_{1234} - BP_{234}$

Similarly

$IP_2 = BP_{1234} - B_{134}$

$IP_3 = BP_{1234} + BP_{124}$

$IP_4 = BP_{1234} - BP_{123}$

$IP_{1234} = IP_1 + IP_2 + IP_3 + IP_4$

Friction power of the engine is given by

$fP = IP_{1234} - BP_{12342}$

Mechanical efficiency $= \frac{BP}{BP + fP} X\, 100$ = %

Break thermal efficiency $(\eta_{Bth}) = \frac{BP}{HS} X\, 100$ = %

Indicated thermal efficiency $(\eta_{Bth}) = \frac{IP}{HS} X\, 100$ = %

W = Load applied in Kg. FP = Frication power

N = Speed in rpm. B.P = Break power

t = time taken for 10cc of fuel in sec.

***Graph:***

Break Power Vs Specific fuel Consumption

Break Power Vs mechanical efficiency

Break Power Vs Indicator thermal efficiency

Break Power Vs Brake thermal efficiency

***Inference:***

- Understand performance of multi cylinder petrol engine.
- Able to draw characteristic curve of multi cylinder petrol engine.
- Understand to measure the Indicated power of multi cylinder petrol engine.

***Application:***

- Automobile vehicles to find Engine Efficiency and fuel consumption.
- Automobile Vehicles engine Rating.

***Result:***

Thus the performance test on the 4 cylinder (multi cylinder) petrol engine was conducted and various graphs were drawn.

*Ex No: 9* *Date :*

## *Determination of COP of a refrigeration system*

***Aim:***

To conduct the performance test on vapor compression refrigeration plant to find out the different factors.

***Apparatus Required:***

1. Thermometer
2. Stop watch
3. Refrigeration test rig

***Procedure:***

1. This equipment is primarily designed to find the co-efficient of performance the refrigerant used.
2. The ratio between the refrigerating effect and the heat equivalent of work applied to a refrigerating machine is known as the co-efficient of performance of the machine.
3. In the test rig the refrigerating effect or output work done can be found by working the temperature difference between the input and output of the cooling water, and the quantity of the cold water for that temperature difference. The input energy or the heat equivalent of work supplied can be found in kilowatt unit from the energy meter reading. The C.O.P. can be found by stored water method.
4. The storage capacity of the evaporator is 5 litres. Before starting the experiments you will have to find it with pure water. Connecting two wires given out o the connector to AC. Single phase 50 cycle supply mains. The voltage should not be below 200 volts and should not be above 250 volts.
5. For that the customer has to take necessary precautions to safe guard the electric equip0ments like motors. In necessary voltage stabilizer has to be fixed at your own cost.
6. Before switching on the fan motor, check whether the low pressure gas gauge shows 40 or 50 PSSI and the low pressure liquid also the same. After that witch on the compressor.

***Observation:***

Volume of tank = $l \times b \times h$ =

Mass of water = $\rho w \times$ volume of tank =

Total power consumed by compressor

= power consumed $\times$ Total time by compressor =

***Tabulation:***

| S. No. | Temperature of water before refrigeration ° C | Temperature of water after refrigeration ° C | Time for 5 rev | T1 ° C | T2 ° C | T3 ° C | T4 ° C |
|---|---|---|---|---|---|---|---|
| 1. | | | | | | | |
| 2. | | | | | | | |
| 3. | | | | | | | |
| 4. | | | | | | | |
| 5. | | | | | | | |
| 6. | | | | | | | |

7. Ensure that the valves before and after the driver is in the opened condition and the charging shout off valve is in the closed condition> never attempt to change the position of expansion valve. Keep the x thermometers in proper position. Note the temperature of water.

8. The temperature before switching on the compressor. Run the compressor for say 30 minutes. After that note temperature and find the difference.

***Formula Used:***

1. Efficiency of cycle = $\dfrac{\text{COP of actual cycle}}{\text{COP of carnot cycle}}$

2. Net refrigeration effect = $M\,(h_{fw1} - h_{fw2})KW$

3. Power consumed by compressor = $Q = \dfrac{3600}{N_e} x \dfrac{N_g}{t} x1000W$

4. COP of carnot cycle = $\dfrac{T_2}{T_2 - T_1}$

***Model Calculation:***

1. Efficiency of cycle $= \dfrac{\text{COP of actual cycle}}{\text{COP of carnot cycle}}$

2. Net refrigeration effect $= M(h_{fw1} - h_{fw2})KW$

3. Power consumed by compressor $= Q = \dfrac{3600}{N_e} x \dfrac{N_g}{t} x1000W$

4. COP of carnot cycle $= \dfrac{T_2}{T_2 - T_1}$

***Result:***

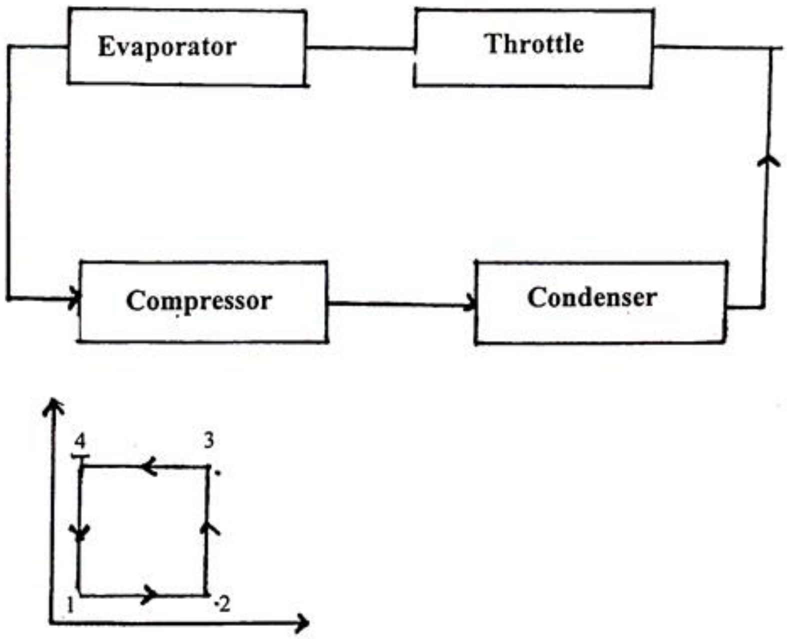
The Coefficient of Performance of given refrigerant is

***Inference:***

I have gained knowledge of measuring COP of a vapour compression refrigeration system.

***Applications:***

1. Design of vapour compression Refrigerators.




*Refrigeration Plant*

1 – 2 → Ispmtrp[oc Compressor

2 – 3 → Constant Prefer heat Rejection in Co4rdenser

3 – 4 → Throtting in throtting valve

4 - 1 → Constant prefer heat addition in evaporator

***Ex No: 10*** ***Date :***

## *Performance test in a HC Refrigeration System*

***Aim:***

To conduct the performance test on a refrigerator test rig with LPG (hydro carbon refrigerant to determine the Coefficient of Performance (COP).

***Apparatus Required:***

1. Thermometer
2. Stop watch
3. Refrigeration test rig

***Procedure:***

1. Fill up the evaporator tank with a known quantity of water (say 8-10 litres).
2. Switch on the compressor
3. After about 5 minutes (after steady state had set in) note the initial energymeter reading and water temperature in the evaporator.
4. After a known period of time, say 30-45 minutes note down the energymeter reading and water temperature. Before noting the water temperature, physically stir the water to ensure the temperature is uniform in the water tank.
5. Calculate the COP.

***Note:***

1. Since COP depends upon the evaporator temperature and condenser temperature, the calculated COP (which is an average value) will be different for varying evaporator, condenser and water temperatures.
2. Refrigerant pressures from the pressure gauges and temperature from the thermocouples can be used to study the vapour pressure at various points in the refrigerant cycle and prepare a enthalpy-pressure diagram.
3. Since standard tables/chart are only available either for iso-Butane or Propane, for experimental calculations involving the mixture of these two gases, the average value of the gas for particular temperature /pressure is taken to be the mixture property.

***Observation:***

Quantity of water in calorimeter (evaporator tank) W = 7.5 kg

$N_e$ = Energy meter constant = 1200

$t_f$ = time taken for final Temp. of cooling water in min.

***Tabulation:***

| S. No. | Temperature of water before refrigeration ° C | Temperature of water after refrigeration ° C | Time for 5 rev | T1 ° C | T2 ° C | T3 ° C | T4 ° C |
|---|---|---|---|---|---|---|---|
| 1. | | | | | | | |
| 2. | | | | | | | |
| 3. | | | | | | | |
| 4. | | | | | | | |
| 5. | | | | | | | |
| 6. | | | | | | | |

***Formula Used:***

1. Net Refrigeration effect /hr = W (Ti – $T_O$) kcal

   1 kcal = 0.001163 kWh

2. Work input = ($E_f$ - $E_o$) kw

3. Coefficient of Performance (COP) = $\frac{refrigeration\ effect}{work\ input}$

4. Actual COP = $\frac{W(T_i - T_o)}{(E_f - E_O)\,x860.4\,kcal}$

   $(E_f - E_O) = \frac{1}{N_e} x \frac{N_g}{t_f}$

   $N_e$ = Energy meter constant

   $N_g$ = No. of revolution = 10

   $t_f$ = time taken for final Temp. of cooling water in min.

5. Theoretical COP = $\frac{h_1 - h_4}{h_2 - h_1}$

6. Relative COP = $\frac{Actual\ COP}{Theoretical\ COP}$

***Model Calculation:***

a. Quantity of water in calorimeter W = 7 kg.

b. Initial water temperature $T_i$ = °C

c. Final water temperature $T_f$ = °C

***Readings 1:***

| | | | | | |
|---|---|---|---|---|---|
| $P_1$ | = | lb/in$^2$ | $P_1$ | = | lb/in$^2$ |
| $P_2$ | = | lb/in$^2$ | $P_2$ | = | lb/in$^2$ |
| $P_3$ | = | lb/in$^2$ | $P_3$ | = | lb/in$^2$ |
| $P_4$ | = | lb/in$^2$ | $P_4$ | = | lb/in$^2$ |

1 bar = 14.564 lb/in$^2$

| | | | | | |
|---|---|---|---|---|---|
| $P_1$ | = | bar | $P_1$ | = | bar |
| $P_2$ | = | bar | $P_2$ | = | bar |
| $P_3$ | = | bar | $P_3$ | = | bar |
| $P_4$ | = | bar | $P_4$ | = | bar |

***For Propane:***

1. Theoretical COP = $\frac{h_1 - h_4}{h_{2-}h_1}$

2. $(E_f - E_O) = \frac{1}{N_e} x \frac{N_g}{t_f}$

   $N_e$ = Energy meter constant

   $N_g$ = No. of revolution = 10

   $t_f$ = time taken for final Temp. of cooling water in min.

3. Net Refrigeration effect /hr = W ($T_i$-$T_O$) kcal

4. Actual COP = $\frac{W\,(T_i - T_o)}{(E_f - E_O)\,x860.4\,kcal}$

5. Relative COP = $\frac{Actual\ COP}{Theoretical\ COP}$

   $N_e$ = Energy meter constant

   $N_g$ = No. of revolution = 10

   $t_f$ = time taken for final Temp. of cooling water in min.

***For Propane:***

1. Theoretical COP = $\frac{h_1 - h_4}{h_2 - h_1}$

2. $(E_f - E_O) = \frac{1}{N_e} x \frac{N_g}{t_f}$

   $N_e$ = Energy meter constant

   $N_g$ = No. of revolution = 10

   $t_f$ = time taken for final Temp. of cooling water in min.

3. Net Refrigeration effect /hr = W ($T_i$-$T_O$) kcal

4. Actual COP = $\frac{W(T_i - T_o)}{(E_f - E_O) x 860.4 kcal}$

5. Relative COP = $\frac{Actual\ COP}{Theoretical\ COP}$

***Result:***

Relative COP for Propane =

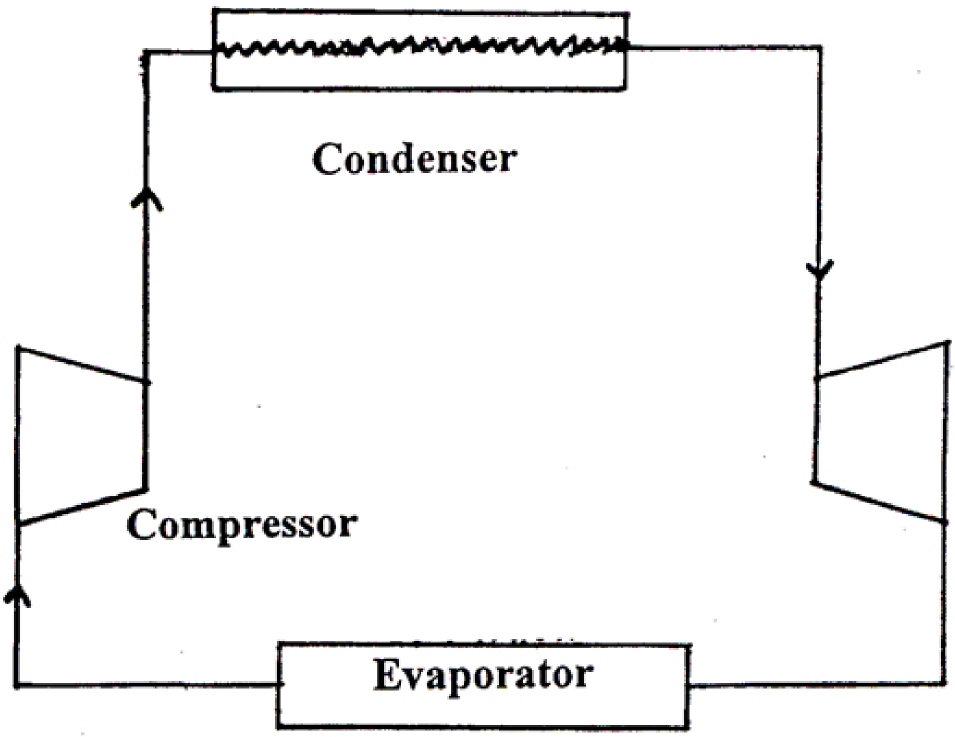
Relative COP for Isobutene =

***Inference:***

I have gained knowledge of measuring COP of a Hydro carbon (HC) refrigeration system

***Applications:***

1. Design of HC Refrigerators.




*Air Conditioning Plant*

***Ex No: 11*** ***Date :***

## *Determination of COP of an air conditioning system*

***Aim:***

To demonstrate the working of air conditioning system and

To demonstrate cooling, heating and humidification processes.

***Apparatus Required:***

1. Stop watch
2. Air Conditioning test rig

***Procedure:***

***The following are the operational procedure for different cycles:***

1. OPEN CYCLE - COOLING
2. Switch – ON the mains and console.
3. Open the window and set the valve to work the Air Conditioning system in the open cycle operation
4. Switch – ON the thermostat, keep at maximum
5. Switch – ON all Switches
6. Switch – ON the compressor of the refrigeration unit. The cooling coil temperature begins to fail.
7. Switch – ON the suction fans
8. Switch – ON pre-heater
9. Observe temperatures ($T_5$ and $T_6$) at the inlet and outlet of the Air Conditioning unit till fairly steady state is reached

***Observation:***

Mass flow = l × b × h

Total power consumed by compressor = power consumed × Total time by compressor

***Tabulation:***

| **S. No.** | **Temperature, °C** | | | | | | **Time for Energy meter reading for 10 pulse** | | **Pressure, Bar** | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **$T_1$** | **$T_2$** | **$T_3$** | **$T_4$** | **$T_5$** | **$T_6$** | **Compressor** | **Heater** | **P1 (low)** | **P2 (high)** |
| **1.** | | | | | | | | | | |
| **2.** | | | | | | | | | | |
| **3.** | | | | | | | | | | |
| **4.** | | | | | | | | | | |
| **5.** | | | | | | | | | | |

***Note:***

$T_1$ to $T_4$ indicates Refrigeration Cycle

$T_5$ & $T_6$ indicate Air conditioner

***10. Note the following:***

$T_1$ = Temperature of refrigeration after Evaporator or inlet to compressor (°)

$T_2$ = Temperature of refrigeration after compressor (°)

$T_3$ = Temperature of refrigeration after Condensation (°)

$T_4$ = Temperature of refrigeration after throttle / Capillary tube (°)

$T_5$ = Air inlet Temperature, before cooling coil (°)

$T_5$ = Air outlet Temperature, after cooling coil and post heater (°)

HP = Pressure, high pressure side PSI

LP = Pressure, low pressure side PSI

V = Air velocity from wind Anemometer

$P_c$ = Power input to the Compressor

$P_h$ = Power output to the heater

Wet and Dry Bulb Temperature before and after cooling Coil and find relative humidity from chart

$\phi_I$ = Relative humidity of air at inlet (°)

$\phi_o$ = Relative humidity of air at inlet (°)

***Open Cycle - Cooling***

Repeat the above procedure (as mentioned in A) with the following changes:

1. Window closed.
2. Valve in Close cycle position to facilitate circulation of air inside the Duct system
3. Additional fan Switched – OFF

Note all parameters as mentioned in A(9)

***Formula Used:***

***Refrigeration Cycle***

1. Co-efficient of performance

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

Where,

$h_1$ = Enthalpy of the refrigerant at exit of the evaporator

$h_2$ = Enthalpy of the refrigerant at exit of the compressor

$h_3$ = Enthalpy of the refrigerant at exit of the condenser

$h_4$ = Enthalpy of the refrigerant at exit of the throttle valve / capillary tube

The values of enthalpies of the refrigerant at different states are obtained from pressure-enthalpy chart provided.

***Note:***

$h_1$ is obtained for Temperature $T_1$ and Pressure P1

$h_2$ is obtained for Temperature $T_2$ and Pressure P2

$h_1$ is obtained for Pressure P2

$h_4$ = $h_3$

2. HP per ton of refrigeration, HP/Ton

$$HP / Ton = \frac{4.715}{COP}$$

3. Power input to the Compressor, HP

$$P_C = \frac{n \times 3600}{K \times T \times 0.736} \quad hp$$

Where,

n = No. of pulses of energy meter (Say 10)

K = Energy meter constant = 3200 pulses / kW-hr

T = time for n pulses, of energy meter in seconds

0.736 = conversion factor to hp

4. Power Input to The Heater, hp

$$P_C = \frac{n \times 3600}{K \times T \times 0.736} \quad HP$$

***Model Calculation:***

$h_1$ =kJ/kg

$h_2$ =kJ/kg

$h_2$ =$h_4$ kJ/kg

a. Coefficient of Performance COP = COP = $\frac{h_1 - h_4}{h_2 - h_1}$

b. H.P. / ton of Ref. = HP / Ton = $\frac{4.715}{COP}$

c. Power input to the Compressor, HP ;

$$P_C = \frac{n \times 3600}{K \times T \times 0.736} = \qquad HP$$

Where,

n = No. of pulses of energy meter (Say 10)

K = Energy meter constant = 3200 pulses / kW-hr

T = time for n pulses, of energy meter in seconds

0.736 = conversion factor to HP

d. Tons of refrigerant, Ton

Ton = $P_C$ X (HP/Ton)

e. Capacity of cooling coil = kJ/kg of dry air

f. Relative humidity = $\phi_1$-$\phi_2$= %

g. Specific humidity = $\omega_1$-$\omega_2$= kJ/kg of air

Where,

n = No. of pulses of energy meter (Say 10)

K = Energy meter constant = 3200 pulses / kW-hr

T = time for n pulses, of energy meter in seconds

0.736 = conversion factor to hp

5. Tons of refrigerant, Ton

Ton= $P_C$ X (HP/TON)

***Air Conditioner***

With obtained condition of Temperature & Relative Humidity of air inlet and outlet from the cooling coil inside the duct.

Read the following from the enthalpy chart:

1. Enthalpy
2. Moisture Content
3. Specific Volume

And find the heat rejected.

Heat rejected by air = $h_5 - h_6$ KJ/kg of dry air

Where,

$h_5$ = Enthalpy of air at the inlet to the cooling coil

$h_6$ = Enthalpy of air at the outlet to the cooling coil

***Result:***

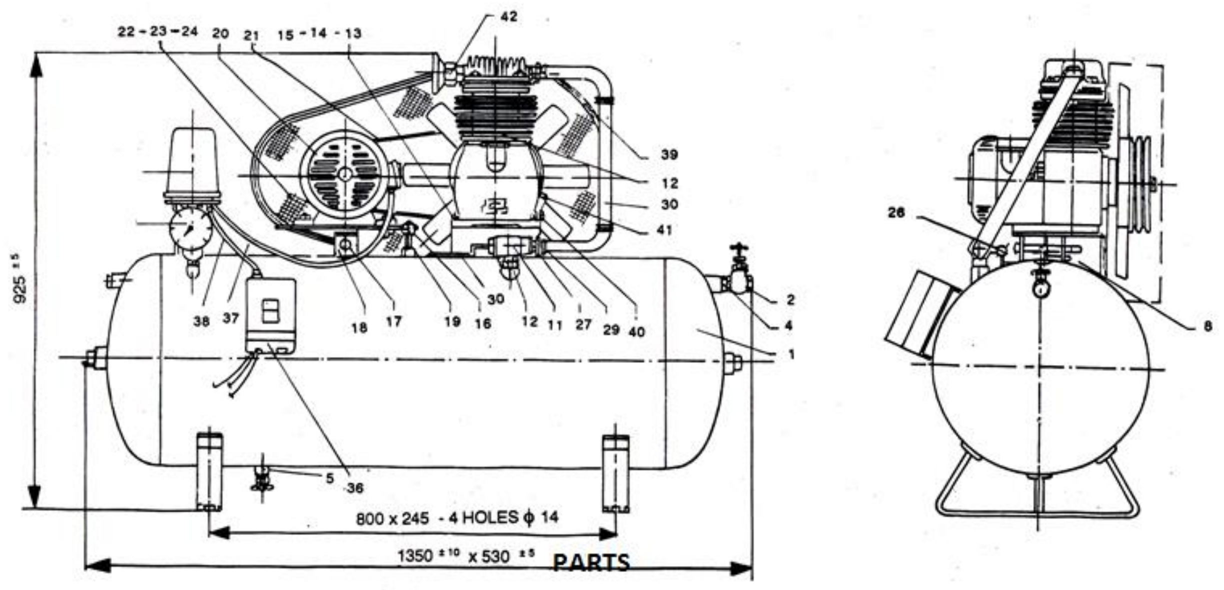
The Coefficient of Performance of given refrigerant is Heat rejected by air =

***Inference:***

I have gained knowledge of measuring COP of a refrigerant

***Applications:***

1. Design of Refrigerators.
2. Design of Air-conditioners.




*Air Compressor*

| S. No. | Particulars | S. No. | Particulars |
|---|---|---|---|
| 1. | 110 Ltrs Receiver Complete | 22. | Hexagonal Screw M10 x 1.5 x 35 |
| 2. | Shut off valve assembly 3/8” BSP | 23. | Spring Washer M 10 |
| 3. | Nipple 3/8” BSP x 3/8” x 40 | 24. | Hexagonal nut M 10 x 1.5 |
| 4. | Plug ½” BSP | 25. | Motor pulley |
| 5. | Drain valve assembly | 26. | After cooler pipe |
| 6. | Connecting nipple ½” BSP x 90 | 27. | Ermeto ½” BSP x 7/8” BSP |
| 7. | Pressure gauge (0-17.6 kg/cm$^2$) | 28. | Ermeto cone 7/8 BSP |
| 8. | Safety valve assembly ¼” BSP | 29. | Ermeto Nut 7/8 BSP |
| 9. | Pressure switch PSI/15 5/c | 30. | Pressure line pipe |
| | Pressure switch PSI/15 3/c | 31. | Nipple 1/8” BSP x ¼” BSP |
| 10. | Nipple ½” BSP x ½” BSP x 45 | 32. | T piece ¼” BSP |
| 11. | Non return valve assembly ½” BSP | 33. | Ermeto ¼” BSP x ¼” BSP |
| 12. | Top Block Assembly | 34. | Ermeto cone ¼” BSP |
| 13. | Hexagonal screw M 10 x 1.5 x 35 | 35. | Ermeto nut ¼” BSP |
| 14. | Spring washer M 10 | 36. | Starter 2 HP |
| 15. | Hexagonal nut M 10 x 1.5 | 37. | Flexible pipe No.1 |
| 16. | Motor plate | 38. | Flexible pipe No.2 |
| 17. | Motor plate rod | 39. | Belt guard |
| 18. | Split pin | 40. | Drain plug |
| 19. | Belt tension adjuster | 41. | Dipstick with plug |
| 20. | Motor – 2 HP S/P | 42. | Air filter Assembly |
| 21. | V Belt B 40 | | |

***Ex No: 12*** ***Date :***

## *Performance test on a reciprocating air compressor*

***Aim:***

To conduct a test in air compressor and to determine the volumetric efficiency at various delivery pressure.

***Apparatus Required:***

1. Thermometer
2. Air compressor

***Procedure:***

1. The outlet valve of the air compressor is closed.
2. Monomeric connection is checked.
3. The compressor is started. The pressure develops slowly. At the particular pressure, the outlet valve is opened slowly and adjusted so that the pressure is maintained constant.
4. At this particular pressure the following observations are taken and tabulated.
   (a). Speed of the air compressor (N) rpm.
   (b). Pressure gauge reading (P) kgf / $cm^2$.
   (C). Manometer Reading ($h_1$, $h_2$) in cm.
   (d). Room temperature (t) in °C.
5. The experiment is repeated for different pressure valves and monomeric reading are found out.
6. The volumetric efficiency is calculated and the maximum volumetric efficiency is found out.

***Observation:***

**Cylinder:** 

d = 70 mm.

l = 60 mm.

**Orifice:**

d = 12 mm.

$C_d$ = 0.62.

***Tabulation:***

| S. No. | Pressure Kg/cm$^2$ | Manometer Reading | | ($h_w$) cm |
|---|---|---|---|---|
| | | ($h_1$) cm | ($h_2$) cm | (h) cm |
| 1. | | | | |
| 2. | | | | |
| 3. | | | | |
| 4. | | | | |
| 5. | | | | |

| **S. No.** | **Pressure Kg/cm$^2$** | **Difference in Manometer cm** | **Amount of air compressed** | | **Volumetric Efficiency, $\eta_{Vol}$ %** |
|---|---|---|---|---|---|
| | | | **$Q_{act}$ x $10^{-3}$ m$^3$/sec** | **$Q_{the}$ x $10^{-3}$ m$^3$/sec** | |
| 1. | | | | | |
| 2. | | | | | |
| 3. | | | | | |
| 4. | | | | | |
| 5. | | | | | |

***Formula Used:***

a. Suction pressure :

$p_a = p_{atm} - p_{gauge}$ KN/ $m^2$

b. Density of air:

$\rho_a = \frac{p_a}{RT} Kg/m^3$

Where,

R - Gas constant 0.287 KJ /Kgk.

T - Room temperature in K

c. To find $Q_{act}$ :

$h_a = \frac{1000\, x (h_w x 10^{-2})}{\rho_a} m\, of\, air\, (h\, in\, cm\, of\, water)$ ; i.e., $\rho_w = 1000$

$Q_{act} = C_d \times a \times V$ ; V= $\sqrt{2gh_a}$

Where,

$C_d$ = Co-efficient of discharge (0.62)

a = Area of the orifice where d = 12 mm

d. To find $Q_{the}$ :

Theoretical discharge, $Q_{the} = \frac{ALN}{60} m^3/\sec$

Where,

A = $\frac{\Pi}{4} x d^2$ = Area of the cylinder (d – 70 mm)

L - Stroke length in mm (60 mm)

N - Speed in rotations per minute (870 rpm)

e. To find Efficiency $\eta_{vol}$ :

Volumetric efficiency, $\eta_{vol} = \frac{Q_{act}}{Q_{the}} x100$

Where,

$Q_{act}$ - Actual Quantity of Air compressed in $m^3$/sec

$Q_{the}$ - Theoretical Quantity of Air compressed in $m^3$/s

***Model Calculation:***

a. Suction pressure :

$p_a$ = $p_{atm}$ — $p_{gauge}$ KN/ m$^2$ =

b. Density of air:

$$\rho_a = \frac{p_a}{RT} Kg/m^3$$

Where,

R - Gas constant 0.287 KJ /Kgk.

T - Room temperature in K

c. To find $Q_{act}$ :

$$h_a = \frac{1000 \times (h_w \times 10^{-2})}{\rho_a} m\, of\ air\ (h\, in\, cm\, of\ water)$$ ; i.e., $\rho_w = 1000$

$Q_{act} = C_d \times a \times V$ ; V= $\sqrt{2gh_a}$

Where,

$C_d$ = Co-efficient of discharge (0.62)

a = Area of the orifice where d = 12 mm

d. To find $Q_{the}$ :

Theoretical discharge, $Q_{the} = \frac{ALN}{60} m^3/\sec$ =

Where,

A = $\frac{\Pi}{4} \times d^2$ = Area of the cylinder (d – 70 mm)

L - Stroke length in mm (60 mm)

N - Speed in rotations per minute (870 rpm)

e. To find Efficiency $\eta_{vol}$ :

Volumetric efficiency, $\eta_{vol} = \frac{Q_{act}}{Q_{the}} \times 100$

Where,

$Q_{act}$ - Actual Quantity of Air compressed in m$^3$/sec

$Q_{the}$ - Theoretical Quantity of Air compressed in m$^3$/s

***Graph:***

Pressure Vs Q the

Pressure Vs Q act

Pressure Vs $\eta_{VOL}$

***Result:***

The volumetric efficiency test on air compressor was conducted.

***Inference:***

I have gained knowledge of measuring volumetric efficiency of an air compressor

***Applications:***

1. Design of Air compressors.

**PROGRAM OUTCOMES (POs)**

Mechanical Engineering Graduates will be able to

| | |
|---|---|
| **1** | **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals and an engineering specialization to solution of complex engineering problems. |
| **2** | **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences. |
| **3** | **Design / development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations. |
| **4** | **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. |
| **5** | **Modern tool usage:** Create, select and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations. |
| **6** | **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. |
| **7** | **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. |
| **8** | **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice. |
| **9** | **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings. |
| **10** | **Communication:** Communicate effectively on complex engineering activities withtheengineering communityandwithsociety atlarge, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions. |
| **11** | **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 in multidisciplinary environments. |
| **12** | **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. |

# K.L.N. COLLEGE OF ENGINEERING

## VISION

**To become a Centre of Excellence in Technical Education and Research in producing Competent and Ethical professionals to the Society.**

## MISSION

**To impart Value and Need based curriculum to the students with enriched skill development in the field of Engineering, Technology, Management and Entrepreneurship and to nurture their character with social concern and to pursue their career in the areas of Research and Industry.**

**Principal** **Secretary &Correspondent** **President**