THERMAL ENGINEERING LABORATORY – II

AIM:

To train the students with principles and operation of thermal Engineering equipments.

OBJECTIVES:

- To experimentally analyze conduction, convection and radiation.
- Performance study on fins, heat exchanger, refrigeration and air conditioning systems are included.

LIST OF EXPERIMENTS:

HEAT TRANSFER:

Thermal conductivity measurement by guarded plate method
Thermal conductivity of pipe insulation using lagged pipe apparatus
Natural convection heat transfer from a vertical cylinder
Forced convection inside tube
Heat transfer from pin-fin (natural & forced convection modes)
Determination of Stefan-Boltzmann constant
Determination of emissivity of a grey surface
Effectiveness of Parallel/counter flow heat exchanger

REFRIGERATION AND AIR CONDITIONING LAB:

1. Determination of COP of a refrigeration system
2. Performance test on single / two stage reciprocating air compressor
3. Performance test in a HC Refrigeration System

LIST OF EQUIPMENTS :

1. Guarded plate apparatus – 1 No.
2. Lagged pipe apparatus – 1 No.
3. Natural convection-vertical cylinder apparatus – 1 No.
4. Forced convection inside tube apparatus – 1 No.
5. Pin-fin apparatus – 1 No.
6. Stefan-Boltzmann apparatus – 1 No.
7. Emissivity measurement apparatus – 1 No.
8. Parallel/counter flow heat exchanger apparatus – 1 No.
9. Single/two stage reciprocating air compressor. – 1 No.
10. Refrigeration test rig – 1 No.
11. Air-conditioning test rig – 1 No.

AATTE201 REFRIGERATION TEST

INTRODUCTION & DESCRIPTION:

The experimental refrigeration cycle test rig (AATTE201) consists of a compressor unit, condenser, evaporator, cooling chamber, controlling devices and measuring instruments. The coefficient of performance of refrigeration plant is given by the ratio of heat absorbed by the refrigerant when passing through the evaporator or the system, to the working input to the compressor to compress the refrigeration.

UTILITIES REQUIRED:

- Flooring area: 6'x3'
- Electrical power supply

TECHNICAL DETAILS:

SPECIFICATIONS:

Plant Capacity: 50 Kg of Ice in 24 Hrs, In Blocks

Hermetically Sealed Compressor: 1/2 Hp Cap.

Air Cooled Condenser: 1/2hp, 12" X 13" X 2 Rows

Fan Motor with Blade: 1/35 Hp

Expansion Device: Thermostatic Expansion Valve (10 To -40 Degc)

Rotameter: 0.6 To 62 Lph (Eureka)

Filter Drier: Dm-50(Dan Foss)

Energy Meter: 2.5 – 5 Amps

FEATURES:

- Hermetically sealed compressor fitted on stand
- Power input through thermostatic switch
- Minimized vibrations

RANGE OF EXPERIMENTS:

- To determine COP of the refrigeration system

AATTE202 SINGLE/TWO STAGE RECIPROCATING AIR COMPRESSOR

INTRODUCTION & DESCRIPTION:

Single stage Air Test Rig (AATTE202) consists of single cylinder, piston & reservoir tank driven by A.C. motor. Thermometers are provided at inlet and outlet. To find out the inlet volume of air an Orificemeter is provided. Pressure Gauge is provided at reservoir tank. Safety valve and auto switch is providing for the safety factor.

UTILITIES REQUIRED:

- Flooring space: 3'x3'
- 3-φ Electrical power supply

TECHNICAL DETAILS:

SPECIFICATIONS :

Model	Free Air Delivery cfm lpm	Working Pressure Kg/cm2 psig	Motor Power Rating HP kW	Tank Capacity Litres
TS10120 H	30 835 cfm lpm	12 175 Kg/cm2 psig	10 7.5 HP kW	250 420 500
HP12250	22 623 cfm lpm	25 350 Kg/cm2 psig	12.5 9.3 HP kW	250 500

FEATURES:

- Lubrication necessity minimized
- Can work under robust conditions

RANGE OF EXPERIMENTS:

- Volumetric efficiency of an Air Compressor.
- Isothermal HP of Air Compressor (Single Stage).
- To calculate the compression ratio.
- To plot the graph of the following characteristics
  - Isothermal Horse Power Vs Delivery Pressure
  - Compression Ratio Vs Delivery Pressure
  - Volumetric Efficiency Vs Delivery Pressure

AATTE203 AIR-CONDITIONING TEST RIG

INTRODUCTION & DESCRIPTION:

The AC test Rig consist of 1.5T sealed compressor unit, a finned condenser (heating coil) and evaporator (cooling coil), a double ended (shaft) motor to run fan and blower simultaneously and fitted on a wooden stand and properly covered by grill. A duct is assembled along with blower unit as a carrier of comfort air, the velocity of the air passing through the coil is measured by using a pitot tube fitted in duct itself and connected to V-tube manometer which is fitted on control panel.

UTILITIES REQUIRED:

- Floor spacing: 5'x3'
- 3-φ Electrical power supply

TECHNICAL DETAILS:

SPECIFICATIONS:

- Supply: 220-240 Volts, 50Hz, 1 Phase.
- Input power: 1.0kW.
- Rated current: 4.5 Amps.
- Operating switches: Main switch & Piano type switches for compressor and heater
- Pressure gauge: 0-300 psi
- Suction gauge: 30-0-150 psi
- Rota meter 0-5 L L PM
- Fan blower motor: 1/30 HP 1-0
- Condensor & Evaporator: Double row finned

FEATURES:

- Refrigerant : R-22

RANGE OF EXPERIMENTS :

- HC AC performance tests
- To calculate the compression ratio.
- To plot the graph of the following characteristics
  - Compression Ratio Vs Delivery Pressure
  - Volumetric Efficiency Vs Delivery Pressure

AATTE204 PARALLEL/COUNTER FLOW HEAT

INTRODUCTION & DESCRIPTION:

AATTE204 consist of concentric tube that exchanger, the hot fluid (i.e. hot water) is obtained form an electric geyser and it flows through the inner tube. The cold fluid is cold water and can be admitted at any one of the ends enabling the heat exchanger to run as a parallel flow apparatus or a counter flow apparatus. This can be done by operating the different values provided. Temperatures of the fluids can be measured using thermometers. Flow rate can be measured using stop watch and measuring flask. The out tube is provided with adequate asbestos rope insulation to minimize the heat loss to the surroundings.

UTILITIES REQUIRED:

- Floor spacing: 5'x3'
- 3-φ Electrical power supply
- Stopwatch
- Measuring tape
- Thermometers (0^o to 100^o)

TECHNICAL DETAILS:

SPECIFICATIONS:

- Length of Heat Exchange 1.6 m
- Outer lite material G.I. ID. - 30mm O.D. - 35mm
- Inner tube material - Copper O.D, 15mm
- Thermometers - 0 to 500C - 2nos.10 to 1000C - 2nos
- Geyser - Instantaneous type. 3 kw capacity - 1 no.
- Measuring flask - 1000 with stop clock

FEATURES:

- Lubrication necessity minimized
- Can work under robust conditions

RANGE OF EXPERIMENTS:

- Effectiveness of Parallel/counter flow heat exchanger

AATTE205 HEAT TRANSFER FROM A PIN-FIN APPARATUS

INTRODUCTION & DESCRIPTION:

Extended surfaces of fins are used to increase the heat transfer rate from a surface to a fluid wherever it is not possible to increase the value of the surface heat transfer coefficient or the temperature difference between the surface and the fluid. The use of this is variety of shapes Circumferential fins around the cylinder of a motor cycle engine and fins attached to condenser tubes of a refrigerator are a few familiar examples.

It is obvious that a fin surface sticks out from the primary heat transfer surface. The temperature difference with surrounding fluid will steadily diminish as one moves out along the fin. The design of the fins therefore required knowledge of the temperature distribution in the fin. The main objective of this experimental set up is to study temperature distribution in a simple pin fin.

UTILITIES REQUIRED:

- Floor spacing: 5'x3'
- Electrical power supply

TECHNICAL DETAILS:

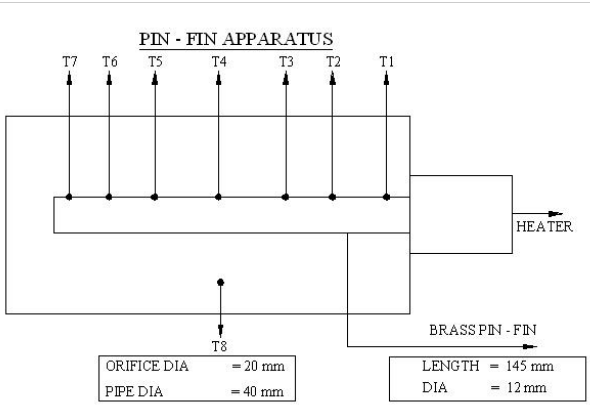
SPECIFICATIONS :

Duct width	b	=	200 mm
Duct height	w	=	120 mm
Orifice dia.	do	=	20 mm
Orifice co-efficient	cd	=	0.6
Fin length	L	=	16cm
Fin diameter	df	=	12mm

(Characteristic length)

RANGE OF EXPERIMENTS:

- To study the temperature distribution along the length of a pin fin in natural & forced convection.
- To calculate Gr, Pr & Nu number in natural conviction.
- Calculate Re , Pr & Nu number in forced conviction.



AATTE206 DETERMINATION OF STEFAN-BOLTZMANN CONSTANT

INTRODUCTION & DESCRIPTION: Stefan – Boltzman law which establishes the dependence of integral hemispherical radiation on temperature. We can verify this phenomenon in this unit. The experimental set up (AATTE206) consisting of concentric hemispheres with provision for the hot water to pass through the annulus. A hot water source is provided. The water flow may be varied using the control valve provided, thereby to control the hot water temperature. A small disk is placed at the bottom of the hemisphere, which receives the heat radiation and can be removed (or) refitted while conducting the experiment. A multi point digital temperature indicator and thermocouples (Fe/Ko) are provided to measure temperature at various points on the radiating surface of the hemisphere and on the disc.

UTILITIES REQUIRED:

- Floor spacing: 5'x3'
- 3-ϕ Electrical power supply

TECHNICAL DETAILS:

SPECIFICATIONS :

Mass of the disc = 0.005 kg.

Dia. of the disc = 0.020 m.

Material of the disc = copper

Cp = 381 J/KgK

FEATURES:

Easy understanding of phenomenon of heat transfer by radiation.

Determination of Stefan-Boltzmann constant.

Built – in timer for temperature readings at constant time intervals.

Digital temperature indicator.

RANGE OF EXPERIMENTS:

Determination of Stefan – Boltzmann constant

Study of effect of hemisphere temperature on the constan

AATTE207 FORCED CONVECTION INSIDE TUBE

INTRODUCTION & DESCRIPTION:

When saturated vapor flows in a tube that is cooled by an exterior fluid, some of the vapor condenses on the tube wall and forms a liquid film. Condensation inside tubes occurs in many applications, particularly in refrigeration condensers. The main resistance to heat transfer for refrigerants and other low-conductivity fluids is the resistance to conduction through the condensate film.

AATTE207 consisted of a closed-loop refrigerant flow circuit driven by a mechanical-sealed rotor pump. An electrically heated boiler generated vapor which passed through a flow meter and into the test section.

UTILITIES REQUIRED:

- Eletricity supply: 1 phase, 220 v Ac, 10 Amp.
- Floor area of 1.2 m*0.5 m

TECHNICAL DETAILS:

SPECIFICATIONS :

- Internal diameter of the tube 5 mm
- External diameter of the tube 6 mm
- Tube thickness 0.5 mm
- Tube Material Stainless steel
- Thermocouple material Chromium-aluminum
- Tube length 900 mm
- Tube thermal conductivity 16.28 W/m °C
- Insulator thickness 50 mm
- Insulator thermal conductivity 0.043 W/m °C
- AC Volt meter 0 to 5 V
- AC Ampere meter 0 to 70 A

FEATURES:

- Forced convection pipe material: Copper tube with thermocouple points, heater to heat the pipe.
- Centrifugal blower to pass the air with air flow controller.
- Temperature indicator with thermocouples, voltmeter, ammeter, heat controller, and monometer are all mounted on control panel table...

AATTE208 NATURAL CONVECTION HEAT TRANSFER FROM A VERTICAL CYLINDER

INTRODUCTION & DESCRIPTION:

AATTE208 consists of a vertical brass pipe heated by a cartridge heater inside. The pipe looses heat to atmosphere by natural convection. It is fitted in an enclosure to provide undisturbed natural convection currents. Thermocouples are attached on the pipe to measure local temperatures. Heater input is measured on voltmeter and ammeter. Thus students can determine overall heat transfer coefficient and local heat transfer coefficients in natural convection at various heat transfer rates.

UTILITIES REQUIRED:

- Floor spacing: 5'x3'
- Electrical power supply

TECHNICAL DETAILS:
SPECIFICATIONS :

- Pipe - Brass pipe, 40 mm. dia. (OD), 600 mm. Long, fitted with
- cartridge heater inside.
- Thermocouples are fitted along the length of pipe for temperature measurement - 7 nos.
- Enclosure 300 mm. x 300 mm. x 900 mm size
- with one side of perspex sheet.
- Measurements & Controls:
- A dimmer stat for heater input control.
- Voltmeter and Ammeter for heater input measurement.
- Multi channel digital temperature indicator.

RANGE OF EXPERIMENTS :

- To determine the overall heat transfer coefficient at the surface of a given vertical metal cylinder by the natural convection method.
- To determine the value of Nusselt number.

AATTE209 THERMAL CONDUCTIVITY OF PIPE INSULATION USING LAGGED PIPE APPARATUS

INTRODUCTION & DESCRIPTION:

Lagging of pipes is required to prevent leakages of heat. AATTE209 is designed to study the lagging phenomenon. In Lagged pipe Apparatus, three concentric pipes are arranged between two supports. The gaps between the pipes are filled compactly by two different insulating materials and heater is provided at the centre of inner pipe. Temperature at various points is measured with Temperature Indicator. Heat input is measured by Voltmeter - Ammeter. The assembly is mounted on angle frame.

UTILITIES REQUIRED:

- Ammeter
- Voltmeter
- Thermocouple
- Temperature indicator

TECHNICAL DETAILS:

SPECIFICATIONS:

- Pipes :
- M.S. Pipe Inside - 5 cm dia approx.
- M.S. Pipe Middle -10 cm dia approx.
- M.S. Pipe Outer -15 cm dia approx.
- Length of Pipes - 1m approx.
- Control panel consisting of …
- Voltmeter -0 - 100/200 volts.
- Ammeter - 0 -2 Amp.
- Dimmer stat for heater, 0-230 V, 2 Amps.
- Digital Temperature Indicator, 0-300 C with least count
- Nichrome cartridge heater of suitable capacity and length

FEATURES:

- Study of the concept of double & single lagging.
- study of effects of different insulating material Combinations.
- Electrical input control & measurement with
- Complete panelized instruments.
- Digital Temperature Indicator.

AATTE210 THERMAL CONDUCTIVITY MEASUREMENT BY GUARDED PLATE METHOD

INTRODUCTION & DESCRIPTION:

Guarded hot plate is a widely used and versatile method for measuring the thermal conductivity of insulations. Although the specimens are often rather large, this usually presents no difficulty. A flat, electrically heated metering section surrounded on all lateral sides by a guard heater section controlled through differential thermocouples, supplies the planar heat source introduced over the hot face of the specimens. The most common measurement configuration is the conventional, symmetrically arranged guarded hot plate where the heater assembly is sandwiched between two specimens. In the single sided configuration, the heat flow is passing through one specimen and the back of the main heater acts as a guard plane creating an adiabatic environment.

UTILITIES REQUIRED:

- Thermocouple
- Temperature indicator

TECHNICAL DETAILS:

SPECIFICATIONS:

- Central Heater of suitable capacity, with 100mm to 150mm dia sandwiched between two copper plates
- Ring guard heater of suitable capacity with 30mm to 150mm width
- sandwiched between two copper plates
- Cooling chamber with water circulation arrangements, Specimen 6 to 20mm thick, 180rnm to 200mm dia.
- Digital voltmeter range of 0-300 volts AC
- Digital Ammeter range of 0-20A AC
- Digital Temperature Indicator 0-400 degree centigrade