SUBJECT: ENERGY CONSERVATION Lab

BRANCH: CE, CSE, EE, ME (A+P)

YEAR: 2ND Year

LIST OF PRACTICALS

SR. NO	NAME OF PRACTICALS
1	To conduct load survey and power consumption calculations of small building.
2	To check efficacy of different lamps by measuring power consumption and lumens using lux meter.
3	To measure energy efficiency ratio (EER) of an air conditioner.
4	To measure effect of valve throttling and variable frequency drive (VFD) on energy consumption by centrifugal pump.
5	To measure and calculate energy saving by arresting air leakages in compressor.
6	To measure the effect of blower speed on energy consumed by it.

Experiment No.-01

Object: - To conduct load survey and power consumption calculations of small building.

Equipment's:- Note book, pen, building (where the survey is to be done)

Procedure: - First of all, we should know whether the building we are surveying is small or not. After selecting the building, we should know the unit of energy. While calculating the energy consumption, the unit of energy is taken in kilowatt hour.

The method used to calculate energy consumption is Power = Current x Voltage and Electrical energy = Power × Total time the appliance ran (in hours). Nowadays the equipment comes in the market according to the rating on which the electrical properties like voltage, current, rating, price and other parameters are written. When we calculate the load, how many bulbs, how many tubes, appliances used in the house, how many watts of power they have, how long they are being used separately. By surveying all these data, we calculate the consumption of electrical energy.

Consider the load of an average household with the following electrical appliances.

S no.	Electric Equipment	Number of Eq.	Wattage	Hours	Watt-Hour
1	20 watt Tube Light	5	20	8	800
2	10 watt bulb	3	10	8	240
3	Ceiling Fan	4	60	8	1920
4	Exhaust Fan	1	100	2	200
5	T.V. LED 32''	1	55	6	330
6	P.C./LAPTOP 15.5''(LCD MONITOR)	1	40	2	80
7	Washing Machine	1	700	1	700
8	Refrigerator (230L)	1	40	24	960
9	A.C. (1.5 ton)	1	1200	2	2400
10	Mixer/Juicer	1	1000	0.5	500
				Total	**5430**

Calculating Total Consumption — from the above table multiply the total load of home appliances used by an average household by 0.8.

Total consumption in a day = 5430 x 0.8

= 4344 watt hour

= 4.344 kilowatt hours

This number of total consumption is not exact but approximate because wattage and time are also almost correct. We take the actual wattage of all the appliances and the time consumed to arrive at the correct consumption.

Precautions:-

The following precautions should be taken while calculating the electrical load inside the building-

1. There should be no mistake in the calculation of all switches and boards.
2. Calculate the power of the equipment correctly.
3. Equipment and switches should be used of proper rating.
4. Care should be taken in making calculations.

Experiment No.-02

Object: -Checking efficiency by measuring power consumption and lumens of different lamps using lux meter.

Necessary equipment:- Different types of lamps, flux meter.

Process:-

(1) Light is a type of radiation energy, which provides the sensation of seeing to our eyes.Light is a type of radiant energy which provides a sense of vision to our eyes.

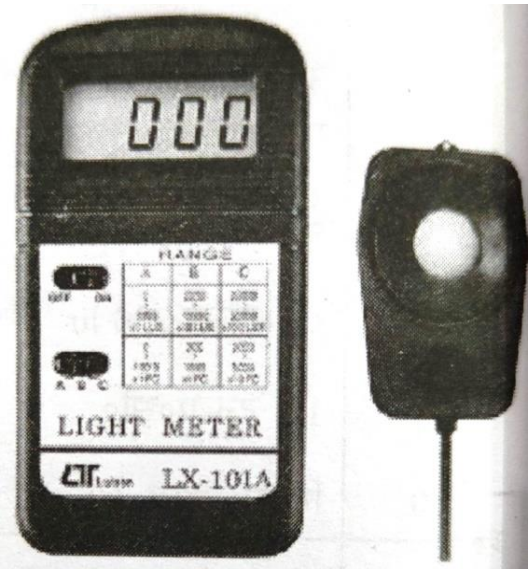
(2) The practical unit of luminous flux (light power) is lumen. Its subtle form is Lm. The amount of light energy radiated per second is called Lumen.

(3) The luminous flux falling on a unit surface area is called illumination. It is measured in lumens per square meter or lux.

(4) Lumen per Watt Capacity - It is the unit of output light power of the lamp and input electrical power, its unit is lumen per watt and it is also called the light efficiency of the lamp.

$$\text{Lamp efficiency} = \frac{\text{output light power}}{\text{Input Electric Power}} \text{ Lumens / watt}$$

To find out the efficiency of an electric lamp, first of all the illuminance of that lamp is determined by Lux meter. Knowing the illumination, it is known that how much is the light flux (lumen) per square meter.



Note:-

by the light source the total radiation energy emitted in one second is called Radiant Flux of the source. Its unit is watt. The visible light emitted by a light source in 1 second is called light pulsation. Its unit is lumen. The human eye is most sensitive to wavelengths near 5550 Å.

If the radiation pulse at 5550 Å flux is If there is one watt then the flame flux is 685 lumen.

Thus 100% efficiency of electric lamps would be equal to 685 lumen/watt. The flame flux emitted by a 100 watt bulb with a coiled tungsten filament filled with a mixture of nitrogen and argon is measured by a lux meter. This is approximately 1630 lumens. So the efficiency of this bulb $= \frac{1630}{100} = 16.30$ lumen/ watts which is 2-4% [100% efficiency equals 685 lumen watts]

Similarly, the luminous flux emitted by a 40 watt fluorescent tube lamp is measured by a lux meter. Hence, the efficiency of this lamp = $\frac{2000}{40} = 50$ lumen/watt, which is 7.3%.

Similarly, the efficiency of High Pressure Mercury Vapour Lamp is up to 30-40 Lumen/Watt. The efficiency of sodium vapour lamps is 40-50 Lumen/Watt. Carbon arc lamps have an efficiency of 40–65 lumens/watt.

Observation:-

S.No	lamp type	Measurement of flux by flux meter	lamp in watt	ת=lumen/watt	%ת= $\frac{\text{ת x1000}}{685}$
1. 2. 3.					

Result:-

Efficiency of different lamps = ……

Precautions:-

(1) The reading taken by the flux meter should be correct.

(2) For calculation the power of different lamps should be in watts.

(3) The calculation should be correct.

Experiment No.-03

Object: - To measure energy efficiency ratio (EER) of an air conditioner.

Principle:-

The energy efficiency ratio (EER) of a heating or cooling appliance is the ratio of heat output (in BTUs) to power input (in Watt-hours). If the air conditioning unit's E.E.R. Higher the ratio the unit will be. more efficient.

EER as per USA. The definition of EER is as follows and it is said that the ratio of output BTU/hr and electrical energy watts of the system is called Energy Efficiency Ratio (EER).

E.E.R. method of measuring:-

Calculate the total heat load by the following terms.

(a) Find the area of the area to be cooled and multiply it by 31.25.

(b) Calculate the heat received by the window. Multiply by 1.4 the result obtained if there is no rod on the window.

North window in BTU = North window area (msq) x 164

South window in BTU = South window area (m.sq) x 868

(c) Heat generated by humans-

Heat generated by humans in BTU = Number of humans x 600

(d) Heat generated by machines –

Heat generated by machines in BTU = Capacity of all machines in Watts x 3.4

(e) Heat produced by lightning-

produced Heat by lightning in BTU = Total Lightning in Watts x 4.25

(f) Total Heat Load in BTUs = Area (BTU) + Window (BTU) + Man (BTU) + Machine (BTU) + Light (BTU)

$$\text{EER} = \frac{\text{cooling output/heating load(in BTU)}}{\text{Electrical EnergyInput (in Watt}-\text{hours) (Wh)}}$$

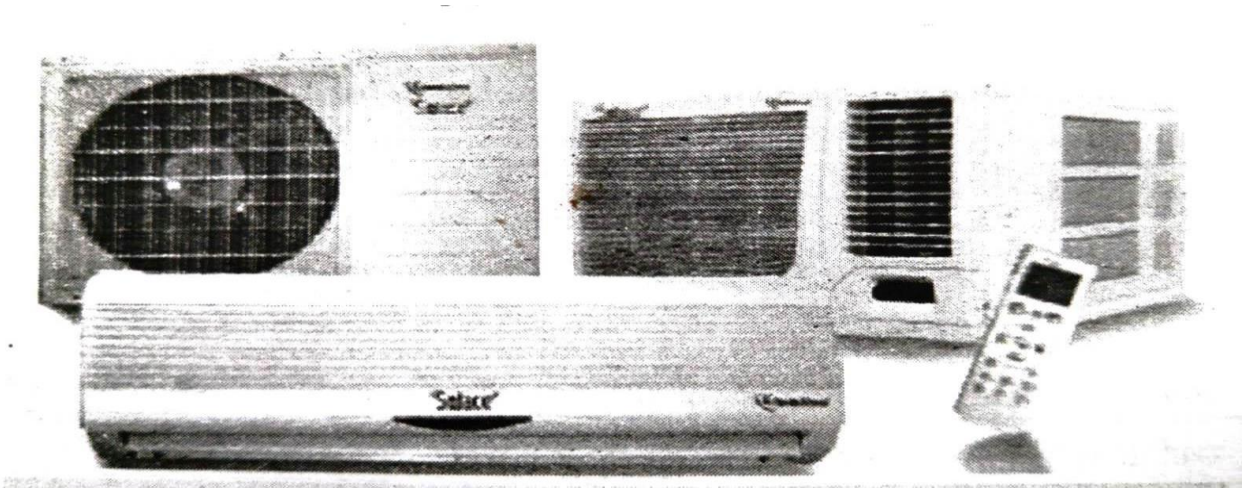
OR

$$\text{as per USA EER} = \frac{\text{cooling output/heating load(BTU/hr)}}{\text{Input Electrical Energy in Watt}}$$

Observation:-

S.No.	1	2	3	4	5	Total Load (in BTU)
Heat generated from various sources (in BTU)						

2. Electrical energy input (in Wh)



Calculation:-

$$\text{EER} = \frac{\text{cooling output/heating load(BTU/hr)}}{\text{Input Electrical Energy in Watt}}$$

Result:-

Energy Efficiency Ratio (EER) = BTU/Wh

Precautions:-

1. Calculate all heat loads correctly.
2. Measure all readings accurately.
3. Calculate all loads in BTUs.

Experiment No.-04

Object: -

To measure effect of valve throttling and variable frequency drive (VFD) on energy consumption by centrifugal pump.

Apparatus:-

Centrifugal Pump

Flow Meter

Energy Meter

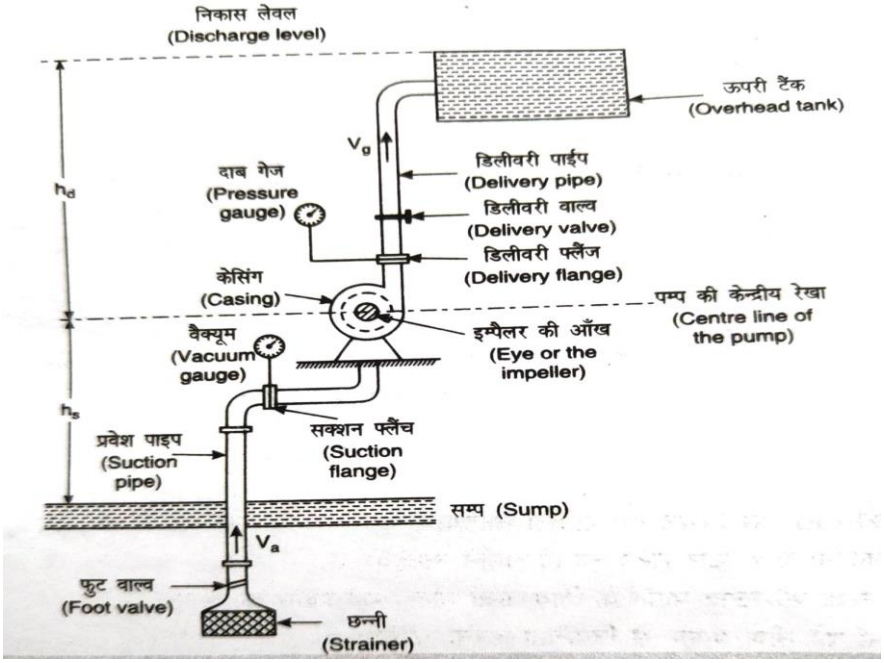
Tachometer etc.

Method:-

When flow is not required, a valve is placed in the flow line to reduce the flow to the pump.

Variable Frequency Drive (VFD) is to be fitted in the line so that the speed of the motor can be increased or decreased as and when required. Through this the feedback of the output can also be taken and it can also be controlled by itself. VFD is used to control the speed of induction motor and synchronous motor by changing the frequency of the supply. The VFD regulates the output voltage in proportion to the output frequency so that the nominally constant ratio of voltage to frequency, which is the A.C. The characteristic of the motor is, it can be obtained.

The flow valve can be opened and closed by throttling the valve. The failure occurs due to the increase in energy and momentum losses. Energy savings of up to 50-60% can be achieved by replacing the throttling valve with a Variable Speed Drive (VSD). throttling valves convert fluid energy into frictional heat, causing much of the pump's energy to be wasted.



Observation table:-

S.NO.	Power (Amp)	Speed (rpm)
1. 2. 3. 4.		

Result – The energy consumption of the pump depends on the speed.

Precautions:-

1. Check the equipment properly.
2. Connect the circuit correctly.
3. Take the reading carefully.
4. Meter connection should be correct.
5. Select the equipment according to the rating.

Experiment No.-05

Object:- To measure and calculate energy saving by arresting air leakages in compressor.

Apparatus:-

Ultrasonic Acoustic Detector

Compressor etc.

Method:-

1. It is not possible to see air leakage, so some other method is needed to detect air leakage. Air leakage is detected by ultrasonic acoustic detector as high frequency sound is generated at the location of air leakage. The device consists of a directional microphone, an amplifier sound filter and an earphone to listen to the sound produced by the locus.

2. In the second method, leakage can be detected by applying soap solution to the place of leakage.

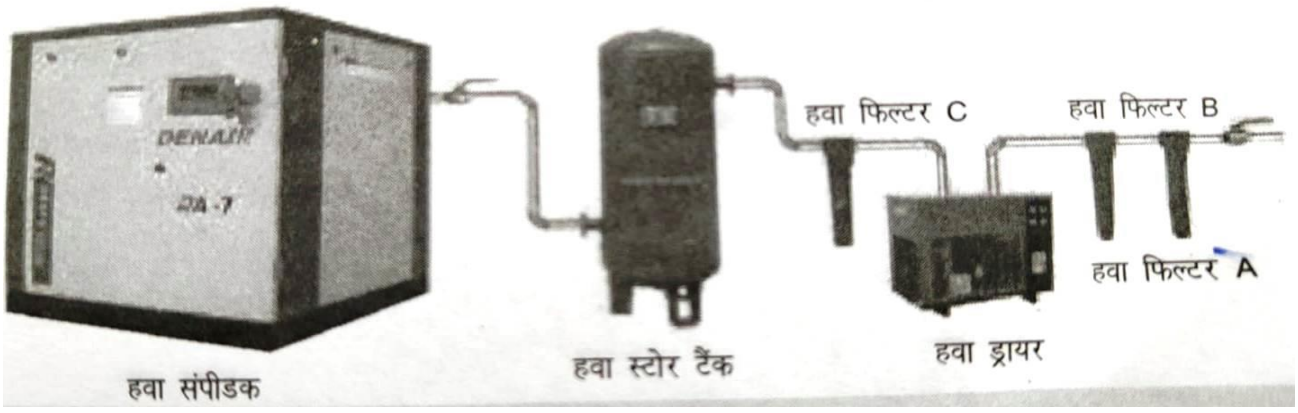
3. Express the loss in compressor efficiency due to leakage in percentage. This is less more than 10% in a good compressor.Low and bad compressors have up to 25-35%.

Formula for leakage calculation (%) $=\frac{\mathrm{Tx100}}{\mathrm{T+\ t}}$

Where,

T = Running time (in minutes)

t = Shutdown time (in minutes)



Calculation:-

Air loss is calculated in 'cubic feet per minute' which is represented in CFM (Cubic Feet per Minute) and is measured in liters. It is as follows-

$$\text{CFM (L)} = \frac{\frac{\text{Air Loss}}{\text{An Atmosphere}} x Volume(\text{ft})3}{\text{time in minutes}}$$

Observation Table:-

Serial Number	CFM (L)
1.	
2.	
3.	
4.	

Result:- Power after closing the air leakage = ……..kWh

Precautions:-

1. Note the unit carefully.
2. Do the calculations correctly.
3. Take utmost care while taking readings.
4. Use the equipment carefully.
5. Get it checked by a skilled observer.

Experiment No.-06

Object:-

To measure the effect of blower speed on energy consumed by it.

Apparatus:-

Blower

Tachometer

Digital clamp metre

Power supply etc.

Method:-

(i) First arrange an electric supply line.

(ii) After power supply, electric blower is connected to this line.

(iii) One of the supply wires between the electric blower and the supply line is taken out through the transformer jaw (aw) provided in the digital clamp.

(iv) Set the rotary switch of the digital clamp meter to 200 amperes.

(v) Thereafter the power supply is left in the circuit or the blower is switched on.

(vi) A digital tachometer is used to check the speed of the blower.

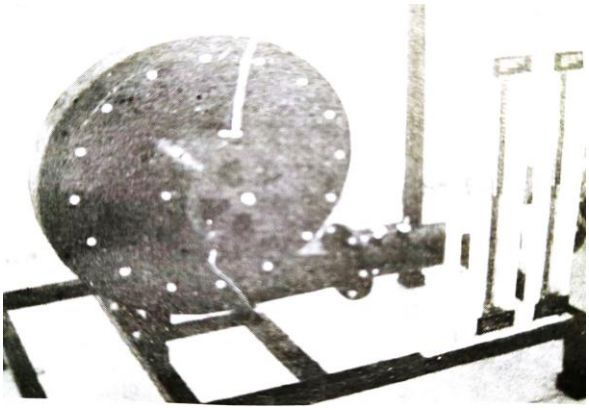
(vii) Now the electrical load is noted on the digital clamp meter.

(viii) After this the speed of blower is changed.

(ix) Re-reading is noted after speed change.

(x) This process can be repeated by running the blower at different speeds.

(xi) In this way the effect on energy consumption can be checked by changing the speed of blower.



Test Table

Serial Number	Blower Speed (in rpm)	Converted Load (in Ampere)
1. 2. 3.		

Result:-

Blower speed from .....rpm to ……rpm load change…… ampere to..... ampere becomes.

Precautions:-

1. Special care should be taken while connecting the blower to the electrical circuit.
2. Before use, it should be checked whether the blower is running at different speeds or not.
3. Always use the wire used in the electric circuit of full load carrying capacity.
4. The blower speed should not be increased excessively otherwise there is a risk of wires melting or burning.
5. Wires should not have joints or joints should be taped.