Unit-III

Illumination

3.1 Introduction - terms used in illumination, laws of illumination,

3.2 Types of sources of illumination - Electric arc, incandescent, gaseous discharge, ~~flas~~ fluroscent

3.3 Arc lamps, Incandescent lamps, LASER, LED, NEON Tungsten - Helogen and sodium ~~lam~~ vapour lamps, flaroscent lamps.

3.4 Types of lighting schemes - Direct, semi-direct, semi-indirect, indirect lighting and general lighting schemes.

3.5 General ideas about street lightings, factory lighting and flood lighting.

Assignment - II

1. Explain types of lighting scheme.
2. Explain law of illumination
3. Define the following -

(a) Luminous flux (b) Candle power (c) Solid angle
(d) Illumination.

Light

The radient energy emitted from a hot body which produces the visual sensation upon the human eyes is known as light. It is denoted by the symbol Q, expressed in lumen-hours (analogous watt-hours).

Light is the prime factor of human life, as all activities of human beings ultimately depends upon the light. Where there is no natural light, use of artificial light is made. Artificial lighting produces electrically on account of its cleanliness, ease of control, steady output as well as its low cost. It is mainly used for decorative purpose, advertising, traffic control, medical field and street lighting etc.

The usual method of producing artificial light consist in raising a solid body or vapour to incescent by appling heat to it. It is found that as the body is gradually heated above room temperature, it begins to radiate energy in the surrounding medium in form of electromagnetic waves of various wave-length.

As heating occurs, the emitted EM(W) have higher energy and eventually becomes visible first red..... then white.

Electromagnetic spectrum spreads over a tremendous range of frequency or wavelengths. as given by -

$$f = \frac{1}{\lambda}$$

Wavelength	Radiated light	frequency
2000	Ultraviolet ray	
5000	violet ray	7.5×10^{14}
6000	Blue	6×10^{14}
7000	Green	5×10^{14}
8000	orange	4.3×10^{14}
	red	

Colour	Wavelength
Violet	4100 Å
Blue	4700 Å
Green	5500 Å
Yellow	5800 Å
Red	6000 Å
orange	6100 Å

Human eyes not equally sensitive to all colours. Eyes are most sensitive in the mid-range near 5500 Å. i.e Green or yellow.

Important terms:

Lighting schemes

Classesification	upward	downward
Direct	10	90
Semi-direct	10-40	60-90
Indirect	90	10
Semi-indirect	60-90	10-40
General	50	50

(A) Direct lighting scheme.
(B) Semi-direct lighting system/scheme
(C) Indirect lighting scheme
(d) Semi-indirect lighting scheme.
(e) General lighting scheme.

(A) Direct lighting scheme:-

In this system, 90% of light is directly focused on the object and light-up the object, the rema 10% is distorted. In this, a V-shaped reflector is placed over bulb which is opened from bottom. It is applied in library, surgerical room etc.

(B) Semi-direct lighting scheme:-

The scheme under which 60-90% is focused on object and remaining portion is reflected here-there. It is used in places of height. In this curved shaped lamp is used.

(c) Indirect-lighting scheme:-

In this 90-95% of light focused on top and 10-5% is focused in bottom. In this there is no shadow formation. Drawing halls, theathers etc.

(d) Semi-indirect lighting:-

In this 60-90% is focused on top and 40-10% is focused at bottom. It is used for decoration purposes, restraunts.

(e) General lighting scheme:-

It is generally used scheme in which 50% light is used to focused on object.

Laws of illumination:

i) Inverse square law of illumination.
ii) Lambart's cosine law.

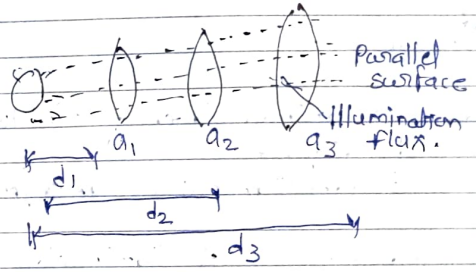
i) Inverse square law of illumination:-

The illumination of the surface is inversely proportional to the square of distance between parallel surface and point surface of light.

i.e,

$$E \propto \frac{i}{d^2} \quad \text{---} (1)$$

Where, i = intensity, E = illumination, d = distance.



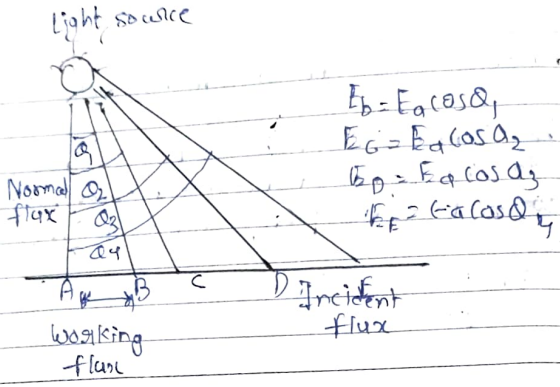
ii) Lambert's cosine law:-

Lambert's cosine law states that illumination of surface is directly proportional to the cosine angle between normal and incident flux.

i.e,

$E \propto \cos\theta$ ($\cos\theta \downarrow$ when $\theta \uparrow$, when $\cos\theta \uparrow$, $\theta \downarrow$)

---(ii)



∴ from eqn (i) & (ii)

$$E \propto \frac{I}{d^2} \cos\theta$$

Where, I = luminous intensity in lumen
d = distance
E = illumination lumen/meter^2

Que A 500 candela power of illumination source is placed at 10m distance from screen so find intensity of light, illumination is perpendicular and illumination is 60° at angle.

Soln Given – I = 500
d = 10m
θ in case-I = 0°
θ in case-II = 60°

I = candela power
$\frac{\Phi}{\omega}$ = $\frac{\text{flux}}{\text{steradian}}$

find – Illumination.

For case-I

$$E = \frac{I}{d^2} \cos\theta$$

$$= \frac{500}{100} \times \cos 0°$$

$$E = 5 \text{ lumen/meter}^2 \text{ or lux.}$$

Case-II,

$$E = \frac{I}{d^2} \cos\theta$$

$$= \frac{500}{100} \times 0.5$$

$$= 2.5 \text{ lux.}$$

Q. A bulb gives 25 candela power, so calculate total flux Φ.

Soln $I_{cp} = 25$ candelapower.

Now, $I = \frac{\Phi}{\omega} = \frac{\text{Total lumen flux}}{\text{Steradian}}$

$I = \frac{\Phi}{4\pi}$ ∵ 4π = max. candela

$\Phi = 25 \times 4 \times 3.14$
$\Phi = 314.15$ lumen

Important terms in illumination

(i) **Luminous flux:-**

The total quantity of light energy emitted per second from a luminous body is called luminous flux. It is represent by F measured in lumens.

(ii) **Luminous indensity:-**

The ratio of luminous flux to ~~steta~~ steradian is known as luminous intensity. It is represented by I measured in candela.

$$I = \frac{\Phi}{\omega}$$

(iii) **Lumen:-**

The unit of luminous flux known as lumen and defined as the amount of luminous flux given out in space represented by one-unit solid angle by a source having an intensity of 1 candel power in all direction.

(iv) **Glarey:-**

Glarey is visual sensation caused by excessive and uncontrolled brightness. It can be disable or simply uncomfortable. Glarey occures when too much light enters our eyes and interfere with eyes ability to manage it. Older people are usually more sensitive to glarey due to the aging characteristics ~~(ii)~~ of the eye.

(v) **Illumination:-**

It is defined as luminous flux falling on a surface per unit area. It is denoted by E. and is measured in lumen/meter^2 (F/m^2) or Lux. or m/cand.

$$E = \frac{F}{A}, \text{ lumen/m}^2 \text{ or lux.}$$

Where, A is area of surface.

(vi) **Candle Power:-**

It is defined as the no. of lumens emitted by a source in a unit solid angle in a given direction. It is denoted by symbol C.P.

$$CP = \frac{\text{lumens}}{\omega} = \frac{F}{\omega}$$

Where, ω = solid angle.

(vii) **Luminous efficency or lamp efficency:-**

It is defined as the ratio of the luminous flux to to power input. Or the efficency of source to convert Suppl Power (in watts) into lumens of light.

$$\eta_e = \frac{\text{Luminous flux}}{\text{input power}}$$

(viii) Mean horizontal candle power :-

It is defined as the mean of candle power in all direction in of horizontal plane coordinate source of light. It is denoted by MHCP.

(ix) Mean Spherical candle power :-

It is defined as the mean of candle power in all direction and in all planes of source of light.

(x) Mean hemi-spherical candle power :-

It is defined as the mean of all candle power in all direction above or below the horizontal planes passing through source of light.

(xi) Reduction factor :-

Reduction factor of source is the ratio of its mean Spherical candle power to its mean horizontal Candle Power.

$$R\text{-}f = \frac{MSCP}{MHCP}$$

(xii) Space hieght ratio :-

It is the ratio of two sucessive source to their mounting hieght is known as space hieght ratio

(xiii) Brightness :-

The brightness of light source is defined as the amount of light emitted. It is measured in candela or lumen also known as luminous intensity

(xiv) Plane angle :-

A plane angle is angle formed by two intersecting line on a plane, and the space between them is either measured in degrees or radians.

(xv) Solid angle :-

It is a 3D angle that measures amount of view or field of view of a object covers from a specific point.

Lamp

The arrangement of material such that emits light and heat on suppling electricity is known as lamp.

(i) Incandescent lamp:

The incandescent lamp is an arrangement that emits light with help of filament that glows when heated by an electrical current. The classification of incandescent lamp is shown in block diagram below.

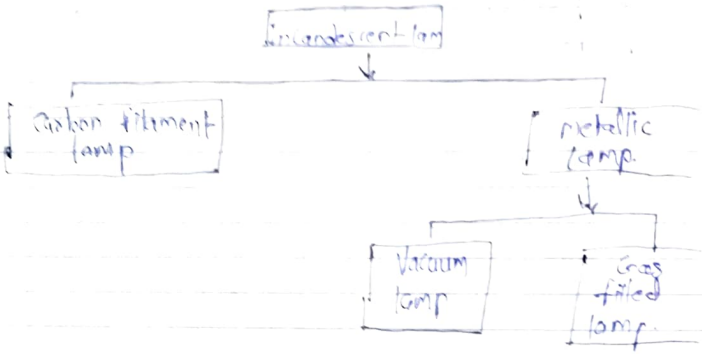


Fig: Block diagram of lamps

(ii) Carbon filament lamp:

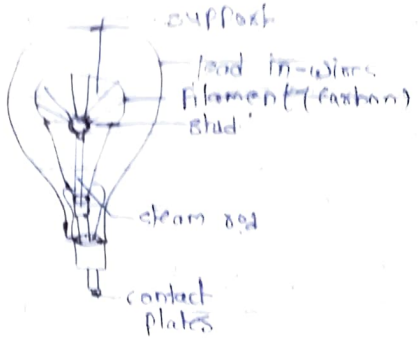


Fig: Incandescent lamp.

The incandescent or filament type lamp consists of a glass globe completely evacuated and a fine wire known as filament within it. The glass globe is evacuated to prevent the oxidation and convection current of the filament and also to prevent the temperature being lowered by radiation.

The material used for making filament of incandescent lamps are carbon, tantalum and tungsten. In carbon filament lamp the filament is made up of carbon and evacuated by glass globe, filled with vaccum, to prevent oxidation of filament. The shape of filament seems like English alphabet Y. The working temperature is 1900 - 2000°C to prevent blackening of bulb. Its melting point is 3500°C.

Working:-

The carbon filament works on the principle by passing electric current through carbon filament, causing it heat up and glow, produces light. The principle behind it is incandescence, where an object is heat up to a certain high temperature and glows i.e emits light.

The light source is a thin carbon filament, typically made from carbonised material when an electric current, it faces a high resistar that produces a high range of heat about 1800-2000°c that makes it emit light.

The glass bulb is either evacuated or filled with inert gases to prevent it from burning or oxidation of the carbon filament.

Properties:-

- The light colour is red or yellow.
- The working hour is 600-700 hours.
- The commercial efficiency of filament ~~is~~ lamp is 4.5 lumen/watt approximately.

(ii) Metallic filament lamp:-

In this filament lamp, the filament is made of tantalum or tungsten. The constructional details is similar to carbon filament lamp.

At present, tungsten is used due to its high efficiency, such as 4.5 F/W as the efficiency of tantalum is 2 F/W. Its melting point 2996°C.

(a) Vacuum filament lamp:-

A vacuum filament lamp is a kind of incandescent lamp that produces the heat and light using the effect of incadescence.

(b) Gas filled lamp:-

It is a type of metal-filament lamp can work at 2000° without oxidation and if it is worked beyond the temperature it vapourised and ~~blat~~ blacken the lamp. It contains ionized gases such as plasma (mixture of Argon, Krypton, Neon etc)

(ii) Gas discharge lamp :-

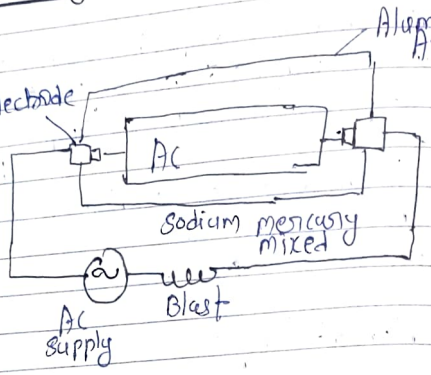


fig :- Gas discharge lamp

In all discharge lamps, an electric current is passed through a gas or vapour which renders its illumination. In this process of producing light by gaseous ~~condition~~ conduction, most commonly used elements are neon, mercury and sodium vapours.

The colours (i.e wavelength) of light produce depends on nature of gas or vapour. ie -

(i) Neon discharge filled give orange-red light.
(ii) Mercury-vapour filled give bluish colour light
(iii) Sodium vapour filled give orange-yellow light

Types :-

The discharge lamps is of two types

- The first type is of those types in which light is same as produced by the light discharge by the gas or vapour.
- The second lamp type which uses the phenomenon of fluorescence.

Demerits :-

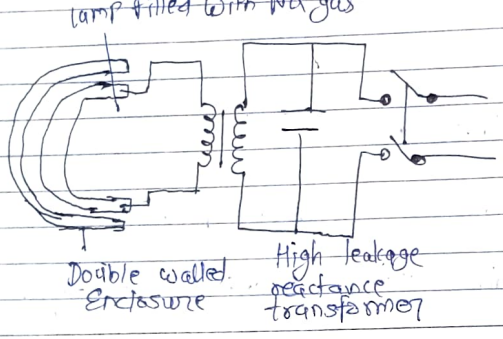
- High intial cost.
- Very low or poor power factor.
- It requires extra element for starting.

Types:-

There are two types of gas discharge lamp

(a) Sodium vapour lamp.
(b) Mercury vapour lamp.

(a) Sodium vapour lamp:-



low Pressure
fig:-1 Sodium Vapour lamp.

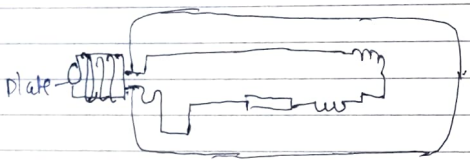


fig:-2 High pressure sodium vapour lamp.

A sodium vapour lamp is a type of gas discharge lamp that uses sodium vapour to produce light typically characterised by its distinctive by its yellow orange glue.

Construction:-

The high and low Pressure sodium vapour lamps is shown in figure. These lamps of low luminosity. So the ~~lamp~~ length of these lamps is large. To get the desired length, it is made in U-shape. Two oxide coated electrode is sealed with ends. The tube contain little sodium and neon gas, enclosed by double-walled vacuum flask to keep temperature within working range.

Working:-

- Before the lamp starts working, sodium is in form of a solid deposited in sides of the tube wall. In beginning, when switch is on it operates as low pressure neon lamp with pink colour.
- It warms and sodium started vaporised and it radiates yellow light and then and after 15 minutes lamp starts giving full light.

Salient features:-

- The efficency of sodium vapour lamp in under practical condition is about 40-50 lm/w
- The working hours of these lamps are 3000 hrs and not affected by voltage fluctuation.
- These are used for highways and general outdoor applications. where colour discrimination is not required.

Advantages:-

- High efficency and energy savings.
- Reduced Energy Consumption.
- Longer ~~#~~ lifespan generally 3000 hrs.
- Excellent lumen maintainance
- Rapid restarting
- Uniform light distribution
- Low maintainance or running cost.

Disadvantages:-

- It has reactivity with water.
- It doesn't resist cosinosive effects.
- It has difficult storage.
- It has hazardous Environmental impact.

Applications:-

- ~~Re~~ Outdoor lightings.
- Spectroscopy
- Pharmaceutical applications.

(b) Mercury-Vapour lamp:-

(A) Low pressure Mercury vapour lamp:-

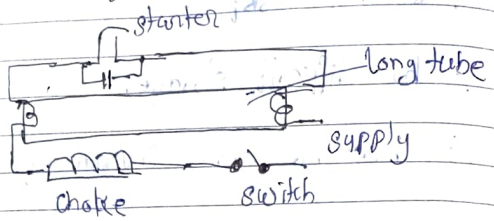


fig:- Low Pressure mercury Vapour lamp.

low pressure mercury vapour lamp is also known as fluorescent lamps. It has variety of advantages and applications. the tubes are obtained in a variety of length and illumination in a variety of colour. It has used to achieve high light intensity without excessive temperature rise and owing to nature of light source, danger of glare is minimised.

Construction :-

The low pressure ~~section~~ mercury-vapour lamp or fluorescent lamp is shown in above figure consiste of starter, choke, switch, tube and input supply. In this due to low pressure, the lamp is in the form of long tube coated with phosphor. The tube contains small amount of mercury and argon gas at pressure of 2.5mm.

electrode
At each end of tube, the is of spiral form made of tungsten and coated with electron emitting material.

The choke is connected in series with the tube filament, provides a voltage impulse for shorting the lamp and acts as ballast, later on when lamp is running. The filament is connected with starter switch glows the lamp with bimetal strip at the electrode.

Parts:-

The main constructional Parts of flourescent lamp is as follows—

(a) Glass tube :-

A sealed glass tube enclosure is used to house the gases and phospher coating.

Gases such as Mercury, argon is filled under low pressure. The gas phospher coating is done that emits the light by striked by UV light produced by the mercury vapour.

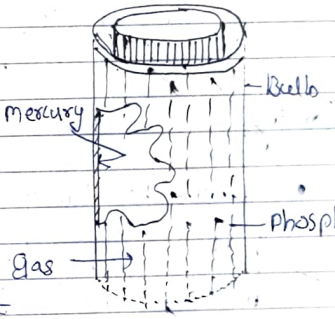


fig:- Parts of lamp

(b) Electrodes:-

It is located at each end of tube. These produces high intensity flashes(arc) when current is made to flow through it, initiating gas excitation process.

(c) Ballast:-

It is a component that ~~pro~~ used to regulate current in lamp and provide necessary voltage to start either magnetic or electrically.

(d) Base:-

The end of lamps that fits to the receptible connects with supply known as base.

Working:-

- When the starter is cold, electrodes are open. When supply is given, full voltage acts as on starter. A glow discharge is set up which warms the electrode and causes bimetal to bend and touch electrode.
- This completes circuit and current flows through causes emission of electrons from filament. At the same time, voltage falls to zero and bimetal cools down and so as electrodes are open and intrupt current flow in circuit.
- Its efforts is to induce high voltage surge of about 1000V, that produces flow of electron between lamp electrode and lamps are light-up immediately then, lamp starting contacts are kept opened.
- This lowered the p.f, improved by condenser of 4μF connected across supply.

Specifications:-

- Voltage rating is 200-230V.
- Power rating is 20-40W.
- Luminous flux is upto 1520 lumen.
- Luminous efficency is about 38 lumen/watt.
- Useful flourescent lamp life is about 7500 hrs normal The active life may varies from 5000-10000 hrs depending upon operating conditions.

S.no	Fluorescent material	Produced light
1.	Cadmium Sillicate	Yellow, pink
2.	Zinc Silicate	Green
3.	Cadmium Borate	Pink colour.
4.	Calcium Tungstate	Blue

Advantages:-

- It has high luminous efficiency.
- It has long life and low running cost.
- Low glare level.
- Less heat emission.

Disadvantages:-

- Stroboscopic effect (flickering) is there.
- A small wattage requiring large no. of fittings.

Comparision of incandescent and fluorescent lamps:-

Aspects	Incandescent lamps	Fluorescent lamp
Luminous efficiency	10-50 lm/w	40-60 lm/w
Cost	Economical with high initial cost	Economical so as initial cost.
Starting	Troubles is there	No trouble is there
Life	5000-1000 hrs	3000 hrs.
Illumination variety of colours	Diffused light Large variety of colours	Shadows obtained Can produce only few colours
Brightness	less	More.

(B) High Pressure mercury vapours lamp:-

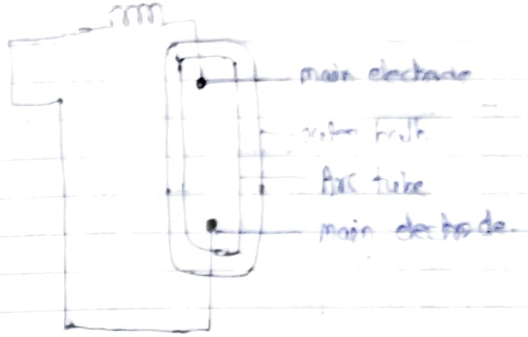


fig:-2 High pressure Mercury vapour lamp

- The high pressure sodium vapour lamp is shown in above figure consists of two bulbs, inner one is arc tube contain discharge gas and outer bulb which protects it from temperature changes.
- The inner tube made up of quartz material whereas outer bulb made of glass. The arc-tube contain small amount of mercury and Argon gas. When supply is applied, the argon gas between electrodes starts discharging and produce heat that vaporises mercury.
- Constantly, pressure increase in arc-tube from 1-2 atm and electrodes glows upto 150 V. The operation takes place in 5-7 minutes. During this time, the discharge is done through mercury vapour and emits greenish blue light.

(iii) Neon-gas lamp or tube :-

Neon gas lamp or tube is used upto the length of 8 meters, may be bend into almost any desired shape. ~~It consist~~ during menufacturing. It consists of a lenght of glass ~~tube~~ tube containing two electrodes normally cylindenical in shape of iron steel or copper. The tubes are mounted either on a wooden frame or a metal base. These are matched with step-up transformers by containing suitable tapings for rated current. Connection between letters are made by nickle wire and glass tube is being sliped over them (Neon tube). The power factor for Neon tubes is quite low and improve by using capacitors. The capacitor is placed on LV side of transformer.

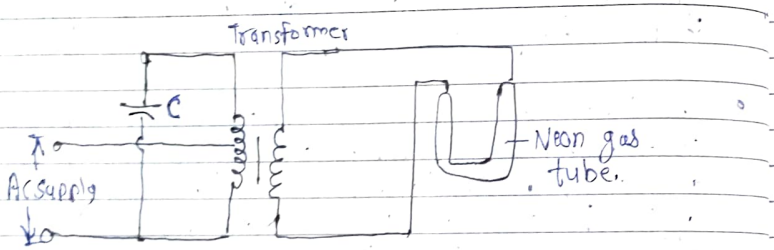


Fig:- Neon lamp

Neon lamps belongs to cold cathode category. The electrodes are in form of iron ~~shaped shells~~ and are coated on inside. The colour of light emitted is red, if the helium gas is used in place of neon, pinkish-white light is obtained. Helium and neon through coloured glass produce a variety of effects. As shown ~~it~~ in figure, the transformer has a high leakage reactance with stable arc in lamp. A capacitor used for power factor improvement, high voltage is used for starting.

The efficency is lies between 15-40 lumen/watt.

Uses :-

These are used as indicator lamps, night lamps for determination of polarity of dc mains and in large sized neon tube for purpose of advertising.

- Comparison of different light sources :-

Aspects	Incandescent lamp	flourscent lamp	Mercury Vapour lamp	Sodium Vapour lamp
Starting	~~The~~ Instant Start	It has reqⁿ time of 1sec	It has reqⁿ time of 5-6 ~~sec~~ min.	They reqⁿ time of 5-6 min
Colour of light	very near to natural	Varies with phosphen coating	It suffers from colour distortion	Yellowish ~~to~~ colour distorted
Intallation and running cost	minimum/ maxim	max/mini.	High but less of fluoressent lamp	maximum/ less for filament lam
Average life	1000 hrs	4000 hrs	8000 hrs	3000 hrs
Efficency	10 lm/w	40 lm/w	40 lm/w	50-60 lm/w

(iv) Compact filament lamp(CFL):-

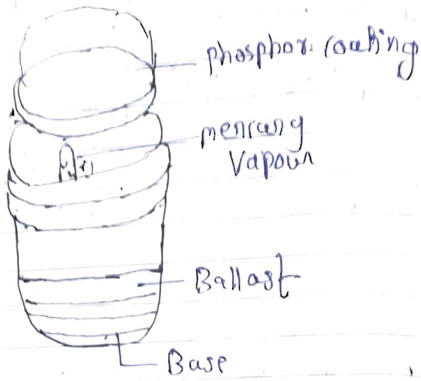


fig:- Compact filament lamp.

A compact filament lamp(CFL) is a type of incandescent lamp, especially a fluorescent lamp designed to replace traditional incandescent bulbs known for compact size and energy efficiency. It is also known as compact fluorescent lamps.

(v) Helogen lamp:-

As the life and efficiency of incandescent lamp fails off with use-partly due to slow evapora: of filament and black deposits formed on the inner surface of bulb. The addition of small helogen gas to fitting gas restores part of tungsten filament's evaporated part back to it by means of chemical reaction in a sort of regenerative cycle.

Advantages:-

- It has longer life about 2000 hrs.
- High operating temperature increases luminous efficiency.
- No evaporation leads to no blackening on the inner surface.

Specifications:-

- These have ratings of [illegible] etc.
- The luminous efficency of about [illegible]

(vi) Arc lamp:-

These lamps are used in search light, projection lamps and other special purpose lamps like those in flash cameras. In an arc lamp, electric current is made to flow through to electrodes in contact with each other, which are drawn apart. The result is an arc being stucks. The arc maintains the current and

very efficent source of light. The various forms of arc lamps are -

(i) Carbon arc lamp.
(ii) Flame arc lamp.
(iii) Magnetic arc lamp.

(i) Carbon arc lamp :-

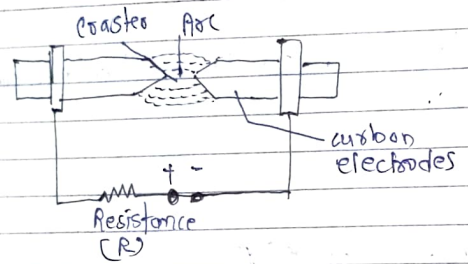


fig :- Carbon arc lamp

Carbon rodes used with AC supply are of the same size is that of Dc supply. This is eeasiest type. When two hard carbon rods are placed end to end and connected to terminals of Dc supply mains not less than 45 V, the current flows through them and ends of carbon rod soon become incandescence. If they are slightly pulled (safe of 2-3 mm) arc will be produced, between two carbon rods and white light will be produced. This arc is maintained by transfer of carbon particles from one rod to another.

It is found that these particles travel from positive carbon rod to negetive. That's why the positive rod becomes hollow after sometime an negetive becomes like a pointed pencil.

Specification :-

- The voltage drop across arc lamp is 45-50 V and supply voltage is 70-100 V.
- In an carbon arc lamp 80% of light given by positive rod and remaining of 20% is from negetive carbon rod and 5% by air.
- Temperature of positive rod between 3500-4000°C and negetive one is about 2500°C.
- The luminous efficency is 12 lm/W.

(ii) Magnetic-arc lamp :-

Magnetic Arc lamp is such a lamp in which positive electrode is made up of copper and negetive electrod made of magnetic oxide of iron are used. The arc is struck in similar way as in case of carbon arc lamp Such lamps are rarely used.

(iii) Flame-arc lamp :-

The principle of operation is similar to that of carbon arc lamp. The electrodes of such lamp has

5-15% of fluoride known as flame mate
and 85-90% of carbon. Generally, coare type
electrode ~~carbons~~ are used. and cavities are
filled with ~~chloride~~ fluoride. It has chara
which radiates light energy efficently from
a very high heated arc Steam, fluoride furns
with vapour along with carbon and these
causes a very high luminous intensity. In addi
to fluoride, these are also some flame materi
Different flame materials produce different
~~materials~~ colours. Most of which don't appeal
to eyes. Its has efficency of 4 lm/w.

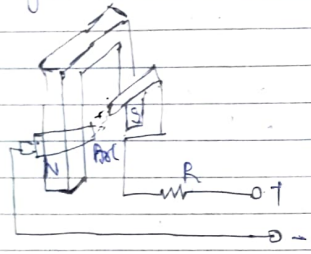


Fig:- flame-arc lamp.

General lighting street, factory and flood lighti

- **Factory lighting:-**

Adequate lighting of factories is of vital importa
As it provides improved eminities for the emplo ees
increased production and has definite economic
value in reducing accidents.

General lighting requirement & installation:-

A factory lighting installation in common with
other indoor equipments should provide an adequat
illumination on working plane. and give a good
distribution of light. It employ simple easily
clean fitting, avoid glare. It is essential not
only to avoid glare from lamp itself but also
reflect glare from any polished surface which ma
be within line of vision. They are three types -
(a) General lighting (b) local lighting (c) Emergency lightin

(i) General lighting:-

The usual scheme in factories and workshops is
to mount a no of lamps at a sufficent hieght so
that uniform distribution of light over the working
plane is obtained.

In large machine shops,
the hieght is governed by the necessity of keepin
lamp above the travelling cranes. In such cases,
it is often desirable to supplyment the main
lighting by side lighting in order to give additional
illumination of on vertical plane.

(ii) Local lighting:-

On some points, fairly intense illumination is requir
for this purpose, local lighting can be provided
by means of adjustible fittings attached to the
machine or bench or mounted on Potable floor
standards. Such lamp should be mounted in deep

reflectors so that glare is avoided.

Potable hand lamps attached to walls plugs by means of trailling leads are used for maintainance, work and emergency lighting. Low voltage lamps of not more than 50V, are recommended for use as portable hand lamps because of such lamps have thicker filament.

Local lighting should never be employed alone, good general lighting is essential so that dark places between local lighting units are avoided.

(iii) Emergency lighting:-

It is very desirable to provide auxilary lighting from sources other than main electric supply. Preferable from batteries or small petrol driven generator set. If however, the emergency light are supplied from main supply, these should completely seperated from main lighting circuit.

In an industrial establishment an adequate amount of light produces following good effects-

- The quality of work improved.
- No. of work stoppages are reduced.
- The productivity of labour increased.
- Accidents are reduced.

A factory lighting installation in common with indoor equipments should provided the following

- Adequate illumination on working plane.
- Good distribution of light.
- Simple and easily clean fitting.
- Avoid glare.
- Street lighting:-

The main objective of street lighting are-

(a) To make traffics obstracte on the road clearly visible in order to promote safety and convenience.

(b) To enhance the community value of street

(c) To make the street more attractive.

The principle employed for street light is different from that of interior lighting. There are no walls and ceilings which reflect or diffuse light. Hence only direct lighting scheme can be employed and hard shadows and high constrasts, can't be avoided. Because of area to illuminated be large, it is done. The two general principle are based in designing of Street lighting installation. They are-

- Diffusion principle
- Spectacular reflection principle.

In this case of lamp fittings, suitable reflectors are required. The design of reflectors is such that they may direct the light downwards, and spread as uniformly as possible over the surface of road. In order to avoid glare, the reflectors are made to have a 'cut-off' between 30-45°. The diffusing natures of the road surface cause the reflection of certain proportion of incidence, like in direction of observer. and therefore, the road surface appears bright. to the observer.

Calculating illumination at any point on road surface, point for point or inverse Square law method is employed.

In Spectacular method Here, the reflectors are curved upwards so that the light is thrown at road at a very large and allowed incidence. In this method, the requirement of pedestrain who requires to see object in his immediate neighbourhood is also fulfilled. This is more economical in comparison to diffusion method of lighting. However, it has a demerit of that it produces glare for motorists.

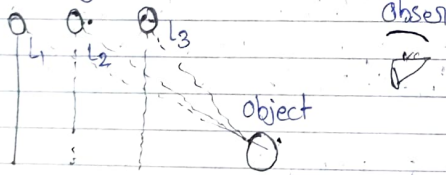


fig:- Spectacular reflection

- **Flood lighting:-**

Flood lighting means flooding of large surface with light from powerful projectors. It is employed to serve one or more of following purpose
(i) Asthetic flood lighting.
(ii) Industrial and commercial flood lighting.
(iii) Advertising.

(i) **Aesthetic flood lighting:-**

For enhancing the beauty of building at night such as public places, ancient building and monument and and some other decorative occasion etc, asthetic floodlighting is employed.

(ii) **Industrial and commercial floodlighting:-**

For illuminating the sports stadium, railway yards etc which covers a unshadowed lighting with huge area this type of flood-lighting is employe

(iii) **Advertising:-**

For illuminatings, hoardings, advertising boards etc this types of flood lighting is widely employe

Concept:-

- For flood lighting, it is necessary to concentrate the light at from light source into a relatively narrow

~~beam~~
beam of light. A particular type of reflector and its housing is used for concentrating the beam light is known as flood lighting projector.

- Since, it is usually installed in a remote positio so it should be weatherproof in construction. It is the most important part of projector, a reflector may be made from ~~constuct~~ silvered glasses of good and of polished metal of about 70°.
- ~~•~~
- The casing and its housing is arranged in such way that the inclination of the beam is varied about vertical and horizontal direction.
- For economic point of view, wide ranged projec is used. With a beam spread of 40-90°. These are used for distance of 30m.

Light Emitting diode (LED)

Light Emitting Diode (LED) is a two lead semicondu device used ~~for~~ a light source application for low consumption equipments. The idea was first taken up by Nick Holonyak in 1962, although he was working for general electrical company. It is a ~~specif~~ specially designed diode having similar electrical characteristics.

Construction:-

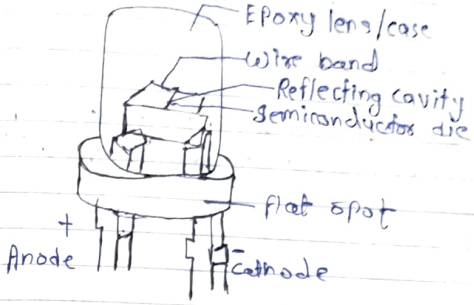


Fig:- Light Emitting diode

Working:-

- The LED is based on working principle of a simple diode. When it is forward biased, the barri is disappears when 0.7V is reached for silicon and 0.3 for Germanium.
- It activates and at a threshold voltage it starts emitting light. It is mixed with some material for emitting the light, for example, Germanium Arsenide.
- At reversed biased, it acts as simple diode, Small leakage current flows till reversed break-over voltage and breakdown of LED takes place. A sharp increase in current is observed.

The light emitted by LED is given by equation-

$E_g = h\nu_g$.

V-I characteristics :-

There are different VI characteristics of LED due to different wavelength colours of emitted light

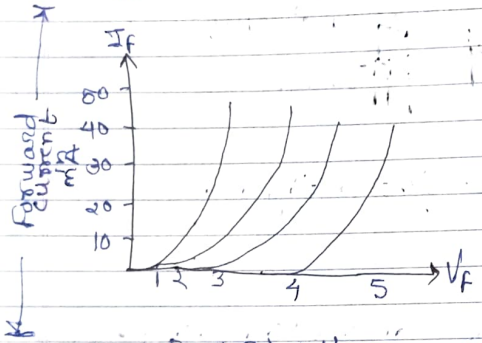


fig:- V-I characteristics at different wavelength

Advantages :-

- It has compact size and low cost.
- Low energy consumption
- Easy to use.

Light Amplification by Stimulated Radiation (LASER)

The word "LASER" refers to "Light Amplification by Stimulated Emission of Radiation". It is a very useful and powerful monochromatic light source of collimated beam in which light is highly coherent.

Characteristics :-

- Monchromaticity.
- Directionality.
- Coherent source of light.
- Intensity is highly focused.

Construction :-

A construction of a ~~laser~~ LASER typically involve a gain medium, pump source, and optical resona resulting a coherent beam of light.

- **Gain medium :-**

It is a material that amplifies the light through Stimulated emission. It can be solid, liquid or gas. It plays an important role for formation of coherent intensive light source.

- **Pump source :-**

This provide energy to excite the atoms or the molecules in gain medium causing to emit the photonic energy. Flash lamps, etc are some of examples.

- **Optical resonator :-**

It is mirror structure that surround gain medium providing feedback to sustain stimulated emission of light.

- **Laser Diode :-**

It is typically of P-type, n-type, or intrensic type of diode forms ph junction, where electron absorbs the Energy and jumps to high level emits light at recombination.

Working :-

The working of LASER based on stimulated light emission, to amplify creating a focused on, coherent source light beam. It involves exciting atoms in a medium which then release photons in a synchronised manner which stimulated with other photons resulting powerful directed light source.

Comparison Ordinary light source & LASER :-

A laser is different of following ways -

Odinary source	LASER
• It is Polychromatic	It is monochromatic
• It has several range of different wavelength	It is only sigle wave-length source of light.
• It is divergent	It is non-divergent.
• Intensity is less	Intensity is high.
• It is non-coherent	It is coherent.
• Low brightness	High brightness.
• Sunlight is example	LASER is example.

Advantages :-

- It used extremely accurate cuts.
- It travels with more speed and efficiently.
- Cost efficent.

Q-1 Explain System of track electrification.

Q-2 Explain all type of electric braking.

Q-3 What is electric traction system. List advantages and disadvantages of electric traction. and also make a list of requirement of ideal traction system.