

# Module 2 Lamps

# Lesson 9

## Discharge Lamp II

## Instructional Objectives

1. List various Discharge Lamps.
2. State Utilization Factor for a Discharge Lamp.
3. What is color rendering.
4. Understand Working of a Fluorescent Lamp.
5. State various types of Phosphors usable.

## Discharge Lamps (contd)...

As already seen in the last lesson Sodium Vapor Lamps are placed most favorable from the utilization point of view with high utilization factor. Low Pressure Mercury Vapor Lamp is seen to radiate clear blue line Spectrum. Low Pressure Sodium vapor radiates Monochrome light. High Pressure Mercury vapor with certain additives like Halides can be made to radiate multi line spectrum. Low Pressure Mercury vapor utilizes only 25 % of energy as compared to Incandescent Lamp. Consuming 7-11 W, with a burning for 5000 hrs. Normally fluorescent lamps based on low pressure mercury vapor are recommended for Homes, Hotels and Restaurants. They give warm white color and are often used as Blended Lamps. Low Pressure Sodium Lamp with outer Envelope's inner surface coated with Indium oxide as selective IR reflector. They have efficacy up to 200 lm / w and are available from 18 to 180W. They are suitable for lighting Highways, Harbors, Marshalling Yards etc. High Pressure Mercury Vapor Lamp are available in the range of 50w to 2000w. The radiation obtained is Bluish white line spectrum. Pure Mercury vapor lamps have very poor CRI, together with phosphors color improves, very much. Halide-iodide additives of Indium and Thallium or Sodium are added to reduce blackening of bulb. High Pressure Sodium Vapor Lamp have excess of sodium which saturates as Vapor of Sodium. Mercury and Xenon are used as buffer gases for ignition. These lamps operate around 700°C with a color temperature of 2100° k at 130 lm / w efficacy.

**Table I Properties of Discharge Lamps**

PROPERTY	INCANDESCENT	MERCURY		SODIUM	
		LP	HP	LP	HP
Flux lm	250 - 40000	450-1200	2000-125000	1800-33000	3300-130000
Efficacy lm / w	10 - 20	41-50	40-63	100-183	70-130
Rating w	25 – 2000	9-25	50-2000	18-180	50-1000
Light Color	Warm-white	warm-white	intermediate	warm-white	warm-white
Color rendering	Excellent	Good	Moderate	non existent	Poor
Ballast	None	built-in	Chock	hybrid	Choke
Starter	None	Built-in	None	Separate or Built into Ballast	
Run up time min	Zero	Zero	3	10	5
Restrike time min	Zero	Zero	5	2	<1

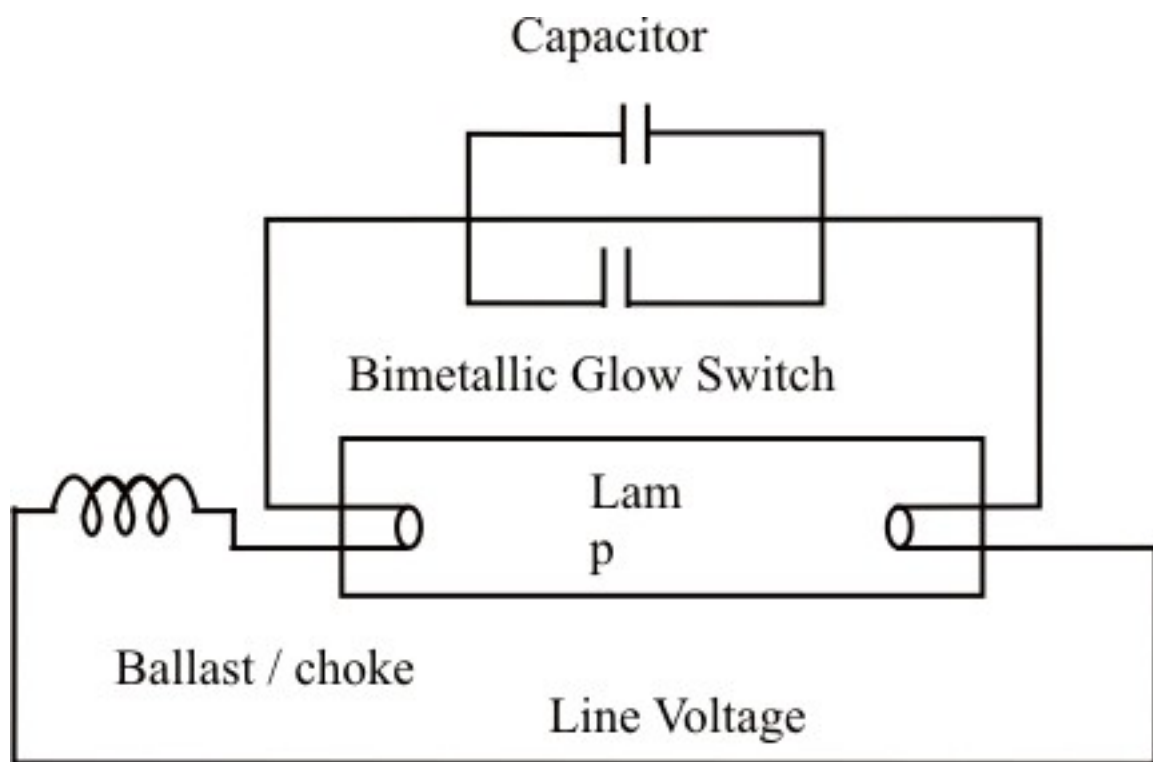
Table I lists various properties associated with various types of discharge lamps.

## Fluorescent Lamp

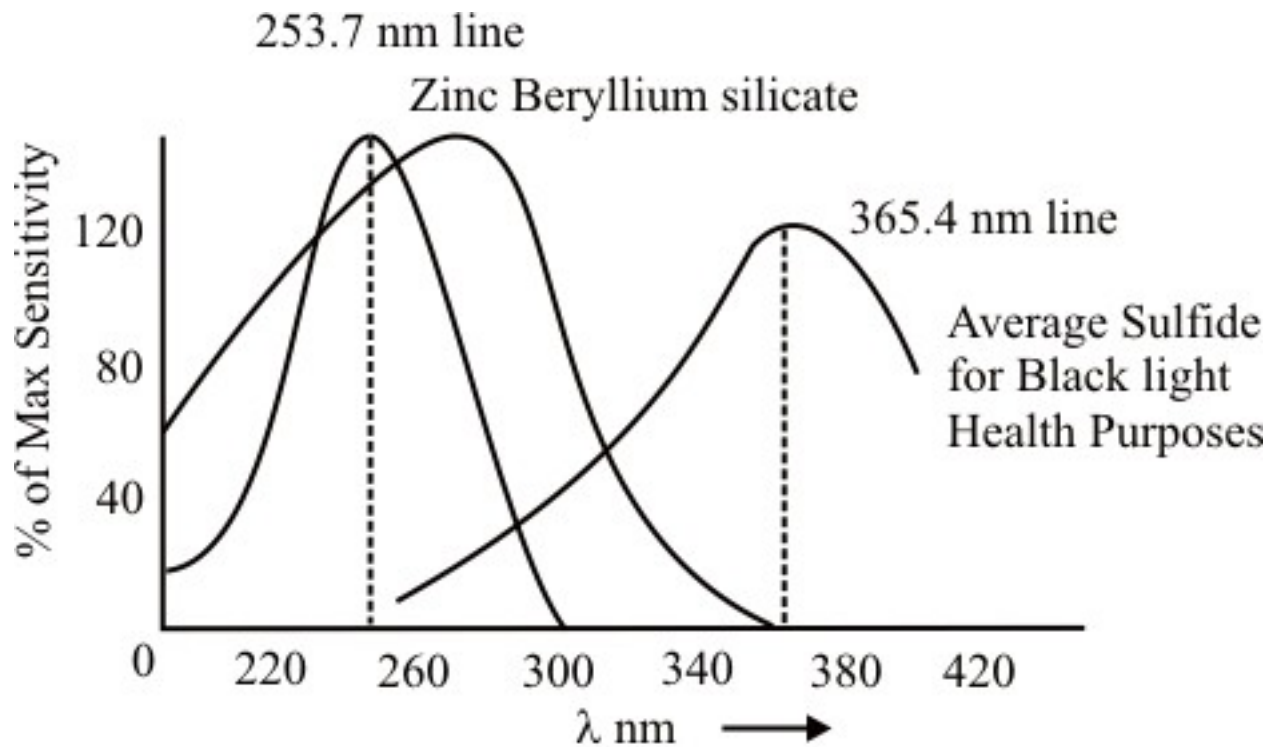
Employs transformation of UV radiation due to low pressure mercury vapor. Luminescent Powder in tubular vapor Lamps Enhances brilliancy of light. Radiation from Low Pressure Mercury Vapor (which is in UV region) is impinged on Luminescent Materials and re – radiated at longer wavelengths of visible spectrum. In a Glass Tube small drop of Mercury and small amount of Argon gas are placed for initiation of discharge. Pressure, voltage and current are so adjusted that 253.7 nm line is excited. This re-radiates at longer wavelength. Typically a 40W lamp requires 2-3g of phosphors. Maximum sensitivity is around 250 – 260 nm. Various types of Fluorescent Lamps are:

1. Day Light Fluorescent Lamps  
- Average Noon Day Light. 6500°k suitable where demands are not exacting
2. Standard white Light - 3500°k general Lighting.
3. 4500°k white Lamp – between std. white Light & Day Light Lamp.
4. Soft white Lamp – Pinker Light. 25% lower light output than Std. white Lamp suitable for Residential lighting and Restaurants.

Dimension and Voltage depend on Luminous Efficacy, Brightness, Lumen Output and Lumen Maintenance. Reliable Starting is achieved by having preheated cathodes / hot cathode. Half the open circuit voltage should be used by the Lamp and the other half by the ballast. Lamp Voltage decides the arc length, bulb diameter and lamp current. Hot Cathode lamps operate at lower voltage < cold Cathode lamps. Typically cold cathodes have 70-100V drop at the cathode.



**Fig. 1: Fluorescent Lamp**



**Fig. 2: Response of Phosphors**

Figure1 shows the schematic of a typical Fluorescent lamp. In a normal lamp the ratio of open circuit voltage to lamp voltage drop is 2 where as in an instant start lamp it is around 4.

Figure2 shows the radiation sensitivity of various phosphors. As may be observed, the peak sensitivity at 253.7 nm is for Zinc Beryllium Sulphate. Table 2 lists various phosphor properties. For each material emitted color after fluorescence, range of emission, peak emission wavelength and peak sensitivity are listed. It may be observed that Zinc Beryllium Silicate has peak emission coinciding with peak eye sensitivity. Hence this is the most commonly employed phosphor.

**Table 2 Characteristics of Fluorescent Chemicals**

<b>Phosphors</b>	<b>Color</b>	<b>Exciting Rang nm</b>	<b>Sensitivity Peak nm</b>	<b>Emitted Range nm</b>	<b>Emitted Peak nm</b>
<b>Calcium Tungstate</b>	<b>Blue</b>	<b>220-300</b>	<b>272</b>	<b>310-700</b>	<b>440</b>
<b>Magnesium Tungstate</b>	<b>Blue – white</b>	<b>220-320</b>	<b>285</b>	<b>360-720</b>	<b>480</b>
<b>Zinc. SiliCate</b>	<b>Green</b>	<b>220-296</b>	<b>253.7</b>	<b>460-640</b>	<b>525</b>
<b>Zinc Beryllium silicate</b>	<b>Yellow white</b>	<b>220-300</b>	<b>253.7</b>	<b>480-750</b>	<b>595</b>
<b>Cadmium Silicate</b>	<b>Yellow Pink</b>	<b>220-300</b>	<b>240</b>	<b>480-740</b>	<b>595</b>
<b>Cadmium Borate</b>	<b>Pink</b>	<b>220-360</b>	<b>250</b>	<b>520-750</b>	<b>615</b>

## Lecture Summary

- LP Na-vapor Lamp – in this type of lamp the outer envelope of inner surface is coated with Indium Oxide & that acts as an IR – reflector
- HP Hg-vapor Lamp – gives rise to bluish white line spectrum, together with some phosphors improves color
- If some luminescent powder is put in the tubular lamps it enhances brilliancy of light
- Radiation from LP Hg-vapor lamp (which is in the UV-region) is impinged on luminescent materials to reradiate at longer wavelength of visible spectrum
- Types of Fluorescent Lamps :
  - Day Light Lamp
  - Standard White Lamp
  - Soft White Lamp
- Factors deciding the dimension of fluorescent lamps :
  - luminous efficiency
  - brightness
  - lumen output
  - lumen maintenance
  - reliable starting
- Factors deciding the lamp voltage :
  - arc length
  - bulb diameter
  - lamp current

## Tutorial Questions

- What are halide lamps?

These discharge lamps contain some additives like Indium, Thallium

- Why are Hg-vapor lamps preferred than Na-lamps?

Hg-vapor lamps have a good CRI while Na-vapor lamps are monochrome

- Describe the working principle of a fluorescent lamp.

The energy of the UV radiation from a LP Hg-vapor lamp is directed on luminescent materials. These in turn give out radiations in the visible region.

- For what wavelength do we get maximum efficiency for a fluorescent lamp?

Maximum sensitivity is achieved at 253.7 nm

- How do we obtain reliable starting of a fluorescent lamp?

By having preheated cathodes or hot cathodes

- What are the voltage drop at the electrodes & the choke for a fluorescent lamp?

At the choke the voltage drop is half the operating voltage. If the cathode is a hot electrode type then voltage drop is 14 – 16 V and if it is a cold cathode type then voltage drop is 70 – 100 V.