

Module 2 Lamps

Lesson 10

Discharge Lamp III

Instructional Objectives

1. How are Fluorescent Lamps specified.
2. Understand how every watt of Power is spent in a fluorescent lamp.
3. State Various applications of UV Light
4. What are CFLs?
5. How do CFLs compare with Ordinary Lamps?

Discharge Lamps (contd.)

Continuing with our discussion on Fluorescent lamps, for a given Current & tube diameter, Voltage Increases as length increases, Voltage Decreases as Diameter increases and Voltage Decreases as Current increases. In other words the ratio of length to diameter remains a constant. Inherently brightness is more at the ends. It is low 6-7 diameters from the end. They are specified as T_x , where x denotes that diameter and is $x/8$ inches. Typically Hot Cathode lamps have 14-16V voltage drop at Cathode, while Cold cathode lamps have 70-100V drop at cathode. Further, radiation increases with the current density. At low temperatures, pressure drops and Mercury tends to condense. To avoid prefer to operate at high temperatures.

Bulb Temperature Vs Light output

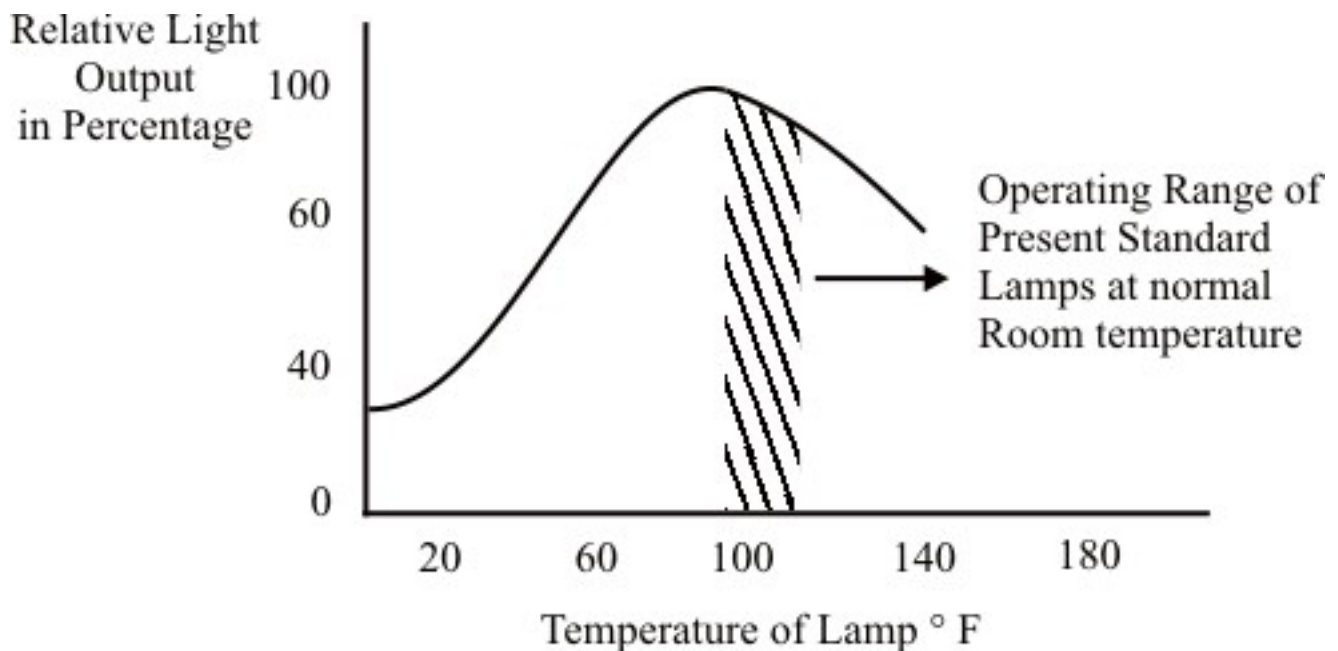


Figure 1: Bulb temperature vs output

Fig 1 shows the variation of light output with bulb temperature. Shaded region indicates normal operation at room temperature. It is seen to have a peak around 100° F.

Fig 2 shows the relative efficiency of a 1.5" dia lamp ($\approx T_{12}$) lamp, with tub length. As may be seen about 80" – 100" are necessary to get a reasonably good light output.

Having understood functioning and characteristic of a fluorescent lamp, it is time, we looked at the energy distribution.

Relative Efficiency of 1.5" Diameter Lamp

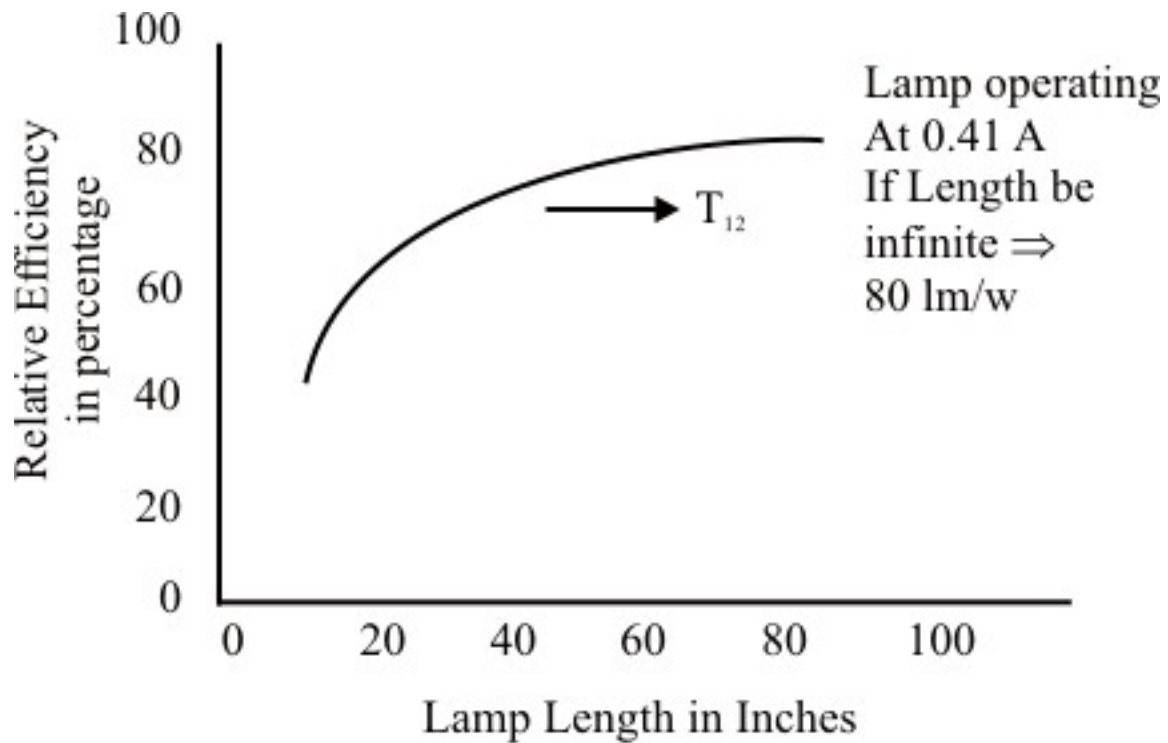


Figure 2: Relative Efficiency of 1.5" Diameter Lamp

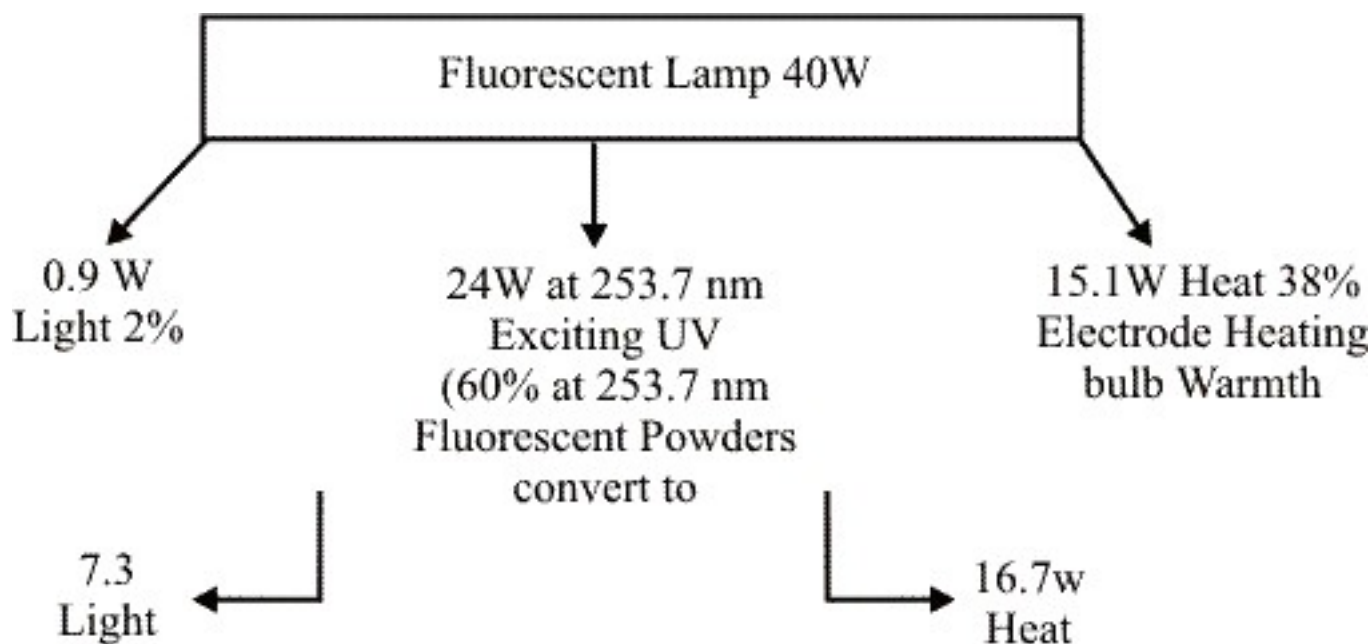


Figure 3: Energy Distribution of 40W Fluorescent Lamp

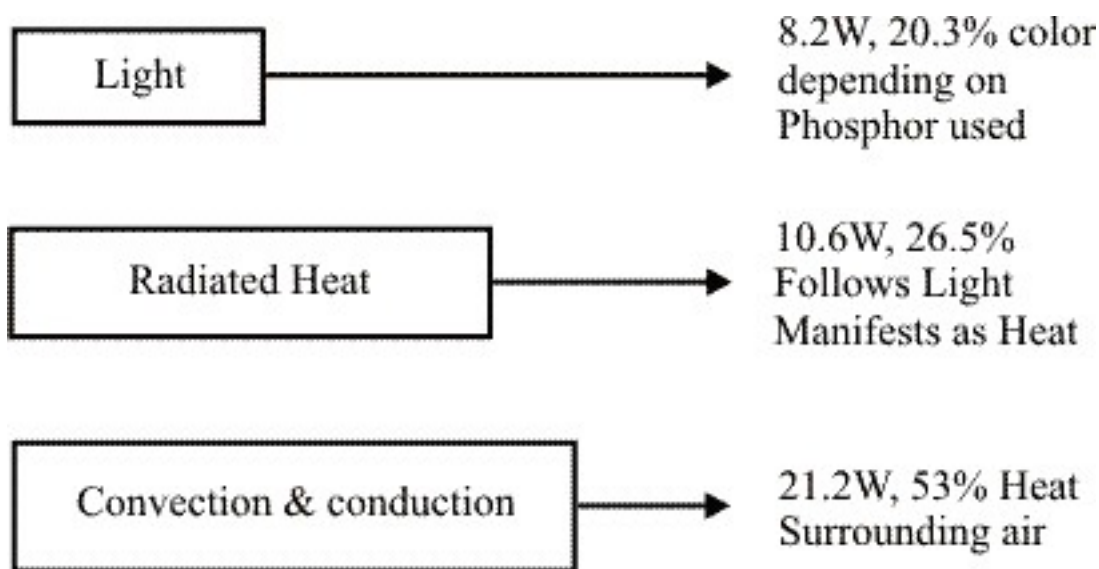


Figure 4: Energy Distribution as Lights heat

As may be seen from Fig 3, which shows the energy distribution of a typical 40 W Fluorescent Lamp, about 20.30% results in useful light output. About 26% is radiated as heat and 53 % results in conductive and convective heat. Important observation to be made is that about 18% light output is through fluorescence. This is the reason; we say that they are more efficient than incandescent lamps.

UV radiation apart from being used to illuminate employing fluorescence is also used for Purification, Detoxifying Bacteria, Curing of Rickets, Colds, TB, and Pernicious Anemia.

Ultraviolet radiation is beneficial in small quantities but direct exposure to heart kidneys should always be avoided. In industry it is used for production of Dyes and Food Preservation. UV radiation helps in producing Vitamin 'D' in Food Sources in Plants and Animals. Various peak sensitivities for different applications are:

1. Germicidal – 260 nm Peak.
2. Erythemal – 296 nm Peak.
3. Fluorescent / Black light – 253.7 nm Peak.

Figs. 5, 6, 7 show typical characteristics of the fluorescent lamps. From Fig 5 it is quite clear that mere increase of current does not guarantee increase in light output.

Fig 6 tells us that one can expect about 2000hr of life with about 80% of nominal output light.

Mortality curve in Fig 7 tells us that close to 80% lamps have more than 80% nominal life. This helps us in arriving at a clear lamp replacement policy.

Fig 8 shows a typical CFL or Compact Fluorescent lamp which is compact with all accessories, with fixture so arranged as to fit in an outlet meant for an incandescent lamp.

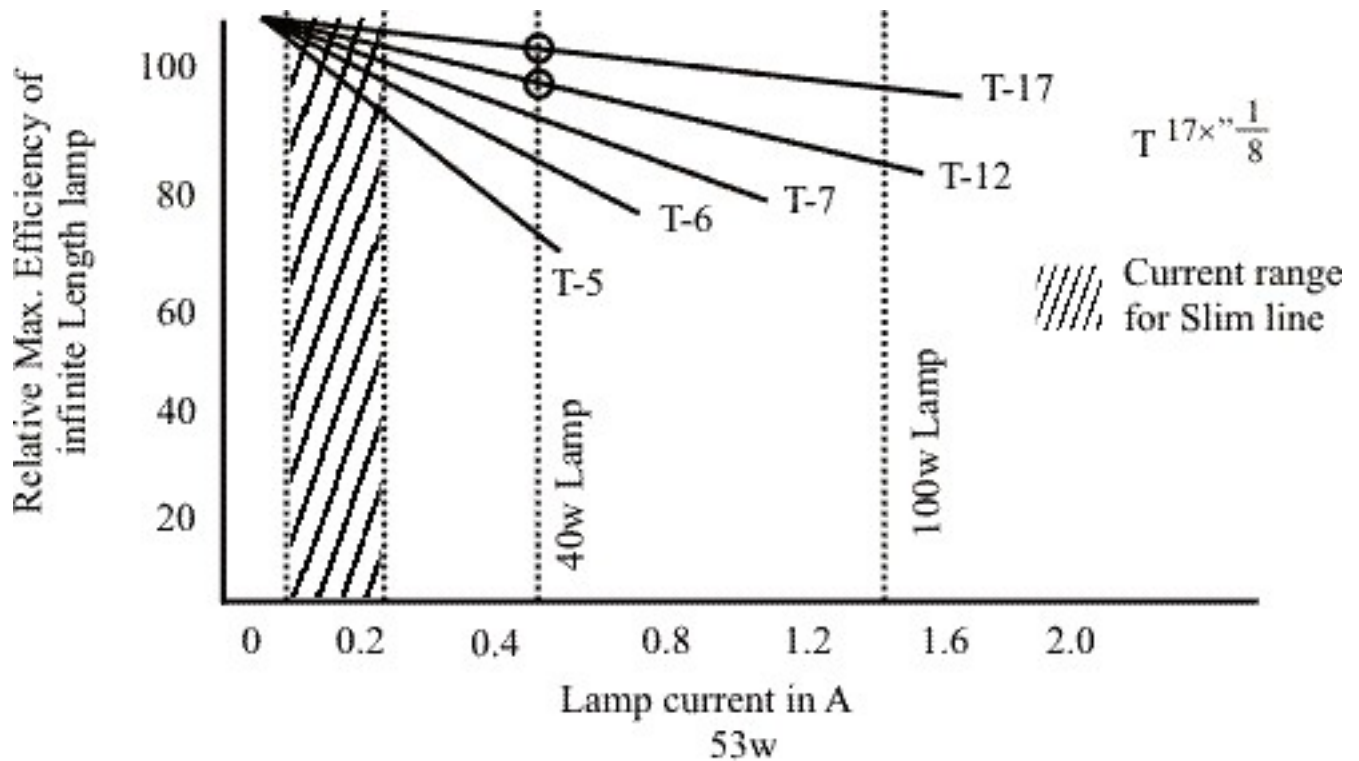


Figure 5: Fluorescent Lamp Characteristics

Lumen Maintenance Curve

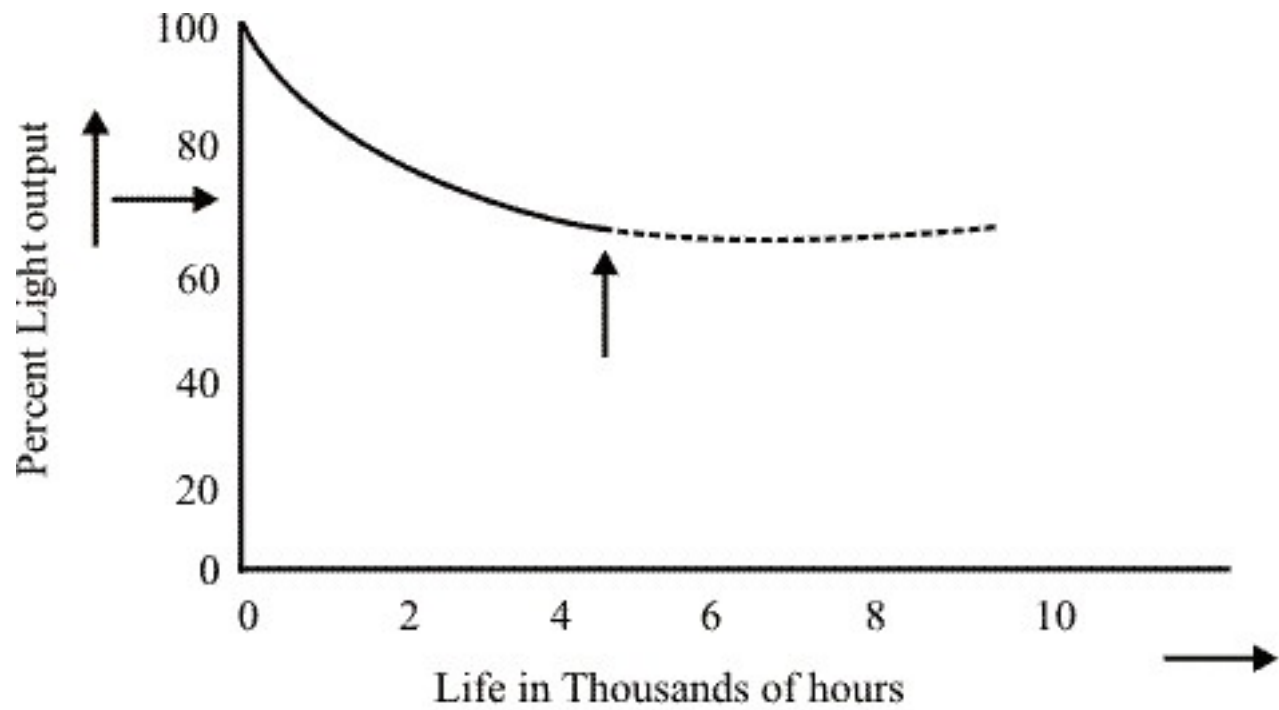


Figure 6: Lumen Maintenance Curve

Fluorescent Lamp Mortality Curve

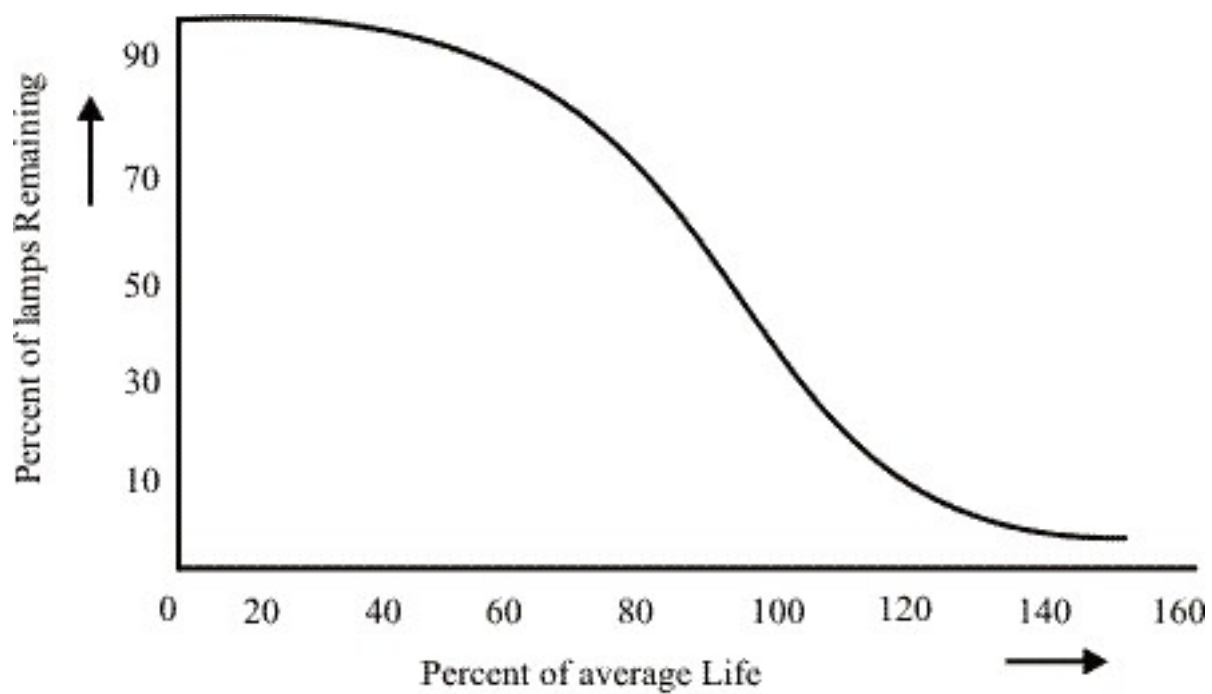


Figure 7: Lamp Mortality Curve

Table 1 compares the characteristics of various fluorescent lamps.

Table 1: Properties of Fluorescent Lamps

Conventional	Energy Saving	CFL
150-5300 lm		600-4800 lm
38-91 lm/W		
4-65W	24-28W	9-55W
Warm white color	- 54W	
Excellent Color Rendering	Good CR	Good CR
Choke additional	Inbuilt	Inbuilt
Zero Run up time		
Zero Restrike time		
5000 hrs.	18000 Hrs	8000 hr
Rs.400/-	Rs. 1000/-	
Rs. 40/-	20 mm	
38 mm, 28-26 mm		

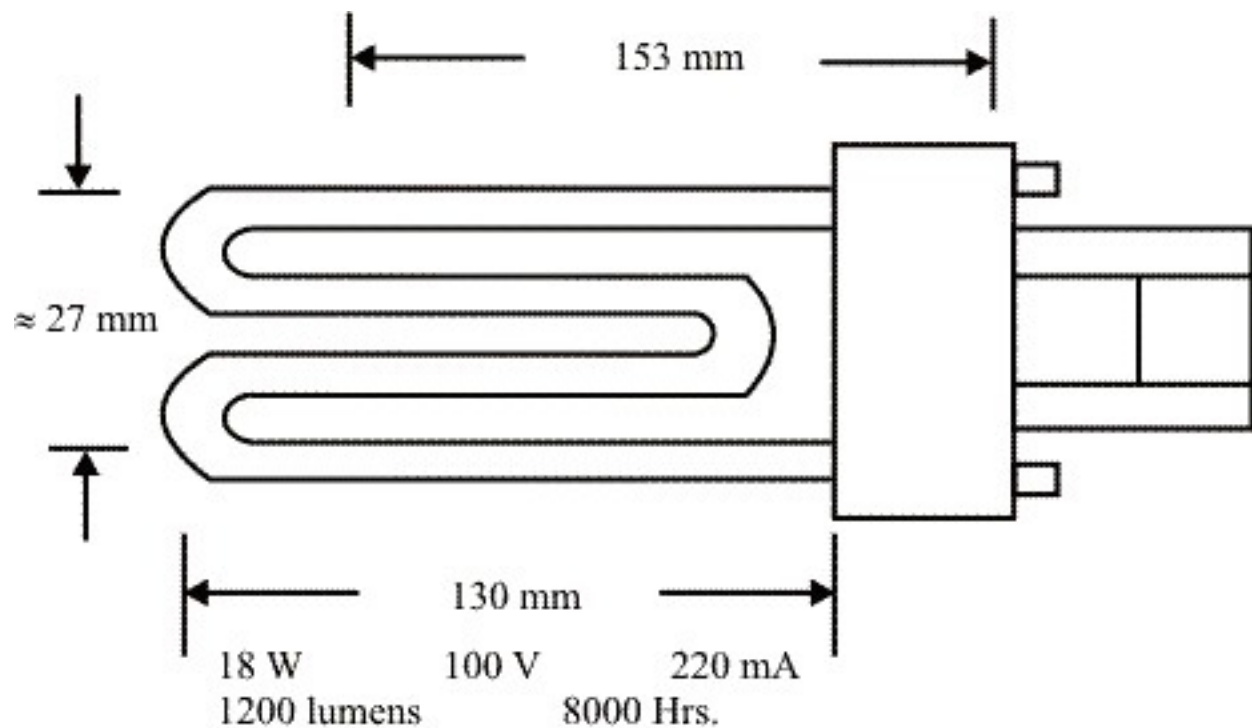


Figure 8: Typical CFL

In addition there are RS or rapid start lamps where electrodes are continuously heated. For instant start, preheated cathodes with reasonably high starting voltage are used. In Explosive environments lamp caps thick with long pins having maximum surface contact are used to avoid sparks.

This lesson has had a look at the characteristics of fluorescent lamps.

Lecture Summary

- Fluorescent lamps are LP Hg-vapor lamps
- For a given current & tube diameter of fluorescent lamp we have :
 - voltage is directly proportional to length
 - voltage is inversely proportional to diameter
 - voltage is inversely proportional to current through discharge tube
- By a T₁₂ fluorescent tube we mean that a tube with diameter of $12 \times (1/8)" = 1.5"$
- Radiation output from a fluorescent tube is directly proportional to the current density in the tube.
- Fluorescent lamps emit a considerable amount of UV & IR radiation along with visible radiation
- UV radiations is beneficial in small quantities. Applications of UV radiation:
 - purification
 - detoxifying bacteria
 - curing of diseases
 - dye & food processing
 - employed in producing Vitamin-D in food sources

- Compact Fluorescent Lamps (CFL) are compact, efficient, energy saving, higher lifetime, reasonably good CRI & near daylight illumination characteristics. Moreover they have all the accessories inbuilt. Hence they are better than common fluorescent lamps

Tutorial Questions

- What do you mean by a T16 tube light?

By a T16 fluorescent tube we mean that a tube with diameter of $16 \times (1/8)' = 2''$

- Why is hot cathode discharge tube preferred than cold cathode discharge tube?

Hot cathode has a voltage drop of 14-16 V whereas cold cathode has a voltage drop of 70-100 V. hence to avoid large voltage drop hot cathode is preferred

- Why is it desirable to operate fluorescent tubes at room temp.?

At low temp., pressure drops & Hg tends to condense while it is unsafe to operate at extreme high temp. Hence fluorescent tubes are operated at around room temp.

- What are three categories of usage of UV radiation?

- Germicidal
- Erythema
- Fluorescent / Black Light

- What are rapid start & instant start fluorescent lamps?

- in rapid start, filaments are heated continuously
- in instant start, preheated cathode is present

- What precautions are taken to use fluorescent lamps in explosive environments?

Lamp caps are present and long thick pins are used to offer maximum surface contacts thereby avoiding sparks