

PART 2



ELECTRICAL LIGHTING MATERIALS

INCANDESCENT LAMP

- has a wide variety of forms, sizes and shapes
- its base is made of different types and design
- the types of lamps are critically dependent on the wattage
- very sensitive to voltage change, eventually affecting the life span.
- at an average of 10% lower voltage supply, its life span is increased by 25% while with 10% over voltage supply, the life span is reduced to 75%.
- less than 10% of the wattage is utilized to produce light and the rest produce heat

Advantages of Incandescent Lamps

- ✓ It is cheaper
- ✓ Instant start and re-start
- ✓ Simple inexpensive dimming
- ✓ Simple and compact installation requiring no accessories
- ✓ It is focusable
- ✓ High power factor
- ✓ It's life is independent of number of start
- ✓ It has a good color

Disadvantages of Incandescent Lamps

- ❖ Has a low efficacy
- ❖ Has shorter life
- ❖ Sensitive and critical on voltage change or fluctuations
- ❖ High maintenance cost
- ❖ Larger heat is being produced

Applications of Incandescent Lamp

- Infrequent or short duration
- Where low cost dimming is necessary
- In focusing fixtures
- Where minimum initial cost is required

FLUORESCENT LAMPS

- ⚡ Was introduced in 1937
- ⚡ Is the best and widely used type of lamp
- ⚡ It requires ballast in its circuit
- ⚡ The ballast is made up of coil with a purpose to limit the current in the circuit which if not controlled will open the fuse or the circuit breaker

Characteristics of Fluorescent Lamp

- ☞ The fluorescent lamp efficacy is much higher than the incandescent lamp
- ☞ About 20% of its input energy becomes light and 80% is converted to heat including the ballast heat energy loss

Efficiency – refers to the amount of energy converted to visible light

Efficacy – is a measure of the lumens per watt produced by the lamp

Preheat Fluorescent Lamp

- ✘ The original fluorescent lamp is the preheated design
- ✘ The circuit use is a separate starter
- ✘ When the lamp circuit is closed, the starter energizes the cathode
- ✘ After 2 to 5 seconds delay, it initiates a high voltage arc across the lamp causing it to start
- ✘ F 20 T 12 WW

Meaning:

F – Fluorescent

20 – 20 watts, tubular shaped bulb

12/8 – 12/8 inches diameter

WW – Warm and White Color

Rapid Start Fluorescent Lamp

- Was introduced in 1952 and called rapid start/preheat lamp
- Eliminates the delay inherent in preheat circuits by constantly keeping the cathodes energized or preheated.
- Disadvantages are it produces glaring light and has very limited application
- F 48 T 12/CW/VHO
 - F – fluorescent, 48 in. long
 - T – tubular 12/8 in. diameter bulb
 - CW/VHO – Cool, White, Very High Output

Instant Start Fluorescent Lamps

- It was introduced in 1944 and called Slimline Lamps
- It has only one pin at each end which acts as a switch to break the ballast circuit when the tube is removed
- More expensive than the rapid start type
- Has the advantage of starting at a much lower ambient temperatures than the rapid start circuits.
- More applicable to outdoor installations
 - F42T6CW
 - Fluorescent lamp, 42 inches long
 - Tubular 6/8 in. diameter
 - Cool White instant start

Cold Cathode Tube

- Have a very long life compared with the hot cathode lamps
- It is not affected by the number of starting or switching
- Cold cathode lamps has a lower overall efficiency than the hot cathode type and is normally used where long continuous burning is required

Characteristics and Operation of Fluorescent Lamp

- ✓ Life Span – The lamp life of these type of lamps depends on the burning hours per start
- ✓ Lumen Output – The lumen output of a fluorescent lamp decreases rapidly during the first 100 hours of burning and thereafter, much more slowly
- ✓ Efficacy – The efficacy of the fluorescent lamp depends on the operating current and the phosphors utilized

MERCURY LAMPS

- ❖ Is a combination of the arc discharge characteristics of a fluorescent lamp and the compact focusable shape of an incandescent lamp
- ❖ These combination effect is responsible for its efficiency and long life in various uses
- ❖ Mercury lamp is a high pressure mercury vapor lamp while fluorescent lamp is a low pressure lamp
- ❖ The efficacy of a clear mercury lamp is almost the same as that of a fluorescent lamp

MERCURY LAMPS

❖ H38MP100DX

H – Mercury lamp

38 – Ballast number

MP – Lamp physical characteristics

100 – Lamp wattage

DX – Indicates phosphors, glass coating or coloring

Special Feature of Mercury Lamp

- It is available in wide variety of shape, sizes, and colors with rating from 50 to 150 watts
- It requires ballast which could be mounted away from the lamp
- Because of its high efficiency, mercury lamp is a good replacement for incandescent lamp in the conservation of energy.
- Dimming of mercury lamp is possible with a dimming ballast

Lamp Life of Mercury Lamp

- The lamp life is extremely long with an average of 24,000 plus hours based on 10 burning hours per start
- This type of lamp is not suitable for installation subject to constant switching
- The life of the lamp is affected by:
 - Ambient Temperature
 - Line Voltage
 - Ballast Design
- Lamp is replaced if accelerated lumens depreciation near the ends of its life span
- Clear lamps have the best lumen maintenance followed by the color improved and phosphors coated units

The Ballast

- ✓ It is necessary to start the lamp and thereafter to control the arc
- ✓ Is a simple reactor which controls the arc after the discharge has been initiated
- ✓ In order to reach a full output, the lamp requires 3 to 6 minutes after switch on

Types of Ballast

- ❑ Reactor Ballast – is a low power factor and does not require voltage regulation. This is only used where line voltage fluctuation does not exceed plus or minus 5%
- ❑ Autotransformer Ballast – is a reactor unit with transformer to match line voltage. It has a low power factor and non-regulating
- ❑ High Power Factor (pf) Autotransformer Ballast – is the same as type 2 except the additional capacitor to improve the pf
- ❑ Constant Wattage Autotransformer Ballast – is also called Lead Circuit Ballast. A regulating high power factor unit that maintains lamp voltage making the wattage and lumen output constant. The lamp wattage varies from 5% with a 10% voltage change

Special Mercury Lamp

- A small mercury lamp to replace interior incandescent lamps
- Available in 40, 50, 75 to 100 and 175 watts sizes in deluxe white and other color corrected design
- Also available are self ballasted lamps

METAL HALIDE LAMPS

- ✿ Basically, are mercury lamps which have been altered by the addition of metals such as thallium, indium, or sodium to the arc tube
- ✿ Such addition of these salts, makes the light radiate other than the basic mercury colors and at the same instance increases its efficacy but reduces the life and lumens maintenance to about 60% at third life
- ✿ The color produced is much warmer than that of the mercury light.

Recommended Application of Metal Halide

- For exterior use, clear lamps are recommended
- For Indoor use, the phosphor coated units are recommended including lights for food display

HIGH PRESSURE SODIUM LAMPS

- ✓ Was first developed and introduced by General Electric Co.
- ✓ It is marketed under the trade name Lucalox, Ceramalux and Analux
- ✓ The efficacy including ballast losses is almost 100 lm/watt which is double that of a color corrected mercury lamp
- ✓ It has a yellowish color similar to a low wattage incandescent lamp and a warm white fluorescent lamp
- ✓ It is small in size, high output and longer life
- ✓ The start and re-strike time is required is shorter
- ✓ Not sensitive to voltage change
- ✓ Its color is constant

LOW PRESSURE SODIUM LAMPS

- Are also called SOX
- It produces light of sodium characteristics monochromatic deep yellow color
- Not applicable for general lighting because of its very high efficacy of over 150 lumens per watt including ballast loss
- It can be used wherever color is not an important criteria
- Is widely used on street, road and area lighting and for emergency or after hours indoor lighting
- Has 100% lumen maintenance
- Long life which could last for 18,000 or more hours, making it the most economical source in terms of cost per million lumens produced.

TUNGSTEN – HALOGEN LAMPS

- ✓ Is usually called Quartz Lamp
- ✓ It is special type of incandescent lamp
- ✓ One of its advantage over normal incandescent lamp is its ability to maintain a constant level of light output throughout its life
- ✓ The life span of a quartz lamp is about three to four times that of the life of a normal incandescent lamp
- ✓ 13% of its wattage produce light and 87% produce heat
- ✓ It is more efficient than an incandescent lamp

LIGHTING FIXTURES

- Are electrical devices designed to hold and connect the lamps to the power supply as well as to control and distribute the light, and to position and protect the lamp
- Purpose:
 - ✓ Lampholders
 - ✓ Reflectors or Shields
 - ✓ Diffusers

COMPACT FLUORESCENT LAMP

Compact Fluorescent Lamps (CFL) are produced for both alternating current (AC) and direct current (DC) input.



DC CFLs are popular for use in recreational vehicles and off-the-grid housing.

The term **off the grid** or off-grid refers to living in a self-sufficient manner without reliance on one or more public utilities.

In North American English the term **recreational vehicle**, and its acronym **RV**, refer to an enclosed piece of equipment dually used as both a vehicle and a temporary travel home. They are also called **motor home** and **motor caravan**



Some families in developing countries are using DC CFLs (with car batteries and small solar panels) and/or wind generators, to replace kerosene lanterns.



CFLs can also be operated with solar powered street lights, using solar panels located on the top or sides of a pole and luminaires that are specially wired to use the lamps.



DESIGN AND APPLICATION ISSUES

In the Philippines



- President Gloria Macapagal Arroyo called for a ban of incandescent light bulbs by 2010 in favor of more energy-efficient fluorescent globes to help cut greenhouse gas emissions and household costs during her closing remarks at the Philippine Energy Summit.
- Once put in effect, the country will be the first in Asia to ban incandescent bulbs.

The primary purposes of CFL design:

- High electrical efficiency
- Durability

Some other areas of CFL design and operation that are problematic:

Quality of light:

- A phosphor emits light in a narrow frequency range, unlike an incandescent filament, which emits the full spectrum, though not all colors equally, of visible light.
- A mix of phosphors gives a good approximation of daylight
- Every extra phosphor added to the coating mix causes a loss of efficiency and increased cost.
- Good quality consumer CFLs use three or four phosphors to achieve a 'white' light

Size:

- CFL light output is roughly proportional to phosphor surface area
- High output CFLs are often larger than their incandescent equivalents
- This means that the CFL may not fit well in existing light fixtures

End of life:

- The electronic ballast may fail since it has a number of component parts
- Such failures may be accompanied by discoloration or distortion of the ballast enclosure, odors, or smoke
- The lamps are internally protected and are meant to fail safely at the end of their lives
- Industry associations are working toward advising consumers of the different failure mode of CFLs compared to incandescent lamps, and to develop lamps with inoffensive failure modes

Dimming:

- Using regular CFLs with a dimmer can shorten bulb life and will void the warranty of certain manufacturers.
- The dimming range of CFL is usually between 20% and 90%.
- Dimmable CFLs are not a 100% replacement for incandescent fixtures that are dimmed for "mood scenes" such as wall sconces in a dining area.
- Below the 20% limit, the lamp remain at the approximate 20% level, in other cases it may flicker or the starter circuitry may stop and restart.
- Above the 80% dim limit, the bulb will generally glow at 100% brightness.
- Dimmable CFLs have a higher purchase cost than standard CFLs due to the additional circuitry required for dimming.
- A further limitation is that multiple dimmable CFLs on the same dimmer switch may not appear to be at the same brightness level.

Heat:

- CFLs get warm in operation, so some CFLs are labelled not to be run base up, since heat will shorten the ballast's lifetime.
- Some CFLs are unsuitable for use in pendant lamps and especially unsuitable for recessed lighting fixtures.
- CFLs intended for use in such fixtures are available.
- Current recommendations for fully enclosed, unventilated light fixtures (such as those recessed into insulated ceilings), are either to use 'reflector CFLs' (R-CFL) or to replace such fixtures with those designed for CFLs.

Time to achieve full brightness:

- Compact fluorescent lamps may provide as little as 50-80% of their rated light output at initial switch on
- Take up to three minutes to warm up
- Color cast may be slightly different immediately after being turned on
- This compares to around 0.1 seconds for incandescent lamps
- It is more of a problem with older lamps, 'warm (color) tone' lamps and at low ambient temperatures.

Infrared signals:

- Electronic devices operated by infrared remote control can interpret the infrared light emitted by CFLs
- A signal limiting the use of CFLs near televisions, radios, remote controls, or mobile phones.

Audible noise:

- CFLs, much as other fluorescent lights, may emit a buzzing sound
- Such sounds are particularly noticeable in quiet rooms, and can be annoying under these circumstances
- Newer compact fluorescent light bulbs are nearly noiseless, but some poorly made CFLs may still emit a buzzing sound.

Use with timers:

- Electronic (but not mechanical) timers can interfere with the electronic ballast in CFLs and can shorten their lifespan.

Fire hazard:

- Inferior quality electronic components used in some CFLs can cause excessive heat or fire

Outdoor use:

- CFLs that are not designed for outdoor use may perform poorly in cold weather
- CFLs are available with cold-weather ballasts, which may be rated to as low as -23°C (-10°F)
- Standard compact fluorescents will fail to operate at low temperatures
- Light output drops at low temperatures.

Differences among manufacturers:

- There are large differences among quality of light, cost, and turn-on time among different manufacturers, even for lamps that appear identical and have the same color temperature.

CFL Comparison with Incandescent Lamps

- Lifespan
- Energy efficiency
- Cost
- Starting Time



LIFESPAN

- The average rated life of a CFL is between 8 and 15 times that of incandescent.
- Typically have a rated lifespan of between 6,000 and 15,000 hours
- Significantly shorter if it is only turned on for a few minutes at a time
- In the case of a 5-minute on/off cycle the lifespan of a CFL can be up to 85% shorter, reducing its lifespan to the level of an incandescent lamp.
- Produce less light later in their life than they do at the start.
- The light output depreciation is exponential, with the fastest losses being soon after the lamp was first used
- Leave them on at least 15 minutes at a time

LIFESPAN

Incandescent Lamp

- Usually manufactured to have a lifespan of 750 hours or 1,000 hours.
- Some incandescent bulbs with long rated life spans of 20,000 hours have reduced light output.

Factors that Affect the Lifespan

- Operating voltage
- Manufacturing defects
- Exposure to voltage spikes
- Mechanical shock
- Frequency of cycling on and off
- Lamp orientation
- Ambient operating temperature

ENERGY EFFICIENCY

- For a given light output, CFLs use between one fifth and one third of the power (measured in watts) of an equivalent incandescent lamp.
- CFLs could save as much as 7% from household usage.
- The typical incandescent lamp waste 90 percent of the energy it uses, producing heat rather than light.

- If incandescent lamps are replaced by CFLs, the heat produced by the building's lighting system will be reduced
- At times when the building requires both heating and lighting, the building's central heating system will then supply the heat
- If the building requires both illumination and cooling, then CFLs will use less electricity themselves and will also reduce the load on the cooling system compared to incandescent lamps

- This results in two concurrent savings, and since most air conditioners are also electrically powered, they are directly comparable.

Compact Fluorescent Lamp (CFL) Performance

750 - 1000 hours

520 lumens

50 watts

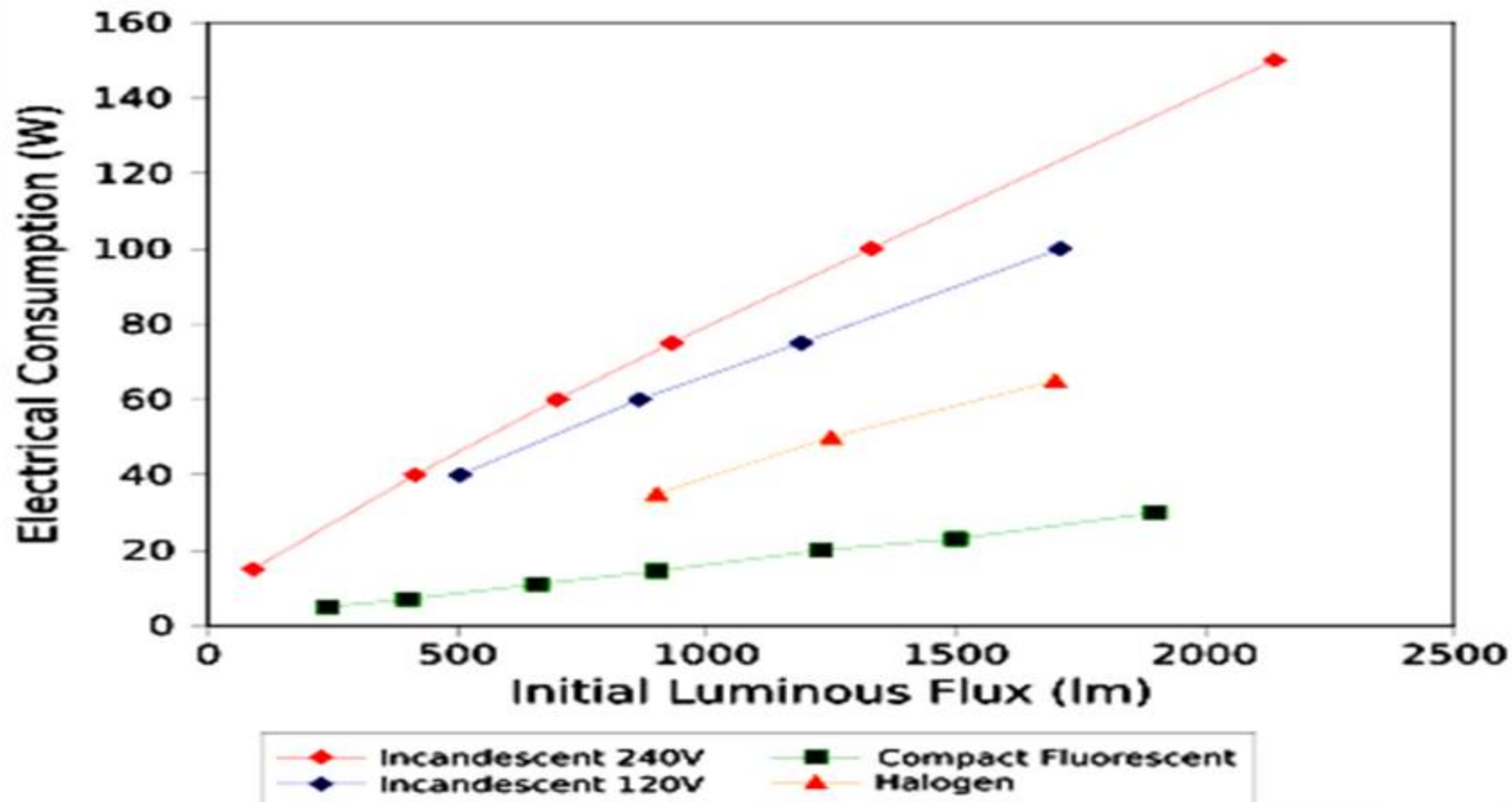


5000 - 10000 hours

500 lumens

10 watts

Electricity Use by Bulb Type



Cost

- a CFL is typically 3 to 10 times greater than that of an equivalent incandescent lamp.
- CFLs are extremely cost-effective in commercial buildings.
- lower energy use will compensate for the higher initial cost in many applications

Cost

SAVINGS CHART - QUALITY CFL vs. QUALITY INCANDESCENT BULB

	INCANDESCENT BULB	COMPACT FLUORESCENT LAMP
Input Power, watts	100 W	20 W
Cost of First Lamp, Php	21.00 Php	150.00 Php
No. of Lamp Replacements, units	5 units	0
Replacement Cost	105.00 Php	0
Energy Cost	5,298.00 Php	1,060.00 Php
Total Energy & Lamp Cost	5,424.00 Php	1,210.00 Php
Net Savings		
Cost, Php		4,214.50 Php
Demand, kW/unit		0.080 kW/unit
Consumption, kWh		480 kWh
Greenhouse Gas (GHG)		285 kg CO ₂ e

Assumptions: a. Quality incandescent bulbs last 1,000 hours per unit

b. Quality CFLs last 6,000 hours per unit, have high efficacy for proper lumen equivalence

c. Residential energy cost projected at P8.83/ kWh (as of June 2005)

Starting time

- CFL
 - CFLs take a perceptible time to achieve full brightness, and can take much longer in very cold temperatures.
 - Certain styles of lamp using a mercury can take up to three minutes to reach full output.

Starting time



- Incandescent Lamp

- Incandescents give light almost immediately upon the application of voltage.

- more attractive for applications such as outdoor or motion-activated lighting.

COMPACT FLOURESCENT LAMP



Other CFL technologies

Other CFL technologies

- Another type of fluorescent lamp is the Electrodeless lamp, known as a radiofluorescent lamp or fluorescent induction lamp.
- These lamps have no wire conductors penetrating their envelopes, and instead excite mercury vapor using a radio-frequency oscillator.

Other CFL technologies

- Some manufacturers make CFL bulbs with an external nano-particle coating of titanium dioxide.
- The manufacturer claims that the titanium dioxide when exposed to UV light produced by the CFL can neutralize odors and kill bacteria, viruses, and mold spores.

Other CFL technologies

- The Cold Cathode Fluorescent Lamp (CCFL) is one of the newest forms of CFL.
- CCFLs use electrodes without a filament.
- The voltage of CCFLs is about 5 times higher than CFLs and the current is about 10 times lower.
- CCFLs have a diameter of about 3 millimeters.
- CCFLs were initially used for backlighting LCD displays, but they are now also manufactured for use as lamps.
- The efficacy (lumens/watt) is about half that of CFLs.

Other CFL technologies

- Their advantages are that they are instant-on, like incandescent,
- They are compatible with timers, photocells and dimmers, and they have a long life of approximately 50,000 hours.
- CCFLs are a convenient transition technology for those who are not comfortable with the short lag time associated with the initial lighting of CFLs.
- They are also an effective and efficient replacement for lighting that is turned on and off frequently with little extended use (e.g. a bathroom or closet).

Thank You!

