

Impact of Compact Fluorescent Lamps on Human Being and Environment

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Abstract: The desire to reduce electrical loading by using energy efficient lighting has resulted in replacement of conventional incandescent lamp with compact fluorescent lamps (CFLs). The use of compact fluorescent lamps is increases day by day in our country. However, every blessing is accompanied with evil things. Exactly in the same way if the excessive use of compact fluorescent lamps is not checked then it can lead to some disastrous and hazardous consequences on this ecosystem as well as on human beings. In this paper hazardous and unexpected consequences of CFLs have been described. An attempt has been made to create awareness regarding harmful effects of using CFLs in large numbers.

Keywords: Compacts fluorescent lamps, bio accumulating process and effect of mercury.

I. INTRODUCTION

With a continuous surge in the demand of electricity since the last decade or so, a huge gap has been created between the demand and supply sides as the generation of power is becoming cumbersome because the price of mineral oil which is one of the major source of generating electricity is reaching its optimum level and hence now it has become inevitable for us to use electricity in a judicious, sustainable and efficient manner. [1]

A Compact fluorescent lamps (CFLs) also called compact fluorescent light, energy saving light, and compact fluorescent tube, is a fluorescent lamp design to replace an incandescent lamp; some types fixed into light fixture formerly used for incandescent lamps. The lamps use a tube which is curved or folded to fit into the space of an incandescent bulb, and compact electronic ballast in the base of the lamp.

Compared to general-service incandescent lamps giving the same amount of visible light, CFLs use one-fifth to one-third the electric power, and last eight to fifteen times longer. A CFL has a higher purchase price than an incandescent lamp, but can save over five times purchase price in electricity costs over the lamp's lifetime. [2] The life span of incandescent lamp is approx. 2000 hours while the life span of CFL is between 6000 hours to 15000 hours. [3]

A CFL bulb is made of glass tube (tube is made of sand, crushed recycled glass, soda ash, lime stone and other raw materials) filled with noble gas (argon) and a small amount of mercury and coated with phosphor. [4][5]

All the compact fluorescent lamps contain a small amount of elemental mercury (Hg), also known as quicksilver. When CFL are cold, some of the mercury in the CFL is in liquid form, but while the lamp is operating, or when the CFL is hot, most of the mercury is in an invisible vapour form. Mercury vapour is a highly toxic substance, with an "extreme" rating as a poison, which can be dangerous to our health. When a CFL is broken, this will release the mercury and contaminate the surrounding area. Liquid mercury will not burn, but instead becomes a vapour when heated. It eventually cools and condenses back to a liquid form, spreading the contamination to larger areas. Inhaling the vapour is the main cause of mercury poisoning, as the mercury is absorbed by the lungs. Mercury can cause severe respiratory tract damage, brain damage, kidney damage, central nervous system damage, and many other serious medical conditions even for extremely small doses. Mercury present in CFLs which are hazardous and when left untreated can cause a great damage to our ecosystem. This hazardous mercury can affect our life in many direct as well as indirect ways like-

1. Mercury can be carried through ocean, rivers, lakes, ponds etc. along with rain water and which can subsequently affect aquatic life as fish and other aquatic animals can get it bio-accumulated.

2. Mercury can be biologically accumulated in soil and which can eventually cause the crops to be poisonous and ultimately its we the human beings who will have to face disastrous consequences. [6]

II. COMPACT FLUORESCENT LAMPS

The idea of replacing inefficient and short-aged incandescent lamps with efficient and long aged fluorescent lamps has resulted in the development of compact fluorescent lamps (CFLs). Compact fluorescent lamps were primarily intended for residential and commercial customers. Lasting much longer and consuming much less energy than incandescent lamps with comparable luminous output, they represented promising new lamp types. Most of countries have been encouraging the use of CFLs. The use of CFL is expected to save up to 10% of a house hold's electricity usage. These countries were even offering CFLs at a highly subsidized price to make them popular. [7]

CFLs have been developed from classical fluorescent discharge lamps, which use magnetic ballast. However in CFLs electronic ballast are used. Electronic ballast changes the frequency of the electrical current without changing the voltage. Magnetic ballasts in fluorescent lamps work at a frequency of 60Hz, electronic ballasts greatly increase that frequency to 20,000Hz. Due to relatively low frequency magnetic ballast produce light flicker and buzzing sound while in CFLs we will not see lights flickering and will not hear a buzzing sound because of electronic ballast. [1][8]. Figure 1 shows the electronic ballast of compact fluorescent lamp.

Basic positive characteristics of CFLs:

1. Smaller active power consumption (approx. by factor 5) and less heat losses (approx. by factor 15) for the same light flow compared to the classic incandescent lamps.
2. The use of the thyristor-controlled dimmers is mostly not applicable due to the way the lamp operators. However, the ability of some CFLs to control the light flow is limited.
3. They are more resistant to voltage fluctuations which causes light flicker (approx. by factor 5) than classic incandescent lamps.
4. Their life span may be in some special cases up to 20 times the life span of the classic incandescent lamps.

Some negative characteristics of CFLs:

1. They are non-linear devices and inject harmonic currents into the network. The character of fundamental harmonic (50Hz) is capacitive.
2. They need up to a few minutes to achieve the rated light flow. At low temperatures they might not ignite at all.
3. CFLs contain mercury (Hg) which is toxic.



Figure-1 Electronic ballast of CFLs

III. MERCURY AND ITS CHEMICAL PROPERTY

Mercury is a chemical element with symbol Hg. Its atomic number is 80 and atomic weight is 201. It is a heavy, silvery white d-block element. Mercury is the only pure liquid metal at room temperature. Mercury is also called quicksilver. figure-2 shows the liquid form of mercury.

It is a poor conductor of heat when compare with other metal but it is a fair conductor of electricity. When mercury is heated, it enters the atmosphere as a colourless, odourless gas. Mercury is a compound that can be found naturally in the environment. It can be found in metal form, as mercury salts or as organic mercury compounds. Mercury combines with other elements to form inorganic mercury compounds and organic mercury compounds. Inorganic mercury compounds are the most common forms of mercury found in drinking water.



Figure-2 Liquid mercury

While organic mercury compounds are the most harmful form of mercury, they are rarely found in drinking water. Methyl mercury is an example of organic mercury compound.

Mercury is used in:

Thermometers, barometers, manometers, sphygmomanometers, float valves, mercury switches, mercury relays, manual blood-pressure devices, fluorescent light bulbs and other devices. [9][10]

IV. WORKING PRINCIPLE OF CFLs

The principle of operation in CFL bulb remains same as in other fluorescent lightning. The tube of CFL is filled with noble gas (argon, neon, helium).the tube is also contains a small amount or mercury that when heated becomes mercury vapour. The inside of the tube is lined with phosphorescent material (mostly phosphorous). In the base of the bulb is electronic ballast that boosts the line voltage up high enough to ionize the gas inside the bulb. As this happens the mercury also vaporised inside the tube. The ionised gas and ionised mercury vapour emit ultraviolet light which strikes the phosphorous. The phosphorous, in turn, emits white light that lights up the room. Figure-3 shows the CFL working procedure.

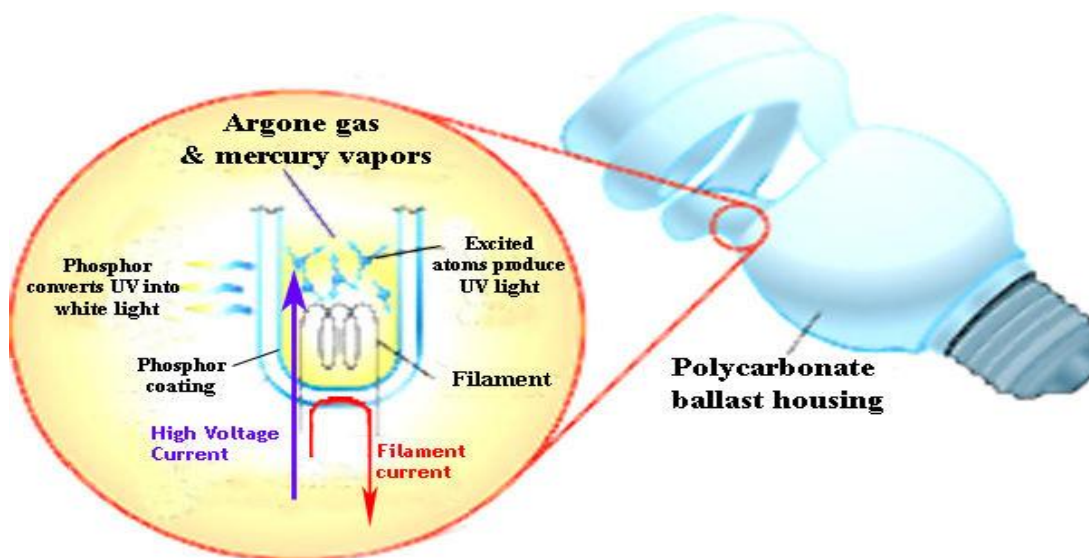


Figure-3 working principle of CFL

V. WHY AND HOW MUCH MERCURY IS USED IN CFLs

Compact fluorescent bulbs are made of glass tubes filled with gas and a small amount of mercury. CFLs produce light when the mercury molecules are excited by electricity running between two electrodes in the base of the bulb. The mercury emits ultraviolet light, which in turn excites the tube's phosphor coating, leading it to emit visible light. Hence all CFLs need mercury to offers light. [11]

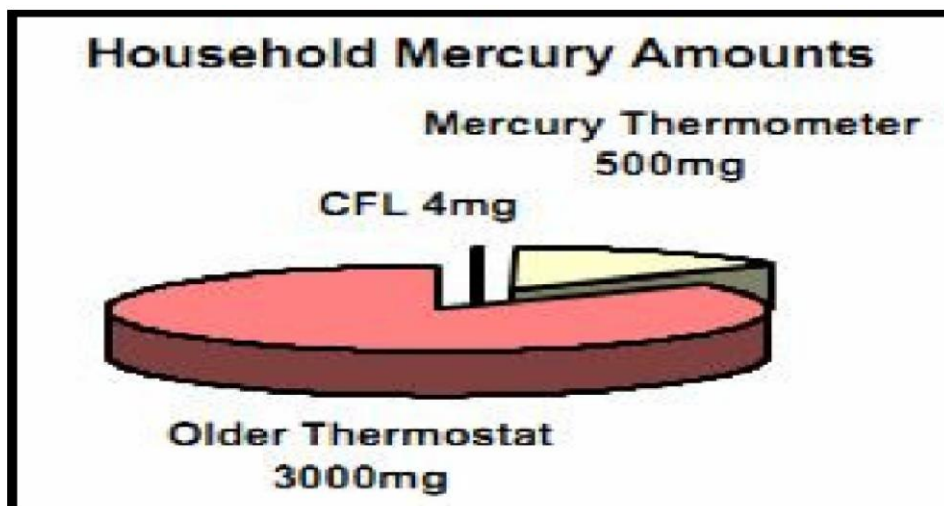


Figure-4 Amount of household mercury

Each bulb contains an average of 5 milligrams of mercury, "which is just enough to cover a ballpoint pen tip". Figure-4 shows the amount of mercury used in household mercury. [12]

VI. EFFECTS OF MERCURY

When CFL is broken, mercury is emitted to the air. This mercury enters into oceans and waterways through rain. Once mercury enters a waterway, naturally occurring bacteria absorb it and convert it to a form called methyl mercury. In this form, it is taken up by tiny aquatic plants and animals. Fish that eat these organisms built up methyl mercury in their bodies. Mercury then works its way up to the food chain as large fish consume contaminated smaller fish. Instead of dissolving or breaking down, mercury accumulates at ever-increasing levels. This process is called bio accumulation.

Mercury can enter the body through the lungs, through the skin, and via the digestive system. Humans risk ingesting dangerous levels of mercury when they eat contaminated fish. Since mercury is odourless, invisible and accumulates in the meat of fish, it is not easy to detect and can't be avoided by trimming of the skin or other parts.

Once in the human body, mercury acts as a neurotoxin, interfering with the brain and nervous system. Figure-5 shows how to mercury entering to environment.

Exposure to mercury can be particularly hazardous for pregnant women and small children. There are following main effects of mercury;

1. During the first several years of life, a child's brain is still developing and rapidly absorbing nutrients. Even in low doses, mercury may affect a child's development, delaying walking and talking, shortening attention span and causing learning disabilities. Less frequent, high dose prenatal and infant exposures to mercury can cause mental retardation, cerebral palsy, deafness and blindness.
2. In adults, mercury poisoning can adversely affect fertility and blood pressure regulation and can cause memory loss, tremors, vision loss and numbness of the fingers and toes. A growing body of evidence suggests that exposure to mercury may also lead to heart disease.
3. Mother who are exposed methyl mercury and breast-feed their babies may also expose their infant children through their milk.[13][14]

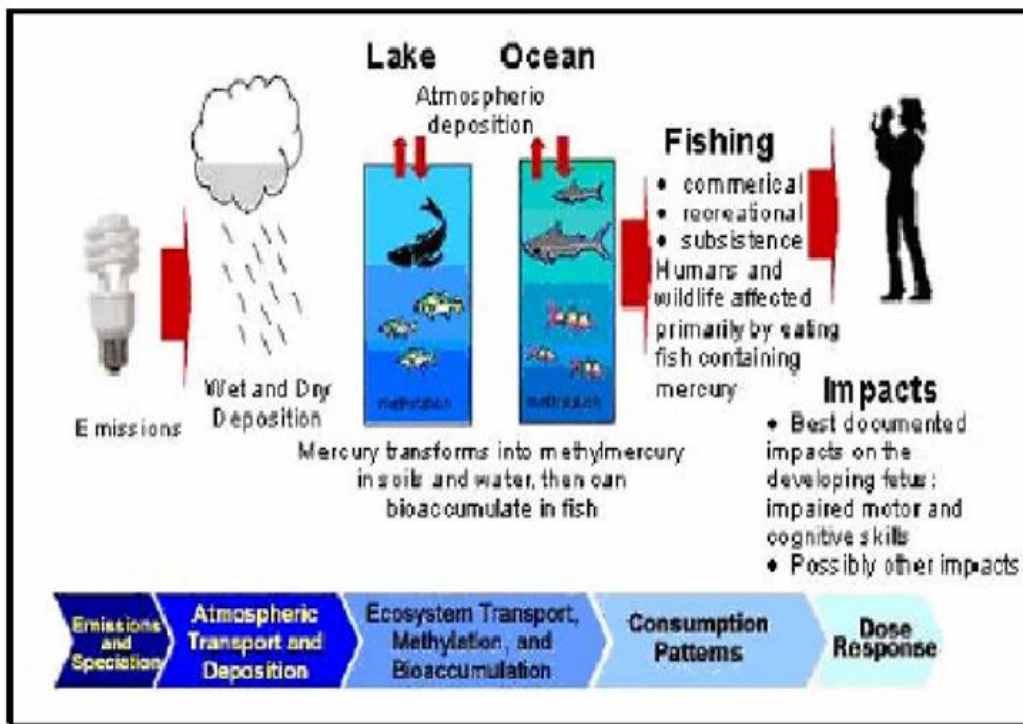


Figure-5 Mercury entering to environment

VII. RECOMMENDATION AND CONCLUSION

No mercury is released when the CFLs are intact (i.e., not broken) or in use, but CFLs can release mercury vapour when broken. Useless or broken CFLs should not be dumped anywhere into dumpster, trash can or at some unsafe place rather it should be treated with extreme care and should be deposited at centres meant for collecting waste CFLs. At these centres the CFLs get recycled and the materials that have been used in the CFLs like glass, metals and virtually every compound used in the making of CFLs can be reuse through the proper means of recycling. Recycling prevents the release of mercury into the environment.

If the CFL gets accidentally broken and scatter on floor then:

- As mercury released vapour, all the doors and window should be opened so that it does not get inhaled by people present there.
- It should not be swiped using vacuum cleaner or broom. It should be cleaned with extreme care using some sophisticated material.

Hence, to solve these problems in advance Government should takes proper steps to promote the use of mercury free light i.e. LED bulb instead of CFLs and incandescent bulbs. To the general population as well as established authority to become aware of the drawbacks of using CFLs and not letting the mercury coming out of CFLs affects our ecosystem and human beings by any means.

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