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How "Bright" is it to Use CFLs? A Look at the Controversy

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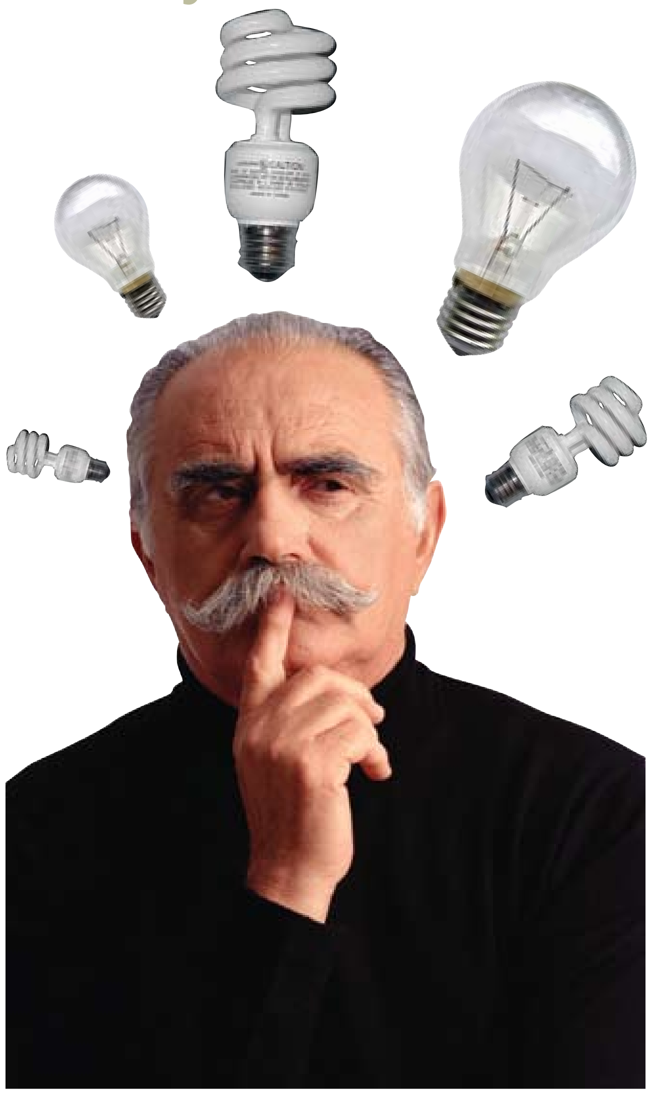
How "bright" is it to use CFLs? A look at the controversy

by Roxanne Greitz Miller



Commonly referred to as CFLs, compact fluorescent lightbulbs are rapidly replacing traditional incandescent lightbulbs for residential use. Most people are currently switching to CFLs to save money or to help the environment, thanks to the reduced energy consumption of CFLs versus incandescent bulbs. Others are switching to CFLs now because of the recently passed federal ban on incandescent lightbulbs, set to take effect in 2012.

However, controversy and even comic parody have arisen surrounding CFL use. CFLs contain small amounts of mercury, and several public forums and news agencies have been announcing that the breakage of a CFL in one's home may result in exposure to dangerously high mercury levels that can cause serious physical side effects. The purpose of this article is to introduce the basics of how incandescent and compact fluorescent lightbulbs work, explain why the switch to CFLs is being promoted, and summarize the potential hazards of CFL use for the residential consumer.

Let there be light

To understand CFLs, it is first useful to understand how an incandescent lightbulb works. An incandescent lightbulb is a simple circuit. It has two metal contacts at the bottom of the bulb's base, and the electrical charge travels into the lightbulb through one contact at the bulb's base. The charge then travels up to a heavily coiled wire filament, suspended between two glass mounts, inside the glass bulb.

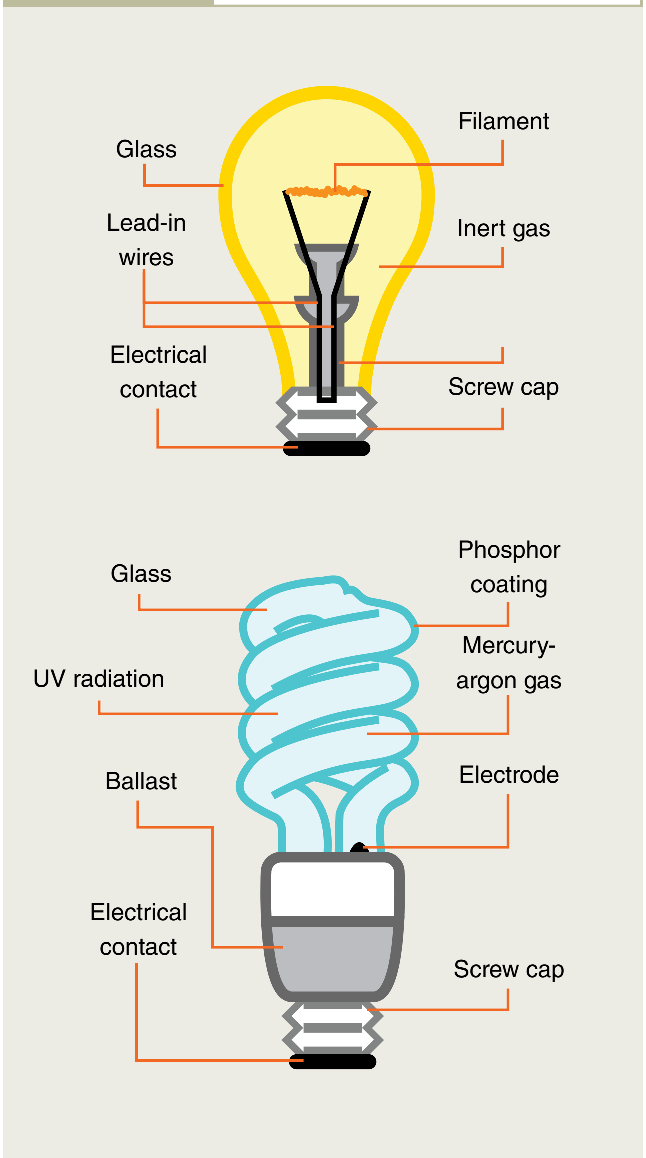
The filament is the key component in the incandescent bulb. It is made of tungsten, which has an extremely high melting point, and can be heated to between 2200°C and 2500°C when a charge is passed through it. The electrons making up the electrical charge collide with the tungsten atoms when passing through the filament, which causes the tungsten atoms to vibrate. The friction produced generates heat (thermal energy), which is released by the electrons in the form of photons (light). Instead of oxygen, the glass bulb contains argon or a mixture of argon and nitrogen or krypton and xenon. This allows the tungsten to reach a high temperature without melting and extends the life of the filament. Typical incandescent lightbulbs last about 1,000 hours.

CFLs work differently than incandescent bulbs. Instead of a filament, CFLs contain a gas-filled tube and a ballast. Ballasts can be either magnetic or electronic; those that are magnetic tend to cause more light flickering (a classic trait of older fluorescent lights). When an electrical charge is introduced to the CFL, the current flows through the ballast, into the tube, and through the gas, which causes the gas to emit ultraviolet (UV) light not visible to the human eye. The UV light then excites (energizes) a phosphor coating on the inside of the tube, which emits visible light. CFLs are estimated to have an average life of about 10,000 hours, depending on the wattage of the bulb and use (see Figure 1 for a comparison of the incandescent and CFL bulbs).

Why switch?

CFLs use between 60% and 80% less energy than their incandescent counterparts. As a result, they are an easy way for homeowners to cut their energy consumption and electric bills without making major changes such as replacing light fixtures or rewiring their homes. One must also consider the environmental effects, such as greenhouse gas emissions, linked to the generation of the electricity needed to power the light. The federal government's Energy Star program (2008) has estimated that if every American household were to replace only one incandescent bulb with a CFL, it would save enough energy to light three million homes, and thereby prevent the release of greenhouse gases equal to the emissions of 800,000 cars.

FIGURE 1 Comparison of bulbs



The controversy

CFLs contain small amounts of mercury, a highly toxic heavy metal, in each bulb. It is important to know that no mercury is released during the normal operation and use of a CFL. However, if the bulb is broken (shattered), either through normal use or during the disposal process, mercury can escape. This is where the concern begins: Is the amount of mercury released from a broken CFL enough to cause harm, either to people or to the environment?

To address these concerns and limit potential exposure effects, the National Electrical Manufacturers Association has made a voluntary commitment to cap the amount of mercury used in CFLs to less than 5 mg for bulbs of 25 watts or less, and less than 6 mg for bulbs ranging from 25 to 40 watts. The average amount of mercury in a CFL is currently 4 mg; however, some bulb manufacturers have been recently producing CFLs with as little as 1.6 mg of mercury per bulb (Energy Star 2008). To provide a visual representation, the amount of mercury in a "classic," old-fashioned personal thermometer was approximately 500 mg. The 4 mg average amount of mercury in a CFL would cover only the tip of a ballpoint pen.

Is the small amount of mercury that could be released from a broken CFL enough to poison someone? According to MedlinePlus (2006), the mercury found in fluorescent bulbs is elemental mercury, as opposed to organic (methyl) mercury or inorganic mercury salts, which are more toxic forms. Elemental mercury is usually relatively harmless if touched or swallowed; however, considerable harm can occur if the mercury is vaporized and inhaled. This can often occur by mistake when people try to vacuum up mercury that has spilled onto the ground. Even so, breathing in a small amount of elemental mercury will cause very few, if any, long-term side effects (MedlinePlus 2006). Inhaling large amounts of elemental mercury, or prolonged inhalation of small amounts each day, may cause symptoms such as metallic taste, vomiting, difficulty breathing, cough, and swollen or bleeding gums. Depending on how much mercury is inhaled, permanent lung damage, long-term brain damage, and death may occur (MedlinePlus 2006).

Several news sources and individuals have used a 1987 article from the medical journal *Pediatrics* as support for the claim that mercury poisoning can indeed occur from exposure to broken fluorescent lightbulbs. The article reported on a single case of mercury poisoning in a 23-month-old (Tunnessen, McMahon, and Baser 1987). However, the child in this case was exposed to much more than a single *bulb*. The child's parents reported that five months prior to the onset of symptoms, a carton of several 8-foot fluorescent tubes was broken in a potting shed where the child and his older siblings often played. Only the 23-month-old child displayed any symptoms of poisoning; the older siblings and parents were symptom free. According to Lighting Design Lab (2008), 4-foot fluorescent tubes (T12s) made prior to 1988 contained approximately 45 mg of mercury per tube. The tubes in this case were 8 feet long, which means they would have contained approximately 90 mg of mercury *each*. If we conservatively estimate that there were only six broken tubes in the carton (potentially, the carton could have held twice that amount), it would mean that the 23-month-old child was exposed to at least 540 mg of mercury, or roughly the equivalent of 130 broken CFLs.

As reported in this column in previous *Science Scope* issues, very young children are particularly susceptible to poisoning and are more commonly affected by poisons than adults due to their proximity to the ground, their play habits, the frequent insertion of fingers and hands into their mouths, and the consumption of nonfood items. This helps explain why the 23-month-old was affected while his older siblings, who also played in the area, and his parents were not. In conclusion, most people would never encounter an equivalent level of mercury exposure from broken CFLs as these children did from multiple broken 8-foot fluorescent tubes. Therefore, the most likely conclusion would be that given the extremely small amount of elemental mercury that would escape from a single broken CFL and given elemental mercury's low potential for poisoning, that, if the broken CFL is cleaned up properly, there should be no ill effects on a person's health from exposure to a broken CFL.

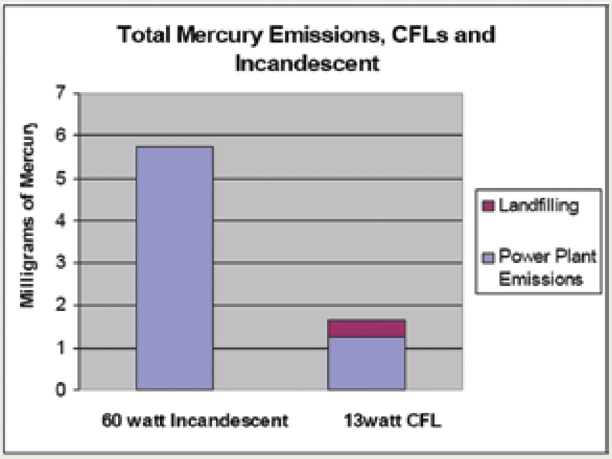
Yet a 2007 news story in the *Ellsworth American* about a Maine resident, Brandy Bridges, who broke a CFL in her daughter's room, suggested completely the opposite. Knowing that CFLs contain mercury, Bridges called local environmental agencies after the mishap and was told that one of her options for cleanup was to contact a hazardous materials group, which gave her an estimate of $2,000 for the cleanup process. Bridges then sealed off her daughter's room with tape and plastic, for fear of contamination, and stated she was unable to afford to clean up. In more recent postings and follow-up commentary to this story, it has been clarified that the local environmental agencies have admitted to overreacting to the situation, and that they assisted Bridges with the cleanup, which was complicated by leaving the broken CFL unattended for a longer period of time. The room is now unsealed and occupied once again.

How should one clean up a broken CFL? Because of the need to keep the potential for vaporization of the mercury low, the cleanup instructions are complex. Here is a composite example of the steps recommended on most websites:

1. Open a window and leave the room for 15 minutes or more.
2. Keep children and pets away from the area.
3. Shut off the central forced-air heating/air conditioning system, if you have one.
4. Carefully scoop up glass fragments and powder using stiff paper or cardboard and place them in a container with a lid or in a sealed plastic bag.
5. Use sticky tape, such as duct tape, to pick up any remaining small glass fragments and powder.
6. Wipe the area clean with damp paper towels or disposable wet wipes and place them in the container or plastic bag.
7. Do not use a vacuum or broom to clean up the broken bulb on hard surfaces.
8. Immediately place all cleanup materials outside the building in a trash container. However, some states/cities prohibit such trash disposal and require that broken and unbroken lamps be taken to a recycling center. Check your local rules.
9. Wash your hands after disposing of the cleanup materials.
10. For at least the next few times you vacuum, keep the central heating/air conditioning system shut off while vacuuming the area and the window open for at least 15 minutes after vacuuming is completed.

I mentioned comic parody at the opening of the article, because my students often come to me with videos they have discovered from YouTube. On the link below, you'll find a spoof of a news show covering CFLs, in which the roving reporter breaks the CFL during the news segment. A "hazmat" team is called in and the reporter ends up being treated for decontamination *a la* the nuclear power plant film

FIGURE 2 A comparison of mercury emissions



WWW.ENERGYSTAR.GOV/IA/PARTNERS/PROMOTIONS/CHANGE_LIGHT/DOWNLOADS/FACT_SHEET_MERCURY.PDF

Silkwood. The video can be found at *www.youtube.com/watch?v=BqrCij6CbHA*. It is also interesting to note that several videos on YouTube, even some from reputable broadcast news sources and channels, reference significant concerns of potential dangers of CFL use.

How much mercury will be introduced into the environment by CFLs? To answer this question, one must consider not only the mercury from the CFL itself when disposed of, but also how much mercury is released into the environment from the generation of the electricity used to power either an incandescent bulb or a CFL. While it is true that the disposal of a mercury-free incandescent bulb does not introduce mercury into the waste stream, the generation of the electricity used to power the bulb does release mercury into the environment. Electricity is the main source of mercury emissions in the United States (Energy Star 2008).

Energy Star provides an excellent comparison of the total net amount of mercury that would be introduced into the environment, both from landfilling and from emissions, for a 13-watt CFL and equivalent 60-watt incandescent bulb powered for an equal number of hours (Figure 2). Because of the significant reduction in electricity needed to power a CFL, the total net amount of mercury introduced into the environment is significantly lower for the CFL (1.6 mg total) compared to the incandescent bulb (5.8 mg total). Therefore, the notion that the use of mercury-containing CFLs will cause greater levels of mercury to be introduced in our environment than use of equivalent mercury-free incandescent bulbs is also false.

This benefit ratio does not include the reductions in carbon emissions from reduced energy consumption or the reduced waste from CFL use due to their longer life than incandescent bulbs. In addition, CFL recycling programs are becoming increasingly popular, which will further reduce introduction of mercury into the environment from CFL disposal and will decrease the amount of CFL waste reaching landfills.

Student perspectives

It is important to help students understand the science behind consumer topics and to increase their media literacy. With students' wide access via technology to unqualified sources of information, and with the strong persuasive power of these sources, it is important that we educate students to question what they see and hear and to seek out verifiable information on a topic. The topic of CFL use could be used to illustrate to students just how important it is for them to adopt the habits of scientific practice and thought when presented with information that affects their daily lives and to speak out and cite reliable sources of scientific evidence to support their claims.

References

Energy Star. 2008. Frequently asked questions: Information on compact fluorescent light bulbs (CFLs) and Mercury. *www.energystar.gov/ia/partners/promotions/change_light/downloads/Fact_Sheet_Mercury.pdf.*

Gosling, N. 2007. Fluorescent bulb break causes costly hassle. *The Ellsworth American*. April 12. *http://ellsworthmaine.com/site/index.php?option=com_content&task=view&id=7446&Itemid=31*.

Lighting Design Lab. 2008. Mercury in fluorescent lamps. *www.lightingdesignlab.com/articles/mercury_in_fl/mercurycfl.htm*.

MedlinePlus. 2006. Mercury. *www.nlm.nih.gov/MEDLINEPLUS/ency/article/002476.htm*.

Tunnessen, W.W., Jr., K.J. McMahon, and M. Baser. 1987. Acrodynia: Exposure to mercury from fluorescent light bulbs. *Pediatrics* 79 (5): 786–89.

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