Fluorescent Light Scientific Essay: Fluorescent Lighting Is Not Healthy

Claim

Fluorescent lighting is not healthy and should be eliminated from public and private places.

Rationale

In order to investigate the claim and establish evidence for the research question, the key terms of the claim must be defined. The claim states that fluorescent lighting is not healthy and thus should be eliminated, making the key terms; fluorescent lighting, not healthy and eliminated.

With this in mind the key terms must be must be formulated:

- How do fluorescent lights work?
- What pertains as unhealthy in regards to lighting?
- Are these factors sufficient evidence that fluorescent lighting should be eliminated?

This research fits into the physics theory of Unit 1 Topic 3 by exploring the circuit functions of fluorescent lights, electrical conversions into light and the chemical reactions that cause them.

Possible research questions:

- Is there evidence of fluorescent lights being unhealthy?
- What are the harmful effects of fluorescent lights?

These questions only consider one variable of the claim and cannot alone be measured, they are too broad to be properly researched.

Henceforth, a research question can be finalised:

- Is there sufficient evidence that fluorescent light is harmful to humans and should they be removed from public and private places?

The expected outcome of this research, based on empirical evidence, is that fluorescent lights have minimum health risks and thus removals are not necessary in any capacity.

Reviewing Relevant Texts

Claimed Health Risks

Chris Adams of Thought Co. claims “there are a number of negative health effects...such as:

- Migraines

- Eyestrain
- Problems sleeping, due to melatonin suppression
- Symptoms of Seasonal Affective Disorder or depression
- Endocrine disruption and poor immune systems
- Female hormonal/menstrual cycle disruption
- Increases in breast cancer rates and tumor formation
- Stress/Anxiety, due to cortisol suppression
- Sexual development/maturation disruption
- Obesity
- Agoraphobia (anxiety disorder) (2018)”

These are claimed to be caused by the Ultraviolet light emitted from the chemical reactions occurring in the light bulb.

On the other side of the argument, the Scientific Committee on Emerging and Newly Identified Health Risks came to the conclusion in recent years that there was “no suitable direct scientific data on the relationship between fluorescent lamps and the symptoms in patients with various conditions (i.e xeroderma pigmentosum, lupus, migraine, epilepsy, myalgic encephalomyelitis, Irlen-Meares syndrome, fibromyalgia, electrosensitivity, AIDS/HIV, dyspraxia, and autism)...Of all compact fluorescent lamps properties, only UV/blue light radiation was identified as a potential risk factor for the aggravation of the light-sensitive symptoms in some patients with such diseases as chronic actinic dermatitis and solar urticaria (2019).”

There are three main characteristics of fluorescent lamps that are sometimes perceived as dangers to the general public; these factors were flicker, electromagnetic fields, and UV/blue light emission. These properties will be explored in this paper.

Relevant Data

How do Fluorescent Lights work?

Fluorescent lights consist of three different types: cold cathode, hot cathode, and electroluminescent. All of which use phosphors excited by electrons to create light.

Fluorescent lamps work by ionizing mercury vapour in a glass tube. This causes electrons in the gas to emit photons at UV frequencies. The UV light is converted into standard visible light using a phosphor coating on the inside of the tube.

Each lamp consists of a main glass tube, tungsten electrodes either side of the tube and a ballast that maintains and regulates a stable current to the electrodes. The electrodes are connected to the electrical circuit that receives power from the AC inlet. The main glass tube is filled with an inert or motionless gas - usually argon - at low pressure, mercury and phosphor powder. The lamp is started using a pulse produced from the ballast. When turned on, current flows through the electrical circuit to the electrodes, creating a voltage across them. Because of this, the electrons will move through the gas from one electrode to the other, the energy turning the liquid mercury into gas. The electrons continue to move throughout the tube, colliding and exciting the gaseous mercury to higher energy levels. As they return to their original energy level, light photons are released.

Flicker Rate

According to the Edison Center, “Light flicker refers to rapid or quick and, repeated changes in the brightness of light over time - light that appears to flutter and be unsteady. It is caused when the voltage supplied to a light source changes or when the power line voltage itself fluctuates (2018).” The flicker depends on several factors such as:

- Reoccurring voltage fluctuations
- Size of fluctuations.
- The amount of ambient light in the lighted area ().

“Modern, electronically ballasted CFLs refresh themselves at between 10,000 and 40,000 cycles per second, rates too fast for the human eye or brain to detect. As far as I’m aware there is no association between headaches and the use of compact fluorescent lamps (Phil Scarbro, 2018)”

UV Radiation

A recent study from the UK Health Protection Agency found measurable levels of UV from single covered CFLs when used at distances less than 1 foot. Following this, as a precaution, these CFLs should not be used at distances less than 1 foot, for more than one hour every 24 hours

The glass used in CFLs already provides a UV filtering effect. In addition, any additional glass, or plastic, or fabric used in lighting fixtures that is between you and the CFL will further reduce the already low levels to still lower levels since these materials act as additional UV filters.

Electromagnetic Fields

The World Health Organization (WHO) concluded in a survey of available scientific literature on the topic that “current evidence does not confirm the existence of any health consequences from exposure to low-level electromagnetic fields” such as those produced by CFL bulbs:

In 2009, a Canadian Executive Summary conducted testing of which demonstrated that a CFL’s electric and magnetic fields arising from its use are below exposure standards based on established effects and thus should not be an issue of health concern.

The recommended safety level for devices emitting electromagnetic fields is between 0.5-2.5mG. Measured at 4 inches and 3 feet, the readings were 400 - 4000mG and 0.1 - 5mG respectively. As most bulbs are placed 3 feet or more away from people, it was concluded that the bulbs have the potential to cause nill to negligible harm.

Quality of Evidence

The evidence proposed is accurate, unbiased and factual in all manners as it disproves or clarifies problems pressing the Fluorescent Light Bulb. All research presented is from reliable sources. The quality of evidence reflects the extent to which confidence in an estimate of the effect is adequate to support a particular recommendation, that fluorescent bulbs are harmless.

All sources indicate no foul play, with no history of negligence, dishonesty or bias, many of which are run by an overarching authority in the scientific community like the World Health Organisation, the Scientific American and the Canadian Department of Natural Resources. Sources also link to other studies conducted with similar results and there is a wide array of which support the presented research. As such, it can be suggested that the evidence presented is reliable, factual and unbiased.

Evaluation of Claim

The research question, “Is there sufficient evidence that fluorescent light is harmful to humans and should they be removed from public and private places?” was addressed by gathering evidence. The evidence suggests that whilst fluorescent lights do produce potentially harmful effects like electromagnetic fields and UV radiation, neither present a large enough threat for the bulb to reasonably be called dangerous. However, as people with certain skin conditions and circumstances can be susceptible to the bulb’s emissions, it cannot be fully established that the bulb is completely safe for all users. The findings of this investigation, applied to the research question, suggest that the claim cannot be completely disproved, but that the main use of fluorescent lights in public and private places can continue without issue.

Improvements to the Investigation

Acknowledging the possibility of harm induced by fluorescent lights, the research could be conducted on alternative light sources that eliminate multiple of its risk factors. Research also taking into account the possibility of harm from the alternative light source.

Extension of the Investigation

Fluorescent Light Alternatives

Type

- Fluorescent
- Incandescent
- LED

Source of Light

- Gas
- Solid (metal)
- Semiconductor

Harmful Emissions

- Mercury, UV radiation
- Carbon Dioxide, Heat
- Eye damage

Spectrum

- Blue to White
- Orange to Red
- Blue to White

Interpretation

The colour temperature of a light, measured in kelvins, is a bulb’s most noticeable characteristic. Daylight, at 5500K, appears much more white and blue than a candle’s orange at 1900 K. For the full nature of a light source, a bulb’s spectral power distribution (SPD) curve must be taken into consideration. SPD describes its irradiance across the entire visible spectrum. An incandescent bulb (Figure 1) achieves its temperature by emitting light over a smooth curve, with the balance tilted toward yellow and red. A CFL (Figure 2), and to a lesser extent an LED (Figure 3), mimics incandescents using a different mixture of light, with spikes and troughs of power strategically positioned across the spectrum to create an averaged colour temperature. This results in less faithful reproduction of colours expressed as a diminished colour rendering index (CRI).

A colour rendering index (CRI) being the quantitative measure of a light source’s ability to reveal the colours of various objects in comparison to an ideal light source like the Sun.

Incandescents emit primarily yellow to red light, similar to sunlight. This is commonly regarded as the most healthy light.

Fluorescents emit a variable intensity of light ranging from white/blue, to green/yellow, to red, all of which are at similar similar intensity but are not possible to predict.

LEDs emit a more balanced mix of colours, resulting in a more white to blue range of visible light.

Comparing Bulb Efficiency to other Lights

Average Rated Life

The rated life is the time it takes for half of the bulbs to fail when they are cycled on for 3 hours and off for 20 minutes. Cycling lamps off and on reduces lamp life.

LEDs have the best Average ARL with an approximate capable 45,000 + cycles before changing bulbs. Incandescents have the worst, not exceeding 2000 cycles.

Conclusion

It can be seen that substantial evidence has been gathered to establish that whilst fluorescent lights are not dangerous to the general public, LEDs can eliminate two of the risk factors present to fluorescents. However, fluorescents do not need to be removed from public and private places. As such, the claim “Fluorescent lighting is not healthy and should be eliminated from public and private places.” cannot be supported by this research, but at the same time, precautions can be taken to ensure they are safe.

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