Fluorescent Lighting in Hyperbaric Facilities

Francois Burman, MSc, Pr Eng / June 2016

learn.hyperbaricmedicine.com

INTRODUCTION

There is a commonly held belief in hyperbaric medicine that fluorescent lights should not be used near hyperbaric chambers. The premise of this belief is one of the following: (1) fluorescent light can damage the acrylic; and/or (2) fluorescent light can cause the hyperbaric patient to have a seizure. This article discusses the issues with fluorescent lighting; and serves as a guide to help with selecting a light source for hyperbaric chamber rooms.

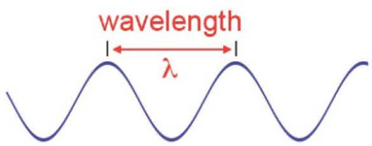
OBJECTIVES:

At the conclusion of this article, the reader will be able to:

- Identify the spectrum of light emitted by fluorescent fixtures.
- Identify the spectrum of light that can harm acrylics
- Explain potential health issues caused by fluorescent lights.

THE BASIC VOCABULARY:

Light radiates in waves. The distance between the peak of one wave and the peak of the next is called "wavelength". Wavelength is measured in nanometers (nm). The spectrum of light emitted by a particular light source (e.g. fluorescent bulb, incandescent bulb, halogen bulb) is described by the range of wavelengths found in the light. The spectrum is different for each light source.



WHAT SPECTRUM OF LIGHT CAN DAMAGE ACRYLIC?

Conventional wisdom about light sources and acrylic chamber windows says, "Ultra-violet (UV) light is bad for acrylic." This is partially true. Part of the spectrum of UV light can affect acrylics. The rest of the spectrum of UV light does not. In other words, "some UV light is bad for acrylic, but not all UV light is bad."

UV is defined as light in the wavelength spectrum of 10-400 nm. UV light is invisible to the human eye (the visible spectrum of light starts at 400 nm). UV is divided into three ranges:

- UVA or longwave (315-400 nm)
- UVB or mid-wave (280-315 nm)
- UVC or shortwave (100-280 nm)

When the wavelength is very short, there is more shortwave energy absorbed by the acrylic material. The absorption of shortwave energy is the cause of potential harm to the acrylic. The *Handbook of Acrylics* textbook (by J. Stachiw)[1] suggests that UV light with a wavelength of less than 320 nm can induce crazing* in acrylics when combined with mechanical stress. Mechanical stress is created when the hyperbaric chamber is pressurized. Mechanical stress may also be left behind in the manufacturing process, if the acrylic is not properly annealed.*

UVC (shortwave) light is usually absorbed in the upper atmosphere, so this is not a significant factor in outdoor exposure to sunlight. However, UVB (mid-wave) is present in sunlight and can affect chamber acrylics. UVC is produced artificially as a germicide (± 254 nm) or to make ozone (185 nm). Therefore, disinfection with UVC and production of ozone should not be allowed near chamber acrylics.

WHAT SPECTRUM OF UV LIGHT COMES FROM A FLUORESCENT FIXTURE?

UV radiation is present in all fluorescent lights and is directly related to the mercury content of the gas in the fluorescent light tubes (argon and mercury gases are traditionally used). The UV light emitted by the mercury activates the tri-phosphate coating on the inside of the tube, which emits visible light (400-700 nm). Fluorescent lighting emits both UVA and UVB radiation. Most fluorescent tube designs minimize the amount of UVA and UVB light that is radiated out of the fixture, making the majority of light radiating from the tube in the visible part of the spectrum. Reviewing the usual range of UV lights (e.g. traditional fluorescent tubes, newer "yellow" tubes, "natural sunshine" lamps, and compact fluorescent lamps (CFL)) reveals that all of these lights have UV

* A minute crack or pattern of cracks in the surface of a material.

* To anneal (*uh*-**neel**) acrylic means to free from internal stress by heating and gradually cooling. The annealing process is an essential part of fabricating acrylics for use in pressure vessels.

© 2016 INTERNATIONAL ATMO INC. ALL RIGHTS RESERVED

emissions well above 320 nm. Almost no UVC light is emitted. Because the majority of the light emitted by fluorescent tubes and CFL's is in the visible part of the light spectrum, we can have confidence that UV light should not contribute to any crazing of hyperbaric chamber acrylics. If one is still concerned about the acrylics, a filter can be used (e.g. UV tube sleeve, UV screen) to eliminate the UV light.

WHAT ABOUT OTHER LIGHT SOURCES?

Mercury vapor discharge lights are a source of UV. The spectrum emitted by mercury vapor lights includes wavelengths shorter than 320 nm. Therefore mercury vapor discharge lights should not be used near hyperbaric chambers. Incandescent lights (i.e. traditional light bulbs) have no UV emissions. Light emitting diodes (LED) have no UV emissions.

ARE THERE OCCUPATIONAL HEALTH RISKS FROM FLUORESCENT LIGHTING?

Yes, but not from the light that is emitted. Exposure to mercury gas is a cancer risk. This is the reason we should not break a fluorescent tube or CFL in close proximity to living things.

It has been suggested that the UV component of fluorescent lighting could be a cause of melanoma (malignant skin cancer). The National Electricity Manufacturers Association (NEMA) [2] has studied this phenomenon in detail, and determined melanoma risk from fluorescent light exposure has not been substantiated by evidence[3]. The risk of melanoma is currently being researched internationally. However, the important issue is that the majority of fluorescent light is in the 500-612 nm range[4], well outside any potentially hazardous UV wavelength range.

Interesting facts about fluorescent lighting:

- Fluorescent lighting contributes to the fading of fabrics, paper and photographs.
- Food illuminated under fluorescent lighting spoils more quickly.
- 8 hours under fluorescent lights equates to about 1 minute of sun exposure in Washington DC in July[2]. This exposure applies to both patients and staff.

DOES FLUORESCENT LIGHT INCREASE THE LIKELIHOOD OF A SEIZURE DURING HYPERBARIC TREATMENT?

No. The connection between light sources and seizures has to do with the flicker rate of the light source (strobe effect). The flicker rate is based on the frequency of the power supply source, measured in Hertz (Hz). The power supply frequency will be 50 Hz or 60 Hz, depending on the country. In the United States, the power supply frequency is 60 Hz. Fluorescent lights flicker at twice the rate of the power supply frequency. Therefore, traditional fluorescent fixtures flicker 120 times per second in the USA (and 100 times per second where the power supply has a frequency of 50 Hz). These flicker rates are fast enough to not be noticeable to the human eye; and neither of these flicker rates should be slow enough to induce seizures. Studies on photosensitive epileptics have shown that flicker rates of 15-18 times per second can induce seizures; and the lowest reported threshold was 3 times per second[5]. Because of the relatively fast flicker rate of fluorescent lights, there is no link between the flickering of fluorescent lights and seizures[6]. However, a faulty fluorescent light may flicker slower than 100 times per second; and could conceivably flicker slow enough to be problematic for a photosensitive epileptic. There is no scientific evidence that properly working fluorescent lights would induce seizures. If the flicker of the fluorescent light is slow enough to be seen, the tube should be replaced.

The type of ballast used in the fluorescent fixture has an effect on the flicker rate. Electromagnetic ballasts used in traditional fluorescent fixtures create a flicker rate of 100-120 times per second. However, modern electronic ballasts create a flicker rate of 20,000-60,000 times per second.

DO FLUORESCENT LIGHTS HAVE ANY OTHER HEALTH EFFECTS?

Yes. Some individuals who have a high “flicker fusion threshold” are sensitive to the flickering of fluorescent fixtures. Typical symptoms are eyestrain, headaches and fatigue. Traditional fluorescent fixtures flickering at 100-120 times per second may affect these people. Newer fixtures using electronic ballasts (flickering at 20,000-60,000 times per second) will not affect these people.

IS THERE ANYTHING ELSE I SHOULD KNOW ABOUT FLUORESCENT LIGHT?

Fluorescent light fixtures are generally better at filling an area with light compared to recessed fixtures (sometimes called “ceiling cans” or “pot lighting”) which are used to create task lighting (i.e. a localized spot of light). Most task lighting fixtures are dimmable; and traditional fluorescent fixtures are not. Many hyperbaric facilities have a mixture of fluorescent fixtures and task lighting. Newer fluorescent fixtures using electronic ballasts are dimmable. This allows us more options to adequately light the chamber area and vary the amount of light above the hyperbaric patient.

CONCLUSION:

In general, conventional fluorescent lamps do not appear to contribute to crazing in correctly manufactured acrylics. Any light source with emissions in the range below 320 nm should be kept away from line-of-site of acrylics.

Regarding medical concerns, fluorescent fixtures are not associated with an increased risk of melanoma; and fluorescent fixtures with electronic ballasts do not contribute to any health-related or *flicker fusion threshold* issues in patients. Where fluorescent fixtures with electronic ballasts are used, there is no concern about a potential increase in seizures.

Facilities should be aware of the actual factors that influence installation considerations, such as: the mercury content of the lamp, type of ballast in the fixture, and the option to install dimming switches. Decisions about lighting the hyperbaric room should be made by the design and safety team of each facility, based on individual considerations (e.g. economic factors, the size of the room, and availability/lack of sunlight). To protect the chamber warranty, you should consult the hyperbaric chamber manufacturer before choosing the light source for a hyperbaric facility.

References:

1. Stachiw, JD. *Handbook of Acrylics for Submersibles, Hyperbaric Chambers, and Aquaria*. Best Publishing. Flagstaff, AZ (2003).
2. NEMA Lamp Section. Ultraviolet Radiation from Fluorescent Lamps. NEMA. Rosslyn, VA (1999).
3. Malignant Melanoma & Fluorescent lighting: CIE-Journal, 7:29 (1988).
4. Finn, DW & Ouellette, MJ. Compact Fluorescent Lamps: What You Should Know. Progressive Architecture, Aug. 1992, pgs 89-92, Canada.
5. Harding G, Wilkins AJ, Erba G, Barkley GL, Fisher RS. Epilepsy Foundation of America Working Group. Photic- and pattern-induced seizures: expert consensus of the Epilepsy Foundation of America Working Group. Epilepsia 2005; 46(9):1423-5
6. Binnie, CD, de Korte, RA, Wisman, T. Fluorescent lighting and epilepsy. Epilepsia Vol. 20, pgs 725-727. Raven Press, New York (1979).

learn.hyperbaricmedicine.com

CONTINUING EDUCATION CREDIT

This article has been reviewed and is acceptable for 0.5 Category A credit hours by the National Board of Diving and Hyperbaric Medical Technology.

To purchase continuing education credit for this article go to **learn.hyperbaricmedicine.com**.

International ATMO, Inc.
405 N Saint Marys Street, Suite 720
San Antonio, Texas 78205
Phone: 210-614-3688
Email: education@hyperbaricmedicine.com
Web: www.hyperbaricmedicine.com

learn.hyperbaricmedicine.com