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An Alternative Light Source for Light Bleaching in Paper Conservation

ABSTRACT

Conservators who work in latitudes or climates that preclude or limit use of sunlight for light bleaching have employed various artificial light sources as a substitute. Most artificial light sources are, however, weaker than sunlight, and their use may require that objects undergoing treatment have to remain in water longer than with sunlight, thus raising concerns about softening of inks or paper. Already used in greenhouses and athletic stadiums, metal halide bulbs hold promise in paper conservation as a means to produce higher levels of illumination and thus enable shorter treatment times than other artificial light sources.

For effective and efficient use of light bleaching for removal of stains or discoloration in works of art on paper, conservators need convenient access to a strong source of illumination. Some are fortunate to live where the climate and latitude assure plentiful and predictable amounts of sunlight, while others must resort to various artificial sources. In our own studio, safe access to sunlight is difficult to arrange and we have had to consider artificial illumination. I have been concerned, however, that with some artificial light sources the length of treatment can be very long. Prolonged exposure to water can lead to softening of both media and paper. While searching for alternatives, I came upon a light source, called "metal halide bulbs," that have some characteristics that might be useful for light bleaching.

Presented at the Book & Paper Group Session, AIC 29th Annual Meeting, May 30–June 5, 2001, Dallas, Texas. Received for publication Fall 2001.

I first noticed these bulbs while browsing through a gardening catalogue, *Worm's Way,* a source of organic and hydroponic gardening supplies.[1] As used in agriculture, a metal halide bulb is held within a reflector, which is suspended above flowers or other plants (fig. 1). In recent years metal halide bulbs have also found widespread use in a variety of situations that require large amounts of light and where the color of the light should be similar to sunlight. Examples of these applications include night lighting in sports stadiums, hydroponic gardening, large-scale aquariums and aquaculture, and as replacements for the less efficient and garish yellow sodium lights commonly used for highway and street lighting.

Designers of artificial lights for greenhouse gardeners have long tried to produce a bulb with less output in the yellow and red end of the spectrum but with more output in the blue end, which would help promote normal growth patterns for plants. The spectral power distribution of a typical metal halide bulb shows a substantial spike

Fig. 1. Typical installation of a metal halide lamp fixture in an agricultural setting. Reproduced courtesy of Hydrofarm Gardening Products.

in the yellow region, but there is also significant energy in the blue wavelengths. From the spectral power distribution chart it is also evident that this light source also emits some energy in the ultraviolet wavelengths (the power distribution chart shows measurable energy beginning at approximately 380 nanometers). To determine how much ultraviolet radiation was produced by the bulb I was using, we used an ultraviolet light meter[2] and foot-candle meter.[3] We found that it produced about 160 microwatts per lumen. Compared to a sunny July day in Boston, this is less than one-half of the microwatts per lumen of ultraviolet energy in sunlight. Although this result was somewhat reassuring, one should nevertheless always take appropriate precautions when working around any source of ultraviolet light, and the *total* amount of lumens—and hence, ultraviolet energy—emitted by metal halide bulbs is large.

WHAT ARE METAL HALIDE BULBS?

Metal halide bulbs belong to a group of light sources called High Intensity Discharge (HID) lamps.[4] Metal halide bulbs exhibit higher efficiency and longer lives than incandescent bulbs or high-output fluorescent lights; and while they are not the most efficient of all HID lamps, metal halides offer excellent color rendition characteristics and the whitest light.

As defined by the Federal Energy Management Program,[5] HID lamps generally consist of a "sealed arc tube inside a glass envelope, or outer jacket [fig. 2]. The inner arc tube is filled with elements that emit light when ionized by electric current. A ballast is required to provide the proper starting voltage and to regulate current during operation." The arc tube contains a "high-pressure mixture of argon, mercury, and a variety of metal halides. The argon gas, which is easily ionized, facilitates striking the arc when voltage is applied across the electrodes. The heat generated by the arc then vaporizes the mercury and metal halides. These metal vapors produce light as the pressure and temperature within the arc tube rises, with the light's color properties depending on the specific mix of metal halides."[6]

USE IN THE PAPER CONSERVATION STUDIO

Figure 3 shows a cross section of a typical metal reflector housing with a metal halide bulb mounted horizontally within it. The bulb with which I have experimented is rated at 1000 watts, and there are vents in the top and sides of the housing to dissipate heat. Although not shown in this figure, in normal use there is also a sheet of tempered glass beneath the bulb. The glass filters out heat and also protects the bulb from spatters of water, which could cause the bulb to shatter.

The lamp housing is connected electrically to a ballast or transformer. The ballast operates on a normal 110-volt line, and draws about 9.2 amps of current. In comparison, many household circuits have a current capacity of from 15 to 30 amps. Obviously, for more than one metal halide fixture, one would have to provide appropriate additional current.

When I began experiments with this lamp, a temporary structure was assembled to support the fixture at an adjustable height above a tray of water. Initially, I had the lamp positioned about eighteen inches above the counter. At this height, the light output was about 13,000 foot-candles. In comparison, light levels on a bright, sunny, June day in Boston can be from over 7,000 up to perhaps 18,000 foot-candles. Concerned that heat might build up in the treatment bath, I placed a thermometer in the tray of water, immersed the test samples of various discolored papers, and left the lamp on for over one hour. A sheet of ultraviolet filtering Plexiglas was placed on top of the tray to protect the samples from ultraviolet radiation, as I would do with actual art works. At the conclusion of this time I was surprised to discover that the temperature of the bath had risen by only one degree Fahrenheit, which suggested that the tempered glass in the lamp housing was indeed effective in blocking most of the infrared radiation. And I was pleased to see that the samples showed a general

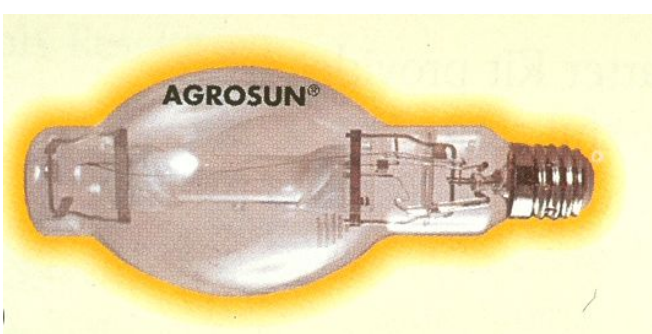

Fig. 2. An "Agrosun" bulb, showing the typical appearance of metal halide bulbs. Reproduced courtesy of Hydrofarm Gardening Products.

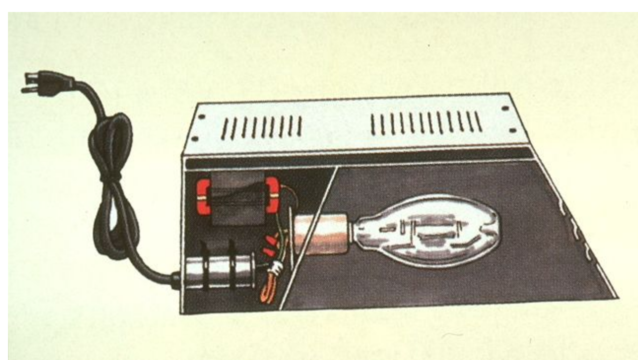

Fig. 3. Cross section of a typical metal reflector housing with metal halide bulb mounted horizontally within it. Reproduced courtesy of Hydrofarm Gardening Products

brightening compared to controls that had been immersed in the water but protected from the light.

The distribution of illumination over the work area varies from place to place, from an area of greatest intensity directly below the bulb to gradually lower levels off to the sides. It should be obvious that the geometry of the light source will influence distribution of light on surfaces it illuminates. To expand the area of illumination, the height of the bulb could be increased, but the intensity of the light will of course decrease in proportion to the inverse square law. To make maximum use of the light from the bulb and to promote more uniform overall illumination, one could perhaps surround the working area with reflective Mylar, which is available from some of the same vendors who supply these bulbs.[7] To increase output and distribution of light over a still wider area, one might consider using not just one but a group of several fixtures.

To suspend a fixture or group of fixtures, one might use an extensible support of the kind commonly used for suspension of lights in photographic studios.[8] These extensible supports can be mounted in tracks on the ceiling and can be moved back and forth, as well as up and down, by a remote control and built-in motor (fig. 4).

If the conservator judges that treatment of an object will require several hours of immersion, buildup of heat in the treatment solution could be a concern, in spite of the presence of the infrared filtering glass in the lamp housing. For control of the temperature, the tray in which the object is to be treated could be placed in a second tray, larger than the first. If water were put into this secondary tray, it could be maintained at a safe temperature by means of a temperature-controlled recirculator.[9] These units are available from laboratory supply houses and are intended to circulate water or aqueous solutions while maintaining the temperature of the solution. A hose draws water out of the secondary tray, and another hose pumps it back in again after adjusting the temperature of the water.

I hope some of these ideas will be useful to other conservators in developing light-bleaching equipment for use in their own studios, and I would enjoy hearing about the experiences of others in using these interesting and potentially useful sources of illumination.

Fig. 4. An extensible support for lighting fixtures. Photo by Roy Perkinson.

NOTES

1. The address of the vendor from whom we purchased our bulb and reflector is as follows: Worm's Way, 7850 North Highway 37, Bloomington, Indiana 47404. Call for other locations or a catalogue: (800) 316-1264. The metal halide bulb and housing discussed in this article were ordered from Worm's Way, cat. no. MHAL100, for the "Super Grow Wing" reflector, with 1000 Watt bulb and glass safety lens.

The original manufacturer of this bulb is Hydrofarm Gardening Products, 755 Southpoint Blvd., Petaluma, California 94954-1495. Tel: (800) 634-9990. URL: <http://www.hydrofarm.com/>. The complete manufacturer's code designation on the bulb itself is as follows: "Agrosun Classic" MS 1000W/HOR/BT37/AS. It is rated at 118,500 lumens, has a projected lifetime of 12,000 hours, and a color temperature of 3000 degrees Kelvin. I am grateful to Mr. Benoit Goessens, of Hydrofarm Gardening Products, for his enormous assistance with my many technical questions, and for his generosity in supplying me with technical literature.

Another among the major manufacturers of metal halide bulbs is Venture Lighting International, 32000 Aurora Road, Solon, Ohio 44139. Tel: (800) 451-2606 or (440) 248-3510. URL: <http://www.venturelighting.com>.

2. Model no. IL 1400A Radiometer/Photometer. International Light, Inc., 17 Graf Road, Newburyport, Massachusetts 01950-4092. Tel: (508) 465-5923. URL: <http://www.intl-light.com/>. I am grateful to Will Jeffers in our Department of Conservation and Collections Management for producing the data on ultraviolet and visible light.

3. Minolta Illuminance Meter, model T/1H.

4. Metal halide bulbs should not be confused with tungsten-halogen bulbs commonly used in households or for lighting in office spaces. The latter contain gaseous halogen elements that permit the tungsten filament to operate at a higher temperature and thus emit brighter and whiter light than ordinary incandescent bulbs, but they do not involve an arc ignition process as do metal halides.

5. Federal Energy Management Program (FEMP). Their web site had some interesting and useful information on this subject. URL: <http://www.pnl.gov/techguide/24.htm>. Another web site of interest is: <http://www.lightforum.com/library/technology/metalhalide.html>.

6. "Pacific Energy Center Factsheet: Metal Halide Lamps," p. 1, Pacific Gas and Electric Company, May, 1997. Available as a PDF document from <http://www.pge.com/pec>.

7. I am grateful to Janice Schopfer, Fine Arts Museums of San Francisco, for sharing this information with me.

8. Professional photographers often employ suspension devices that might be employed for supporting metal halide lamp fixtures. I am grateful to Tom Lang, Head of Photographic Services at the Museum of Fine Arts, Boston, for suggesting an appropriate mechanism made by the Gruppo Manfrotto, Industria Fototecnica Firenze (IFF), called a "Top Suspension" system. It is based on a pantograph mechanism and is available with a motor that could raise and lower the lamp fixture. This equipment is distributed through the Bogen Photo Company.

9. Temperature-controlled recirculator, cat. no. U-12104-00. Cole-Parmer Instrument Company, 625 E. Bunker Court, Vernon Hills, Illinois 60061-1844. One may also wish to purchase 8-mm tubing and an adapter (cat. no. U-01267-30 and U-01267-50, respectively), that would assist in connecting the recirculator to a tray of water in which the actual treatment tray rests.

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