

Novel Methods for Testing Image Permanence of Digital Output Materials

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Abstract

We present a novel method for testing the light stability of digital output materials The benefits are reduced cycle time, less impact of reciprocity failure and lower original and maintenance costs are the benefits of testing the light-stability of digital output materials with a sulfur-bulb based light fading unit. The output is very low in ultraviolet and infrared radiation and can be run at the same intensities as xenon-arc weatherometers. If the goal of the experiment is to simulate indoor lighting conditions, the sulfur-bulb based unit will closely simulate the effects of a very high intensity fluorescent fading unit with less cooling problems and considerably lower costs. Data are given comparing the fading of several digital output systems using high and low intensity fluorescent, xenon arc, and sulfur-bulb based fading units.

Introduction

The sulfur-bulb based fading unit is being promoted for light stability studies of digital output materials because:

- It reduces cycle time
- It is economical
- It is theoretically less prone to reciprocity law failure.

This fading tool can be set at 50 Klux with great reliability and can get answers to problems currently only solvable with a 5.4 Klux fluorescent fading unit. This speeds up testing by a factor of 10X. An entire unit costs $5000 as opposed to $50,000 for a xenon-arc 50 Klux unit. The bulb is not expected to wear out ~~a~~ mechanical part is the weak link and the whole unit costs only twice as much as one xenon-arc tube. The cooling required for the sulfur bulb is minimal compared to that of the xenon arc source, which is rich in infrared radiation. Because the sulfur bulb has almost no ultraviolet radiation, it should be much less prone to the reciprocity law failure that plagues highly accelerated light sources that contains ultraviolet radiation.

Experimental

The system consists of a variable-adjust power supply and a magnetron very much like the one in your microwave oven. The generated radio frequency microwaves are used to excite a very small concentration of sulfur vapor in an inert argon atmosphere. There is no filament to burn out and the only moving part is a motor to rotate the bulb for cooling purposes and to mix the plasma. In the full assembly there is a reflector behind the bulb to focus the light ahead of the bulb. There is a wire screen assembly to ensure that no stray microwaves can get out to affect the health of the operator or anyone else in the vicinity. The light next enters the light pipe. This can be of almost any configuration. Those at the Air and Space Museum are much longer and narrower than the one we are using for our fading experiments. The light reflects off the top surface of the pipe and off the reflector at the capped end of the pipe, and can only leave this assembly through the bottom of the light pipe, where we focus it on a curved sample surface below.

Our sample surface is raised up and down by a pneumatic system, which is also capable of rotating the surface 180 degrees to improve uniformity of exposure. The samples are 16 mm by 11-inch strips of photographic paper, which are fastened to the sample surface by magnetic holders, which work well for this prototype unit. A series of detectors is used to monitor the light intensity at various distances along the sample surface.

Our current operating mode consists of having the sample surface in one orientation for half of the test time and then rotating the surface 180 degrees for the other half of the test time.

Figure 1 shows the uniformity of the testing over 14 days at 50 Klux light intensity. At this level of uniformity it is believed that the unit will be process capable for a wide variety of samples including chromogenic and inkjet papers.

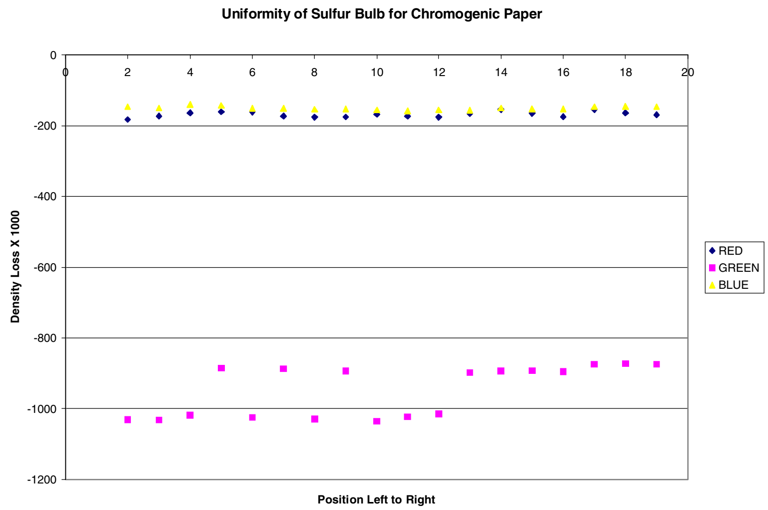

Figure 1 Uniformity of fade as function of position

We ran a large experiment with our inkjet development community to investigate the relationship of fade testing of many different media in most of our different fade units. This testing is completed for 21 days of treatment in the sulfur unit and we have data for 160 different ink and paper combinations showing that the unit closest to our sulfur unit is the 50 Klux filtered high intensity fluorescent unit. This is not surprising as the intensities and spectral distributions are similar.

What follows are the data for all the test variations sorted by color separation or by pure dye (C, M, and Y). We have plotted rate of fade of the sulfur apparatus versus the rate of fade for the 5.4 Klux filtered fluorescent. Correlation is quite good. If the thermal effect of fade is significant, the warm sulfur bulb unit, currently operating at about 100 °F, does not relate as well to the other fluorescent units, but more closely simulates daylight conditions. Other materials that are not as dependent on the heat will more closely simulate fluorescent fading, especially the filtered type that has minimal ultraviolet emission.

Additional Comments

The primary application that we envision as shown in the data presented earlier is as a replacement for fluorescent fading experiments, which take lots of time to run. From a consumer standpoint, the fading of images displayed in homes or offices is dependent on light of about 100-400 lux and the thermal fading, which is always present, whether the lights are on or not. The best simulation of this type of lighting is 5.4 Klux fluorescent. But, at this intensity, these tests often take ½ year or more to reach the desired endpoints. With the sulfur bulb fade unit, the data can be obtained and the home or office display information can be calculated in a matter of little over a month. With our previous methods, the testing was not over before commercialization of a subsequent generation of product began. The addition of extra cooling will allow the unit to run at true ambient temperature and extend the range of products we can successfully test on this unit.

As a lighting source, the sulfur bulb has been used for building lighting as we have previously seen. It has also been used as a grow lamp. Other applications include outdoor lighting of parking lots and swimming pools.

The sulfur bulb invention has won several awards including Popular Science's 1995 Best of What's New Award and Discover the World of Science's Sixth Annual Technology Award, also in 1995. This article featured a picture of the bulb's principal inventor, Michael Ury.

Biography

David Kopperl has a MS Chemistry Degree from Rochester Institute of Technology and has worked for Eastman Kodak Company for 31 years; the last 25 of which were in the area of image permanence. He is a member of ANSI and ISO committees on image permanence and physical properties.

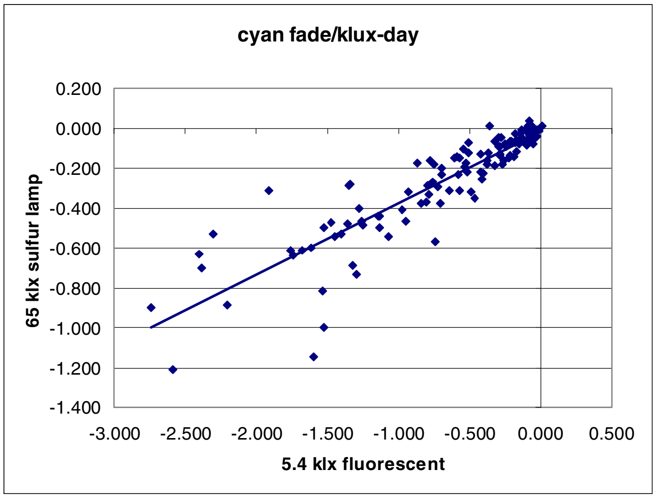

Figure 2. cyan fade rate, sulfur versus 5.4 fluorescent

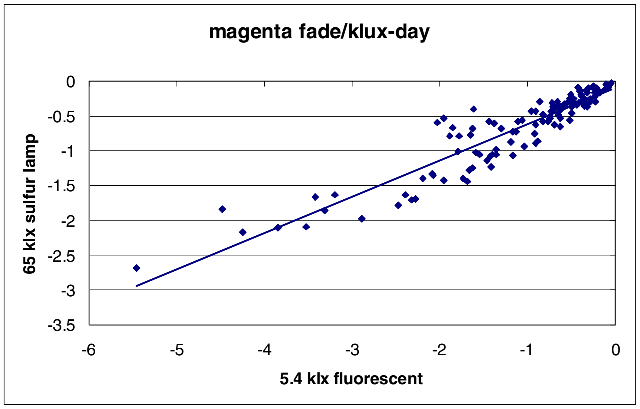

Figure 3. Magenta fade rate, sulfur versus 5.4 fluorescent

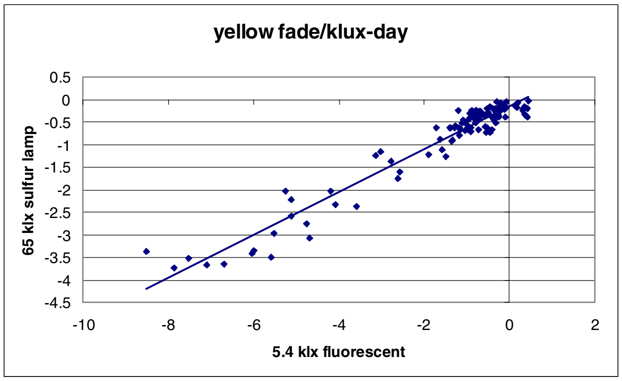

Figure 4. Yellow fade rate, sulfur versus 5.4 fluorescent