Light Stability Characteristics of Contone Ink Jet Printing Systems The Effect of Printing with Dots

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Abstract

High quality continuous tone ink jet images are produced by varying the dot size in small steps, and printing at high dot placement resolutions (300 dpi). These inks are typically dye based, and as such have limited light stability. The light stability characteristics are significantly different depending upon how much ink is placed in a single pixel element. This paper demonstrates the significant difference in behavior, offers a solution, and provides data to support the solution.

Introduction

High quality ink jet printers, such as those manufactured by Iris Graphics, provide continuous tone - photo realistic prints. These printers, when linked to a high powered workstation in a prepress environment, provide a color matched proof which can be used to monitor production press color consistency. Once the press run is complete, the proof may be discarded. However, as this market progresses, as well in other high quality contone printing markets, the need to keep or display the print increases. Thus putting the light stability of these images into question.

The high quality ink jet printers described here use a patented technology which jets a continuous stream of 20 micron diameter drops at a rate of 1 million per second per nozzle. The inks used are typically water soluble organic dyes, and as such suffer from fading when exposed to light for a period of time. These printers also generate density variations by varying the amount of ink placed in a given pixel. This can be varied from 1 to 31 of these micro droplets per color per pixel. Thus the printed dot size can vary from about 25 microns up to about 500 microns. A specific color is created by calculating the amount of each necessary to achieve the hue and chroma necessary.

Images that are exposed to light—visible and ultraviolet will fade. This fading can be reduced by the usual methods—adding a UV protective laminate, coating, or glass, posting the image away from direct light, etc. However, when fading has occurred, the very light shades, such as flesh tones will show a greater visible decline than heavier inked regions. We have attempted to quantify, explain, and offer additional observations of this effect.

Experimental Description

Step wedge images were produced on a high quality contone printer (Iris Graphics 3024). These step wedges vary the amount of ink placed in each pixel in the following manner - 5%, 10%, 20%, ... 90%, 100%. The image was printed on a gelatin coated paper and subjected to accelerated fading of a total of 30 kJ/cm^2 of light with 280 and 310 nm cutoff filters using a Sunchex fadometer (Atlas). This setup is used to simulate direct sunlight through a window pane. This process was repeated with different media and inks of different dye concentration and measurements taken at 10 kJ/cm^2 intervals. 10 kJ/cm^2 is approximately 25 hours of Sunchex operation.

Results and Discussion

The fading characteristic of one yellow ink is represented in Figure 1. The measurements are represented in CIELab DE*. CIELab DE* is the Euclidian distance between two colors in CIELab* colorspace. The CIELab DE* was virtually completely due to changes in the positive b* component. One can see that the fading characteristics seem to be divided into two regions. The first region—that of lower ink amount—fades at a considerably more rapid pace than the second region—that of high ink amounts. In fact, when examining the dot patterns closely, it appears that the difference is directly related to the amount of “white” space visible. One could quickly suggest that the differences are due to the amount of dye available in the space or internal reflectance of light within the gel coated paper.

The Effect of Transparent and Reflective Media

Two different media, one transparent (IRIS Transparency) and the other an opaque gel coated paper (IRIS Semi-Matte) - were printed with the same step pattern and subjected to the same light stability testing. However, the transparent film was backed with black paper

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to reduce the amount of reflection. The results depicted in Figure 2 show a pronounced effect. Areas of the same amount of ink (20%), where the dots are distinct and separated from other dots, showed a significantly larger fade in the reflective paper than the transparent film. After only 10 kJ/cm^2 of lighting, a 54.6% benefit is observed on the transparent film. By the 30 kJ/cm^2 mark, the difference has diminished to a 42.5% benefit, indicating the rapid initial decline of the reflective film image.

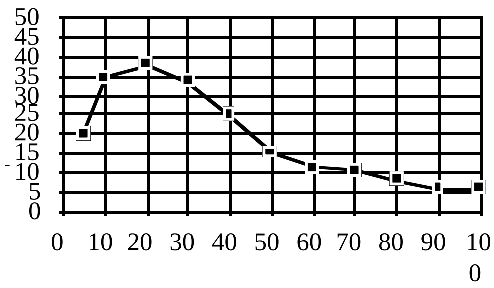

Figure 1. IS&T Ink 1 from 5% to 100%

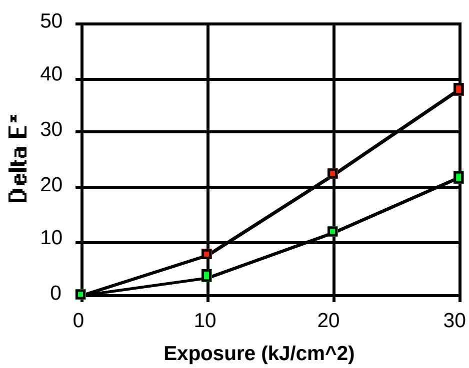

Figure 2. IS&T Ink 1 @ 20% dot

If one then compares the 100% dot region of the reflective and transparent media in Figure 3, we see the differences are significantly reduced. In fact the differences measured are nearly the same. This would suggest that internal reflectance, predominantly around the edges play a major role in the fade mechanism of these prints.

Additional support for the edge reflectance theory is provided by the following. An additional ink was prepared, effectively diluting the dye concentration to 20% of the control ink used above. When printed in the same manner described above, the 100% ink level provided a region density roughly equivalent to the 20% dot level of the control ink. The light stability of the lower dye concentration ink (at 100% ink level) was very significantly better than the control ink (at 20% ink level)- Figure 4. The lower concentration dye faded only one third that of the higher concentration dye at similar densities.

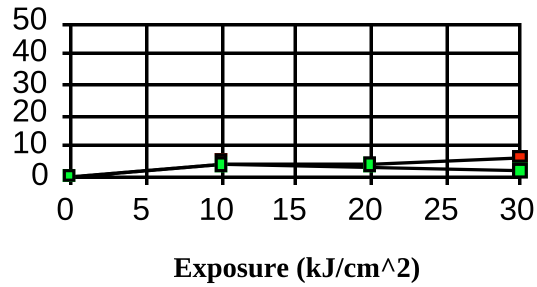

Figure 3. IS&T Ink 1 @ 100% dot

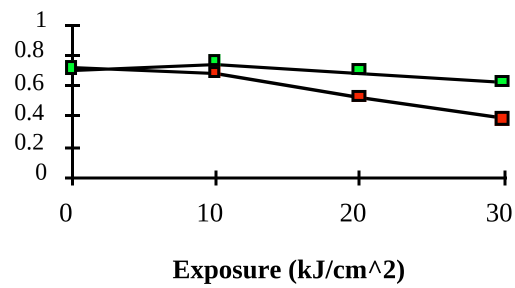

Figure 4. IS&T Ink 1 vs. IS&T Ink 2 at Equal Density

Conclusions

Internal reflectance plays a significant role in the fading of images created by discrete dots. Furthermore, the edge effects are the major source of the light that accelerates fading. This is a major difference between analog imaging methods and discrete dot digital techniques. The light stability methods currently published have been developed by and for the film industry. New or modified methods are necessary to describe differences, such as this edge effect, specific to discrete dot digital techniques.