Light Fading and Pollution Tests of Proofing Materials

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Abstract

The way proofs are made in the printing industry has changed in recent years. A number of digital proofing systems have come to the market. More and more people are looking into using digital proofs as contract proofs or for remote color proofing devices. However, it has to be kept in mind that at this point in time a digital proof is not yet the standard contract proof. This topic is still under investigation.

The purpose of this study is to provide a better understanding of the fading behavior of new proofing materials used in the printing industry. The proofs produced by these systems are the basis for decisions that usually involve large amounts of money. It is therefore important that the fading behavior of the proofing materials is studied carefully. Test conditions for this research are: framed samples under high-intensity fluorescent light, and ozone and nitrogen dioxide to better predict the influence of possible environmental pollutants.

Introduction

The migration from traditional contract proofing to digital contract proofing has inspired this investigation of digital contract proofs. “Contract proof” is a term used in the printing industry to refer to an imaged representation of what the customer can expect to receive in the final produced job; the customer signs the proof, giving it an “ok” on both color and content, making it a contract proof. Traditionally, films used to create the plates to print a job were used to make proofs that clients would sign off on.

As digital technologies have progressed and computer-to-plate (CTP) has begun replacing films for plate-making, the industry has begun to accept many types of digital output as contract proofs. Different customers have different requirements when it comes to a contract proof. Some may want a proof that simulates halftone dots, while other customers may not care about halftone dots. The printer may have requirements that are similar to or add to those of the customer when it comes to investing in a digital device for the contract proofs. Some of these requirements would be: color repeatability, compliance with industry standards, the presence of a control scale, cost-effectiveness, and proofing time.

The light fastness of a colorant needs only to be sufficient for its intended use. Common practice in industry for image stability of a contract proof is 28 to 30 days. However, this is the shortest period during which the print should be stable. Some might argue that it needs to be stable for a longer time. One reason for this might be if a legal issue were to arise where a client was not satisfied with the final product. This might require the contract proof to play a role in answering the question of who is liable in a legal battle, the printing company or the client.

Another question is how long an average contract proof being kept by a printing company. Most companies keep their contract proofs for a certain period of time, e.g., one to two years. It should be noted that the proofs will most likely be kept under office-environment conditions, unframed.

Materials Tested

Three different digital proofing technologies were utilized for this investigation (manufacturers A, B and C). An analog proofing technology (manufacturer D) was used as a benchmark for the digital proofing devices given, its acceptance as the technology for contract proofing.

Performed Tests

The IPI Standard Test Target was used to gather both densitometric and colorimetric data. Each target contains ten steps of varying densities from 10 to 100 dot percentage of each of the pure colors as well as red, green, blue and black. Several samples of the target were generated from each of the four proofing devices; one was frozen as a control, two were tested behind glass and two were tested without glass. The ISO 300 test target was used in order to determine fading effects on a pictorial image.

Filtered testing provided the opportunity to minimize the presence of other variables that could cause fading, such as ozone and other air pollutants. Unfiltered testing of the samples was performed in order to simulate real-life circumstances, considering that proofs are not normally protected by glass.

The accelerated high-intensity light-fading test was done in a light-fading unit at Image Permanence Institute. Forty-two cool-white fluorescent tubes were used as a light source. To provide a humidity- and temperature-controlled environment and to cool down the tubes, the unit stands in a separate room with an air-conditioning system. An air stream of about 1.3 m/s, at 18°C and 55% RH is continuously passed across the tubes and the surface of the test samples to produce a white backing temperature of 20°C ± 2°C and 50% ± 5% RH. The measurement of optical density (Status A) as well as the reflectance spectrum of the samples was done with a GretagMacbeth SpectroScan spectrophotometer.

Unfiltered: Samples were exposed to 50 klx fluorescent light and the normal airflow in the light-fading room.

Glass filtered: Samples were filtered with window glass and were exposed to 50 klx fluorescent light. There was no airflow and only part of the UV light hitting the samples. The spectral energy distribution of the tubes as well as the transmission of the window glass meet the standard requirements.

Samples were removed at set times to be measured and scanned in order to closely monitor the fading process. Testing assumes 450 lux of exposure for 12 hours per day as the average real-environment exposure. This results in a testing time of a bit more than three hours to reach the simulated 30 days of exposure.

Results

The results discussed in the following section show that the samples produced by the proofing devices tested were stable for the required 30 days.

As observed in Figures 1a and 1b, the cyan dye was fairly stable in most samples tested, with the exception of the samples of manufacturer A, which reached the endpoint for the filtered and unfiltered samples in less than 540 days. Although Figures 1a and 1b indicate the instability of this material over the extent of the testing, the samples were indeed stable for the first 30 days as required for their intended use.

Figure 2 shows that the yellow dye was fairly stable for all the tested samples. Overall, the samples of manufacturer D, unfiltered, seemed to be the most stable.

Catalytic Fading

Signs of catalytic fading were observed in the samples of manufacturer A, both filtered and unfiltered, and the unfiltered samples of manufacturer C. When comparing Figures 2 and 3, it can be observed that the neutral patch in the samples of manufacturer A shows evidence of catalytic fading related to the yellow dye. When the yellow dye was combined with other dyes, its rate of fading was increased. This behavior was more significant with the unfiltered samples than with the filtered samples.

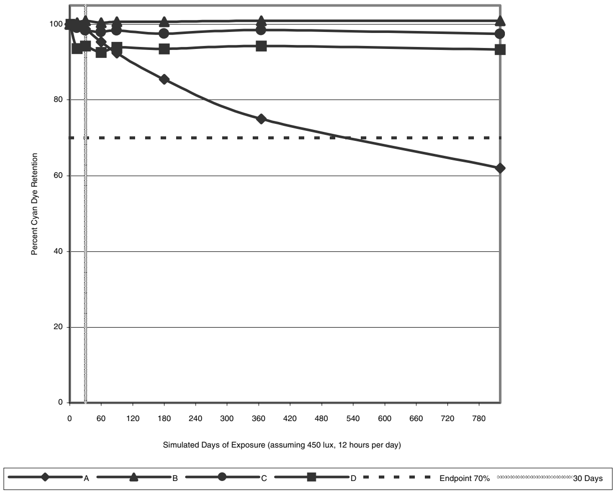

Figure 1a. Percent cyan dye retention in 1.0 above Dmin pure cyan patch during exposure to 50 kilolux filtered cool white fluorescent light.

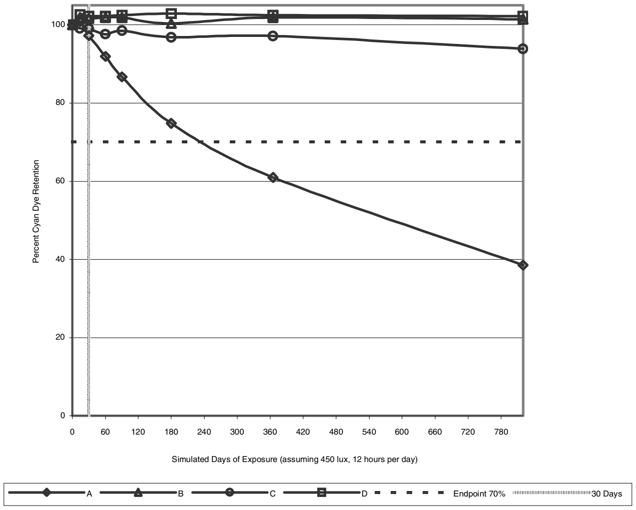

Figure 1b. Percent cyan dye retention in 1.0 above Dmin pure cyan patch during exposure to 50 kilolux unfiltered cool white fluorescent light.

Color Balance

Color balance was determined by inspecting the neutral patches. Figures 4a and 4b show the red-green color imbalance. Both samples of manufacturer A, filtered and unfiltered, show a shift towards the red. Both reached the endpoint before the testing was complete. The remaining samples performed well, as they never reached either endpoint, with the exception of the filtered samples of manufacturer C which exhibited greater variation.

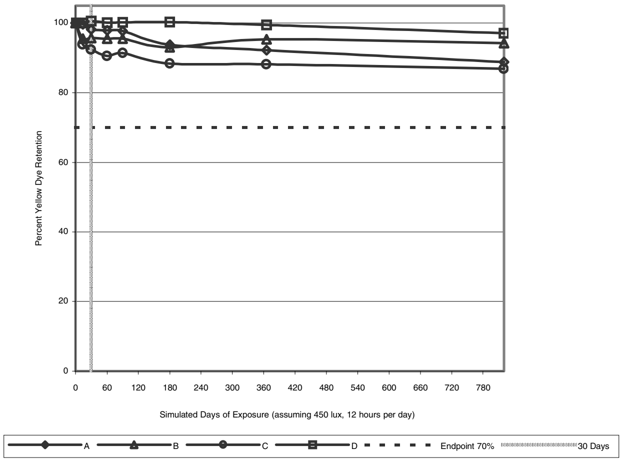

Figure 2. Percent yellow dye retention in 1.0 above Dmin pure yellow patch during exposure to 50 kilolux unfiltered cool white fluorescent light.

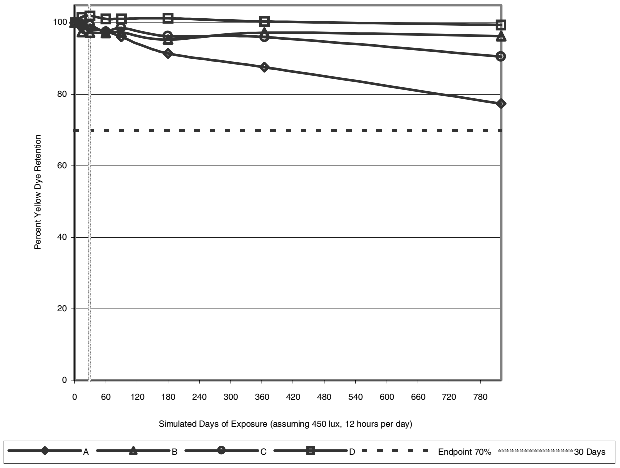

Figure 3. Percent yellow dye retention in 1.0 above Dmin neutral patch during exposure to 50 kilolux unfiltered cool white fluorescent light.

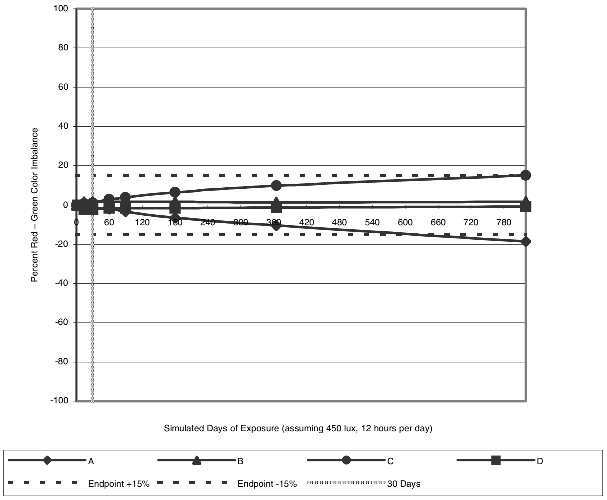

Figure 4a. Percent red – green color imbalance in 1.0 above Dmin neutral patch during exposure to 50 kilolux filtered cool white fluorescent light.

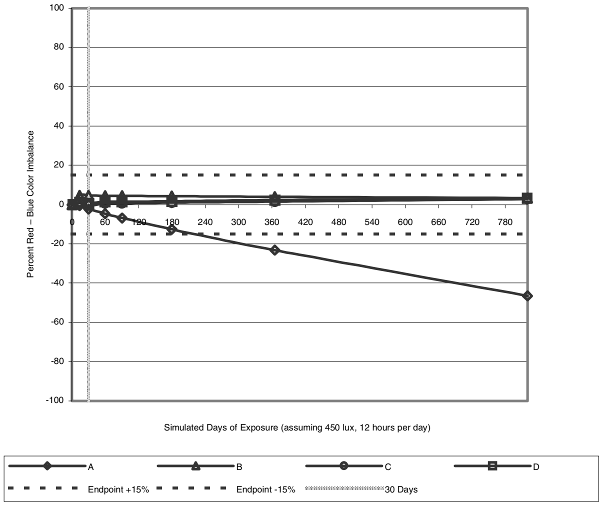

Figure 4b. Percent red – green color imbalance in 1.0 above Dmin neutral patch during exposure to 50 kilolux unfiltered cool white fluorescent light.

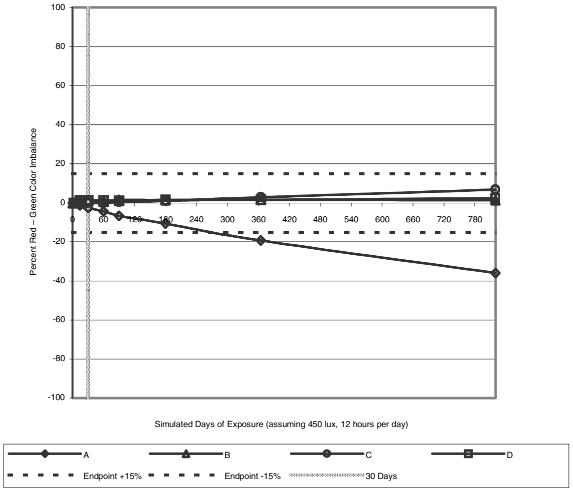

Figure 5. Percent red – blue color imbalance in 1.0 above Dmin neutral patch during exposure to 50 kilolux unfiltered cool white fluorescent light.

Figure 5 shows the red-blue color imbalance. Both samples of manufacturer A, filtered and unfiltered, show a shift towards red due to greater fading of the cyan dye and less fading of the yellow dye. Both reached the endpoint before the testing was complete. The remaining samples performed well, as they never reached either endpoint.

Color Gamut

Figures 6 and 7 show how fading affects the color gamut of the materials. Figure 6 shows the fading behavior of the least stable proofing material. Figure 7 shows that there is almost no effect on the gamut of the analog proofing material during fading.

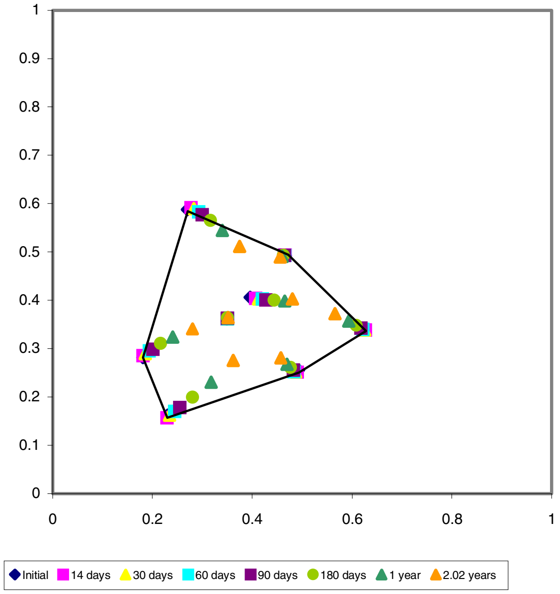

Figure 6. Chromaticity diagram (color gamut), corresponding to manufacturer A. Samples were unfiltered.

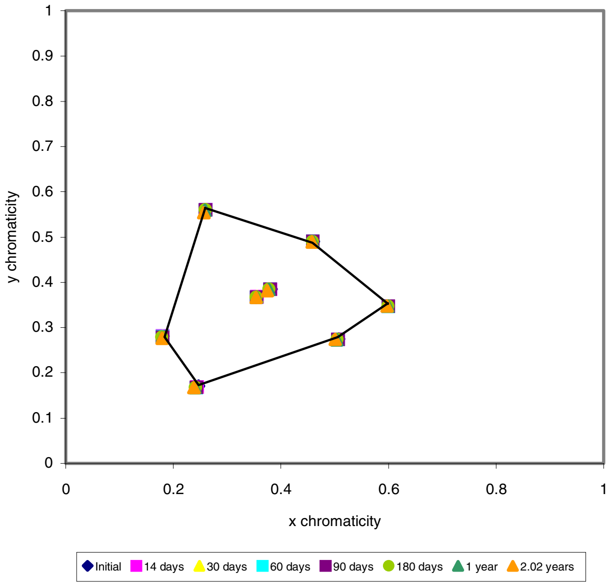

Figure 7. Chromaticity diagram (color gamut), corresponding to manufacturer D. Samples were unfiltered.

Conclusion

Regardless of the overall fading, all the samples performed very well within the 30-day period required by the industry. Overall most of the samples were very stable throughout the exposure period.

However, samples from manufacturer A, both filtered and unfiltered, showed more significant fading than any of the other samples.

An interesting twist of this investigation is that filtered samples from manufacturer D showed more fading for the majority of the testing period than the unfiltered samples.

This investigation was conducted to determine the light fastness of three digital proofing devices and one analog device as a benchmark for comparison. The result of testing is that the samples of manufacturer B performed as well and in some cases better than the benchmark over the duration of testing. In some cases the filtered samples from manufacturer C performed as well or better than the benchmark.

With regard to the image permanence of samples printed on digital proofing devices, there are a number of areas that need further study. The following studies would be of significant interest to the digital printing and proofing industry: ozone, humidity, acidity, abrasion, and fingerprint testing. These types of further testing would help evaluate, on a higher level, the effects of multiple variables in the real-work environment on the degradation of digital proofing materials.

References

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Biography

Franziska Frey is an Assistant Professor at the School of Print Media at Rochester Institute of Technology. Franziska Frey received her Ph.D. degree in Natural Sciences (Concentration: Imaging Science) from the Swiss Federal Institute of Technology in Zurich, Switzerland in 1994. Before joining the faculty of the School of Printing, she has worked as a research scientist at the Image Permanence Institute at RIT. Her work has primarily focused on establishing guidelines for viewing, scanning, quality control, and archiving digital images. Franziska publishes, consults, and teaches in the US and around the world on various issues related to establishing digital image databases and digital libraries. She is also actively involved in several international standards groups.