Image Stability of Images Printed on Acidic VS Acid-Free Paper—An Album Enthusiast's Point of View

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Abstract

Many commercially available inkjet papers are formulated with acidic paper bases. This situation runs contrary to the general recommendation for acid-free[1] papers in the scrapbook industry. Anecdotal evidence suggests that the reason for the prevalence of acidic papers may be due to the imaging industry's reliance on light stability information when comparing various papers. We have compared the performance of the same microporous inkjet coating on acidic and acid-free paper base. We confirmed that the rate of paper yellowing in the dark is greater with acidic paper bases. We also found that inkjet prints did exhibit somewhat better light stability with acidic paper bases. Consequently, the most stable paper for inkjet prints will depend on the specific paper and the intended application.

Experimental

We generated sample prints on acid-free Creative Memories Inkjet Glossy Photo Paper, **AF**, and on an acidic, non-buffered paper base with the same microporous coating, **ANB**, with an Epson 2200 pigment printer and with an Epson 960 dye printer, Table 1. Specimens were incubated at 50% RH at 40, 50, 60 and 70°C.

Table 1. Characterization of AF and ANB Inkjet Papers.

Paper	pH[2]	Lignin[3]	Buffer[4]
AF	8.1	Negative	2.3
ANB	6.4	Negative	0.0%

Densities were read with a Gretag McBeth Spectrolino Spectrophotometer, while d_{min} was read with a Gretag McBeth Spectro Eye set to read Status A reflection optical densities. Other specimens were placed at 94 klux in an Atlas CI-3000 Xenon Arc Weatherometer for 24, 48, 96, 192 and 384 hours at 50% RH, and density changes were measured with the same techniques given above.

Criteria for failure were the same as the ANSI illustrative endpoints: 30% density loss for yellow, magenta, cyan, or neutral at a density of 1.0 and 15% color balance shift for any pair of primary colorants in the neutral patch.[5] For backside yellowing, 0.08 increase in Status A blue density was used.[6]

Print life calculations assume an average illumination of 500 lx, which is the level recommended for practical appraisal of prints,[7] for 12h/day.

Results and Discussion

Thermal Yellowing

Because of the stability of ink jet images in the dark, only data for the back-side yellowing of the papers at 70°C is available at this time. The backside yellowing in a 70°C environmental chamber is shown in Table 2. As expected, the **AF** paper was more stable to thermal yellowing than the **ANB** paper. These results are for just one temperature; however, an Arrhenius series is ongoing and will hopefully result in a more complete understanding of thermal yellowing.

Table 2. Dark Stability Failure Modes and Endpoint Times for AF and ANB Prints.

Paper	Failure Mode	Days	Comment
ANB	d_{min}(B)	24	Backside yellowing
AF	d_{min}(B)	>98	Backside yellowing

Light Stability

The light fading results are more complicated. When colorants were tested separately, magenta was the least stable for dye-based inkjet and yellow was the least stable for pigment-based inkjet. Table 3 shows several failure modes for the light fading portion of this experiment. For the dye-based prints, **AF** shows considerably less image stability in two of the three modes and very similar results to **ANB** in the third mode.

Table 3. Light Stability Failure Modes for Inkjet Prints on AF and ANB.

Paper-Colorant	Failure Mode	Hours	Comment
ANB-Dye	$d_M(G)$	130	Magenta
ANB-Dye	$d_N(G)-d_N(R)$	170	Red-green balance
ANB-Dye	$d_N(G)$	230	Magenta in neutral
AF-Dye	$d_N(G)-d_N(R)$	75	Red-green balance
AF-Dye	$d_M(G)$	145	Magenta
AF-Dye	$d_N(G)$	155	Magenta in neutral
ANB-Pigment	$d_Y(B)$	220	Yellow
AF-Pigment	$d_Y(B)$	180	Yellow

The pigmented papers show only one failure mode, yellow density, during the course of the experiment. In this case, **AF** paper is somewhat less stable than **ANB** paper.

Light stability information is frequently reported as print life, with an estimate of the years to reach the first end point at a specified illumination. For dye-based systems, the projected print life is 3.2 years for **AF** and 5.6 years for **ANB**. Consequently, a manufacturer that sold **ANB** could claim a greater lifetime, even though it is formulated with acidic paper, which is generally not recommended for long-term preservation. For pigment-based systems, the projected print life is 7.8 years for **AF** and 9.5 years for **ANB**. Of course if the print is stored in an album and handled infrequently, it will never reach these endpoints. Instead, dark stability and the acidic nature of the paper will be more important.

Conclusions

Different factors control dark stability and light stability. A paper that is optimized for display may not be optimized for long-term preservation. In fact, the microporous inkjet papers evaluated in this study exhibit this behavior. For this reason, we recommend carefully considering the intended application when selecting inkjet paper.

References

1. The term acid-free is frequently not defined within the scrapbook industry. For this paper, acid-free is defined according to ISO 18902, *Imaging Materials – Processed photographic films, plates and papers – Filing enclosures and storage containers* as paper having a measured, certified cold extraction pH value within a range of 7.0 to 9.5.
2. ISO 6588:1981, *Paper, board, and pulps – Determination of pH of aqueous extracts.*
3. ASTM D1030-1995(1999), *Standard Test Method for Fiber Analysis of Paper and Paperboard,* Appendix X5.
4. ISO 10716:1994*, Paper and board –Determination of alkali reserve.*
5. ANSI IT9.9-1996, *American National Standard—for Imaging Materials—Stability of Color Photographic Images—Methods for Measuring* uses this as an illustrative endpoint, i.e. >0.3 loss from a 1.0 patch and a color balance shift of > 0.15 from a neutral.
6. ISO 18929:2003, *Imaging Materials—Wet-processed silver-gelatin type black-and-white photographic reflections prints—Specifications for dark storage,* Section 6.3
7. ISO 3664:2000, *Viewing conditions – Graphic technology and photography*

Biography

David Kopperl is a Sr. Materials Scientist with Creative Memories. He specializes in predictive testing and testing of digital materials. He holds an MS degree in Chemistry from Rochester Institute of Technology. He has been involved with Image Permanence Committees of ANSI and ISO since 1981.