Analysis of Ink Dry Down For Hexachrome Inks For Sheetfed Offset Printing

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Keywords

ink dry down, sheetfed ink

Abstract

Sheetfed inks dry mainly by absorption and oxidation. It usually takes 24 hours to completely dry. This study tests the dry down behavior of sheetfed ink from the first minute that the sheet is pulled out from the press. Each ink has a different amount of dry down. To compensate for ink dry down, wet aim must be set for solid density at the beginning to accomplish the final result of solid density value which conforms to the standard after the ink dries.

Introduction

Drying is one of the issues of lithographic printing. It is easy to make an ink that dries faster, but if it dries too fast, then it dries on the rollers. Using a drier such as UV or IR dries the ink on the paper instead of on the rollers. For decades, the printing industry has been trying to find the solution to speedier drying. New types of ink and paper are introduced, yet the dry down behavior still remains. This study is designed to show the ink dry down of one ink set on a sheetfed lithographic press.

Literature Review

Oller (2002) stated that "The past few years have seen a flurry of development in sheetfed-ink technologies, all aiming to meet the challenge of changing pressroom trends," (p. 32). In the same article, John Vogel, vice president, national accounts, Flint Ink (Ann Arbor, MI) Commercial Division said "We're seeing shorter runs requiring quicker turnaround. Printers are influenced on how soon they have to get a job printed and out the door. They need a product that will dry quicker and not give them issues in finishing," (Oller, 2002, p. 32).

A crucial property of ink is drying quality. With sheetfed inks, there are two stages in the drying process. According to International Paper Company (2004), sheetfed inks dry mainly by absorption and oxidation. Absorption is the process of the solvent penetrating into the paper which the ink sets. Ink setting is the removal of the solvent from the ink film by absorption into the stock. This raises the viscosity of the ink. Oxidation is the process in which oxygen crosslinks with the oils and varnishes in the ink to form a solid. When ink has hardened, the vehicle has completely solidified on the paper surface and will not transfer. The time it takes for liquid ink to harden to a solid state is called the drying time. Ink hardening (drying) is accomplished over a longer period of time, normally up to 24 hours. As the ink dries, the surface becomes rougher and, under normal conditions, the density is lowered by the increase in surface reflections.

Kipphan (2001) stated that one problem with offset printing is that the ink is usually not sufficiently dry after printing. This is the reason why immediate processing and finishing of printed sheets is difficult to implement (p. 356). To prevent ink setoff for sheetfed printing, often there is a fine powder sprayed on the finished print in the delivery stack. It is a challenge facing ink manufacturers to develop and bring about new ink systems for speedier drying (Kipphan, 2001, pp. 356-357).

Since the densitometer illuminates the ink surface vertically and views the reflected light at 45° the density measured approaches the true diffuse density of the body of the ink. A wet ink film will have less diffuse reflectance than a dry ink film. Consequently, as the ink film dries, its diffuse density drops. It is generally agreed that polarization filters exhibit less difference in density measurements between a wet and a dry ink film, by removing the difference between the surface reflections of the wet and the dry ink film (Tobias Associates, Inc., n.d.). Because a polarizing densitometer was not available, this aspect of ink dry down was not investigated.

Methodology

The Heidelberg Speedmaster sheetfed offset lithographic press at the Rochester Institute of Technology was used to print the cover of this Test Targets publication version 4.0. The first calibration run was on April 21, 2004, the second run was on April 28, 2004, and the final production run was on May 12, 2004. They were printed using the 6-color Hexachrome process from Pantone, Inc. Here is the ink and paper information:

Sunchemical Ink: OSSF Hexachrome Cyan Blue , O/S Hexachrome Magenta, OSSF Hexachrome Yellow, Hexachrome Orange, OSSF Hexachrome Green, OSSF Process Black.

After the press OK was achieved, one sheet was pulled and the X-Rite Auto-Tracking Spectrophotometer was used to measure the color bar that consisted of 6 solid

color patches for each ink key. Altogether 19 ink keys were scanned, and the actual average density value of each ink was collected for analysis. For each run, the readings were taken approximately at 1, 10, 15, 20, 30, 45, 60, 120, 1000 minutes, then the value was recorded in the Excel template to plot the graph of density values against time in log scale. The dry down value is calculated from the value of the solid density as first measured minus the final solid density.

Results

The first press run was for calibration and profiling. In theory, the first run should have defined the printing condition that is going to be used for the following runs. It was not known how much dry down to expect, therefore, the initial wet aim values were set to Pantone dry status T densities. For the first run, it was not understood how to read the densities of the orange and green ink with the X-Rite Auto-Tracking Spectrophotometer; therefore, only CMYK densities are reported.

	K	C	M	Y
Wet Aim	1.90	1.60	1.44	0.97
Dry Down	0.04	0.11	0.20	0.05
Deviation from Aim	0.08	0.15	0.20	0.08

Table 1: First run dry down values.

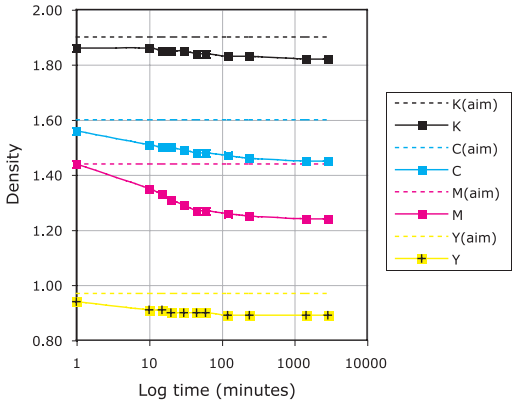

Figure 1: First run ink dry down on April 21, 2004.

Table 1 shows ink dry down and how much it deviates from the aim value. Magenta ink has the most severe drop from the initial value. Cyan ink dry down is relatively high. Yellow ink dries back less, and black ink dries down the least. Relative to the dry aim, magenta shows the most deviation, yellow and black gives the same value. As shown in Figure 1. The dashed straight lines represent the aim value while the dropping lines represent the solid density measured at corresponding time. Apparently, all inks decline in the same pattern. Most of the dry down takes place in the first 2 hours, but some further change may still take place up to after 24 hours.

The purpose of the second run was to test images with profiles. After the first run it was found that all inks dry back significantly. Taking into account ink dry down, wet aim densities were set higher than the dry aim. The same measurement procedure was applied with the second run, but this time orange, using the blue filter, and green ink, using the red filter, were included.

	K	C	M	Y	G	O
Dry Aim	1.90	1.60	1.44	0.97	1.37	1.41
Wet Aim	1.99	1.70	1.67	1.11	1.57	1.76
Dry Down	0.06	0.14	0.31	0.07	0.06	0.33
Deviation from Aim	0.03	-0.04	-0.08	0.07	0.14	0.02

Table 2: Second run dry down values.

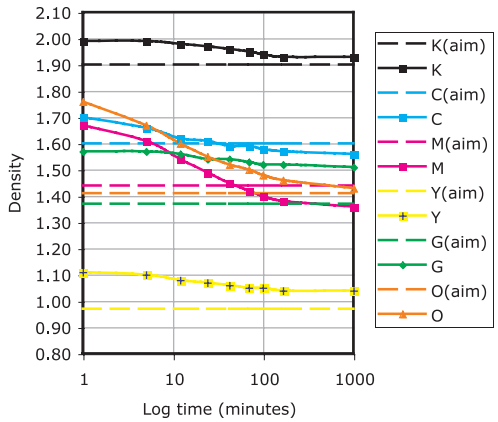

Figure 2: Second run ink dry down on April 28, 2004.

As Table 2 above shows, orange and magenta inks have the highest dry down of more than 0.30. Relative to the aim values, most inks were close except green, which had been over compensated.

Figure 2 shows ink dry down for the second run. Notice that the aim value lines are under the actual solid density because of precompensation. Surprisingly, for the second run, magenta and orange dry down was much higher than for the first run.

The third run is the final production run. The dry down values from the second run were used to set the wet aims.

Because the ink levels had to be set lower on the side of the sheet, instead of taking the actual average value of solid density across the whole sheet as we did in previous run, we only recorded ink key seven where the values were close to the aim point (except for black which was on the dark side only for that key).

	K	C	M	Y	G	O
Dry Aim	1.90	1.60	1.44	0.97	1.37	1.41
Wet Aim	1.97	1.69	1.65	1.02	1.42	1.61
Dry Down	0.07	0.09	0.21	0.05	0.05	0.20
Deviation from Aim	0.11	0.01	0.11	0.02	-0.02	0.08

Table 3: Third run dry down values.

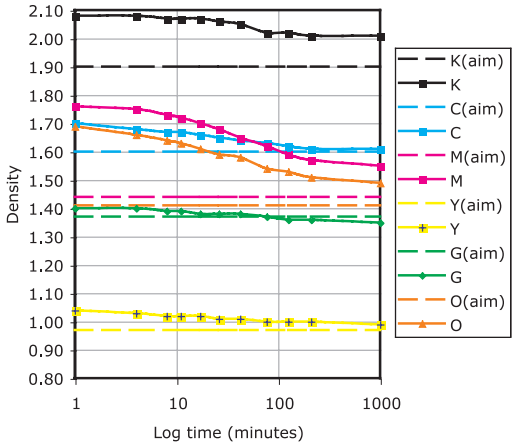

Figure 3: Third run ink dry down.

Table 3 shows the final run. Again magenta and orange have the highest value at 0.20. Black, cyan, yellow, and green have relatively small dry down values compared to magenta and orange. Relative to the aim values, cyan, yellow, and green reached the dry aim value at the end. Orange, magenta, and black remain higher value toward the end.

Trying to compensate and achieve the result of dry aim value at the end, Figure 3 shows the third run ink dry down which reflects the second run estimation. As the ink dry down less than the second run unexpectedly, orange and magenta remain high value at the end. Black is higher than the aim since the start because the ink key measured happened to be on the high side for black ink.

Discussion

Table 4 shows relative dry down values for all three runs. The data indicates that the second run has much higher dry down than the first and third run. Figures 4, 5 and 6 show the detail in graphical format. The solid density relative to the beginning measured value toward the end. In each of the three runs, orange and magenta ink dried down the most, while black and yellow dried down the least.

Dry Down %	K	C	M	Y	G	O
1st Run	2.20	7.10	13.90	5.30		
2nd Run	3.00	8.20	18.60	6.30	3.80	18.80
Final Run	3.40	5.30	11.90	4.80	3.60	11.80

Table 4: Dry down values for three runs.

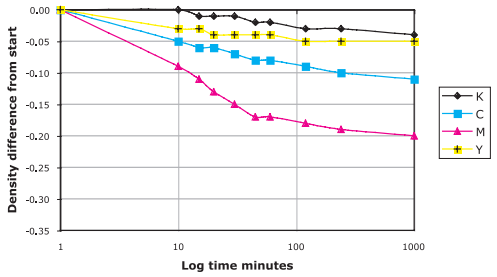

Figure 4: Relative Hexachrome ink dry down 1st run.

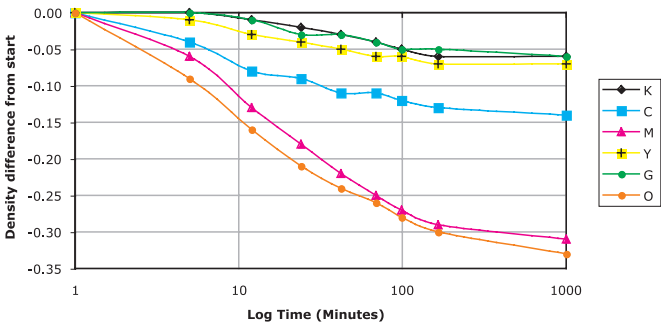

Figure 5: Relative Hexachrome ink dry down 2nd run.

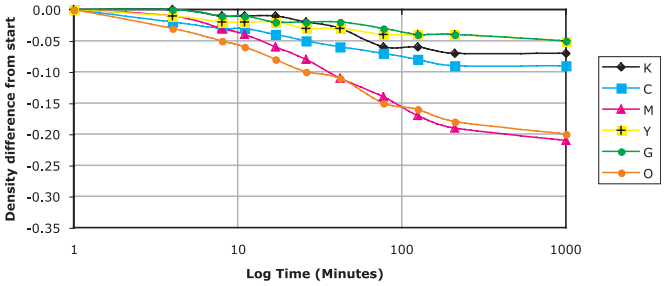

Figure 6: Relative Hexachrome ink dry down 3rd run.

Conclusion

Ink dry down must be known at the device calibration phase of the color management process. It takes up to 24 hours for ink to be dried thoroughly. Inks dry the most during the first 2 hours, and then continue to gradually drop another 0.01 to 0.02 over the next few hours. Not all inks have the same dry down, for that reason dry down has to be determined experimentally. The fact that both the orange and the magenta ink had the largest dry down, might be related to the fact that both inks are fluorescent. However, this is only a hypothesis because yellow also had some fluorescence and did not dry down as much.

Acknowledgement

Thanks must go to Franz Sigg for his help and support through completion of this study.

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