INK TRANSFER FROM THE OFFSET BLANKET

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Abstract: Ink transfer studies at GATF show that ink transfer to an offset blanket from the printing plate is similar to transfer to paper in letterpress. Once on the blanket, selected ink components are absorbed and the ink begins to set. Percent transfer to paper is less than percent transfer to the blanket for this reason. Percent transfer to paper is an inverse function of the length of time the ink contacts the blanket. When ink layers accumulate on the blanket, the stability of the last down ink increases and percent transfer approaches 100 percent. The printing speed in this experiment is slower than modern printing presses, but the interaction of the ink with the blanket could serve as a model for offset printing problems like piling in the image area.

INTRODUCTION

Ink transfer studies at GATF are concerned with transfer to and from the offset blanket as well as to the paper. In the course of these studies, the percent transfer of ink from the blanket to the paper was always less than transfer from the plate to the blanket. Part of the explanation could be the time scale of proof press printing compared to a high speed press. Proof press operation takes two to five minutes which is a long time for a thin film of ink to be at rest. Web offset inks printed to the proof press blanket turned from glossy to matte within the time of the printing operation. The same phenomenon results in non uniform solid prints. The uniformity of the solids improved if two or three layers of ink were applied to the blanket before a print was pulled. An analogous situation exists on a production press during makeready. The first few hundred impressions are waste as the press comes up to color and the blanket is "conditioned" with ink. The experiment described in this report will suggest that the first ink layer arriving at the blanket surface is immobi-

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lized to a certain extent by the blanket during the moment of impression. Transfer of ink to the blanket from the plate can be treated conceptually with the Walker and Fetsko transfer equations (Walker, 1955). An immediate consequence of ink immobilization is that not all of the ink is available for retransfer to the paper. The elastomeric offset blanket does more than just immobilize the ink film. Time and concentration dependent diffusion of ink components, such as ink oils, into the blanket face results in a dynamic immobilization which has a more familiar name in offset printing: blanket piling in the image area.

Piling in the image area doesn't occur on every printing job. As the press comes up to color and reaches steady state, it is tempting to imagine transfer from the blanket as close to one hundred percent. There should be an ink film thickness on the blanket at which the blanket can be considered "conditioned". Additional ink films printed onto the conditioning ink film would transfer to paper at higher percentages unhindered by blanket interactions. The optimum blanket ink film thickness to perform this conditioning may depend on blanket and ink type, as well as the many other variables in offset printing. An attempt will be made to characterize ink and blanket interactions, by studying ink transfer to and from an offset blanket, with a web offset and a sheetfed offset ink with various ink film thickness already on the blanket.

EXPERIMENTAL

The collection of data involved determining the amount of ink per unit area on a printing plate, blanket, and paper. All printing was done on an electronic IGT-AC2 proof press. Printing speed was a constant 0.3 meters per second (60 feet per minute) and printing pressure was a static 0.005 inch interference from plate to blanket and, including the paper 0.008 inch interference from blanket to paper. The paper was a 60 pound coated stock. Flow properties for two cyan inks used in this report are shown in Table I.

	Sheetfed Cyan	Web Offset Cyan
Viscosity, poises	298	114
yield, dynes/cm^2	2900	1360
tack, 400 rpm	13	13

Table I. Flow properties of the two inks used in this study

The same conventional 3-ply blanket was used for both inks. Blanket wash, between printing trials was pressroom quality naphtha. The ink on the plate and paper was weighed to the nearest tenth of a milligram with a Chain-o-matic double pan analytical balance. The amount of ink on the blanket was determined by difference of the weight of the plate before and after transfer to the blanket.

To study the effect of previous blanket ink layer thickness on ink transfer required that multiple, reproducible ink transfers to the blanket could be made. For example, Table II lists the ink film thickness transferred to the blanket in six independent transfers for one chosen blanket film thickness. The blanket was cleaned with naphtha and wiped dry between each transfer.

Ink Film Thickness on Plate grams/m^2	Ink Film Thickness Transferred to the Blanket grams/m^2	Percent Transfer
4.52	1.66	36.7
4.25	1.57	36.9
4.67	1.78	38.1
4.49	1.64	36.5
4.70	1.71	36.4
4.56	1.73	37.9
	1.68 average	37.1

Table II. Experimental reproducibility of ink transfer to a clean blanket.

RESULTS AND DISCUSSION

The very thin ink films of lithography and carefully balanced formulations probably change composition while in contact with the blanket surface. Composition changes result in altered tack and viscosity which would directly reduce ink transfer from the blanket similar to that shown in Table III for five separate and independent printing experiments.

Ink on Blanket grams/m^2	Time on Blanket Before transfer, minutes	Ink Transfer to Paper, grams/m^2	Percent Transfer
3.75	2.5	0.68	18.4
3.88	3.0	0.59	15.2
3.70	3.5	0.48	12.9
3.75	4.0	0.38	10.0
3.69	6	0.16	4

Table III. Influence of time on ink transfer from the blanket.

The role of the blanket in offset ink transfer can be better appreciated by examination of ink transfer without it, that is, letterpress with offset inks as shown in Table IV.

SHEETFED INK			WEB OFFSET INK		
Ink on Plate grams/m²	Ink Transferred to Ink Layer grams/m²	Percent Transfer	Ink on Blanket grams/m²	Ink Transferred to Paper grams/m²	Percent Transfer
2.03	0.36	17.8	1.94	0.41	21.5
3.49	0.91	26.4	2.88	1.02	35.8
2.71	0.69	26.0	3.20	1.02	32.2
4.13	1.19	29.4	4.23	1.64	39.3
5.32	1.69	32.3	4.40	1.78	41.1
5.50	1.67	30.9	4.90	2.01	41.7

Table IV. Percent transfer from plate to paper.

The film thicknesses on the plate are more representative of lithography than letterpress. The transfer percentages for the web ink are higher than the sheetfed ink probably due to the lower viscosity of the web ink. At four and five grams per square meter on the plate, the transfer percentages are still increasing. Complete ink coverage of the paper is not achieved at 1.7 grams per square meter. An offset print at 1.7 grams/meter^2 would be well over target density.

The offset process involves two transfers: to the blanket and from the blanket. Ink transfer data for both inks to and from a previously cleaned conventional offset blanket are shown in Appendix A. For both inks, (in the Appendix) the percent ink transfer to the blanket is decreasing as the ink film thickness on the plate increases, the opposite of data shown in Table IV for direct transfer to paper. The range of transfer percentages to the blanket for each ink is similar reflecting the ink receptivity of the blanket. Transfer percentages from the blanket to the paper are scattered ranging from 25 to 75 percent. The amount of time that the inks were on the blanket before printing to paper was five to ten seconds, just long enough to switch discs on the IGT. Variability of ink transfer from the blanket could possibly be a manifestation of residual naphtha in the blanket pores from previous printing experiments (resulting in high transfers) or interaction of ink components with the blanket surface (producing low percent transfers). Both possibilities exist.

An ink film weight of 1.7 grams per square meter on the blanket surface can be considered analogous to a piled ink layer accumulated on the blanket as the press comes to color. The effect of the blanket ink receptivity would be diminished and a wet-on-wet trapping situation should now exist. Tables V and VI show ink transfer to and from the blanket with a preexisting ink layer of 1.7 grams per square meter.

Ink on Plate grams/m²	Ink Transferred to Ink Layer grams/m²	Percent Transfer	Ink on Blanket grams/m²	Ink Transferred to Paper grams/m²	Percent Transfer
2.26	0.82	36.3	0.82	1.03	125.0
3.17	1.10	34.7	1.10	1.09	99.1
3.89	1.48	38.0	1.48	1.10	74.3
4.81	1.80	37.4	1.80	1.34	74.4
5.30	2.10	39.6	2.10	1.45	69.0
6.44	2.65	41.2	2.65	1.47	55.5

Table V. Sheetfed ink, transfer to and from 1.7 grams per square meter ink layer.

Ink on Plate grams/m²	Ink Transferred to Ink Layer grams/m²	Percent Transfer	Ink on Blanket grams/m²	Ink Transferred to Paper grams/m²	Percent Transfer
2.48	1.18	48.2	1.18	0.69	57.6
2.91	1.39	48.4	1.39	0.85	60.3
3.53	1.69	48.7	1.69	1.18	68.4
4.87	2.44	50.9	2.44	1.18	47.4
5.34	2.62	49.8	2.62	1.52	57.1
5.63	2.74	49.5	2.74	1.32	47.4

Table VI. Web offset ink, transfer to and from 1.7 grams per square meter ink layer.

The higher viscosity sheetfed ink now exhibits greater transfer from the blanket and established ink layer than the web offset ink, especially near one gram per square meter. The magnitudes of percent transfer to the inked blanket are the same. The web ink percent transfer to the inked blanket is consistently greater than that of the sheetfed ink. The 1.7 grams per square meter ink layer appears to have effectively minimized blanket interactions with the presumably higher solids sheetfed ink, but not in the case of the web ink. The web ink may be losing ink oil solvents to the blanket or previous ink layer.

The layer of ink on the blanket was approximately five minutes old, and for this reason can be compared to a piled ink layer. The ink was not dry, since the first few splits to the paper in the case of the sheetfed ink occurred within the established ink layer. Not once did this occur for the web ink which may have appreciably changed structure within the five minute period.

As the established layer of ink on the blanket is increased further, to an arbitrary 2.3 grams per square meter, the observed results are similar but more exaggerated as shown in Tables VII and VIII.

Ink on Plate grams/m²	Ink Transferred to Ink Layer grams/m²	Percent Transfer	Ink on Blanket grams/m²	Ink Transferred to Paper grams/m²	Percent Transfer
2.14	0.41	19.1	0.41	1.27	309.7
2.88	0.68	23.5	0.68	1.18	174.3
3.85	1.27	32.9	1.27	1.09	85.8
4.70	1.78	37.8	1.78	1.32	74.2
5.46	2.10	38.5	2.10	1.59	75.7
5.46	1.94	35.5	1.94	1.70	87.6

Table VII. Sheetfed ink, transfer to and from 2.3 grams per square meter ink layer.

Ink on Plate grams/m²	Ink Transferred to Ink Layer grams/m²	Percent Transfer	Ink on Blanket grams/m²	Ink Transferred to Paper grams/m²	Percent Transfer
2.19	1.05	48.7	1.05	0.83	77.9
3.06	1.46	48.5	1.46	1.16	78.0
3.64	1.78	49.7	1.78	1.34	74.0
4.36	2.08	48.5	2.08	1.36	64.1
5.27	2.55	49.1	2.55	1.79	69.2
5.63	2.87	51.8	2.87	1.52	52.2

Table VIII. Web offset ink, transfer to and from 2.3 grams per square meter ink layer.

CONCLUSIONS

The data shows that ink transfer from an offset blanket increases as the thickness of ink in a piled layer on the blanket, the effects of the blanket imbibing ink components, and vice versa, is minimized. For this particular sheetfed ink and blanket combination, the ink film thickness required on the blanket for blanket isolation is less than for this particular web offset ink. The web offset ink is lower in viscosity, and one would expect greater percent transfer than the sheetfed ink, all other things being equal, unless there was blanket absorption of ink oils or piling of the web ink.

REFERENCE

Walker, W. C., and Fetsko, J. M.,

1955, "A Concept of Ink Transfer during Printing", American Ink Maker, 33 (12), p. 38.

Appendix A. Ink Transfer to a Clean Offset Blanket

Sheetfed ink transfer to clean offset blanket

Ink Film Thickness on plate grams/m^2	Ink Film Thickness on Blanket grams/m^2	Percent Transfer	Ink Film Thickness on Paper grams/m^2	Percent Transfer
2.61	1.12	43.7	0.61	53.9
2.26	0.80	36.0	0.65	80.0
2.35	1.12	48.5	0.45	39.7
2.15	1.09	51.3	0.53	47.5
2.04	1.02	50.4	0.34	33.3
2.70	1.16	43.6	0.51	43.1
2.88	1.30	45.9	0.35	28.8
2.66	1.21	46.3	0.53	42.6
2.79	1.27	46.1	0.33	25.3
2.32	1.15	50.0	0.36	31.2
2.55	1.03	41.1	0.36	34.5
3.06	1.25	41.4	0.54	42.9
2.68	1.03	39.2	0.53	50.0
2.97	1.10	37.8	0.49	43.5
2.91	1.35	47.2	0.78	56.6
3.78	1.48	39.7	0.65	43.4
3.84	1.60	42.4	0.47	28.9
3.89	1.56	40.0	0.98	62.8
3.98	1.41	35.9	1.07	74.7
3.94	1.57	40.5	0.76	47.7
4.63	1.76	38.7	0.81	45.5
4.60	1.73	38.2	0.79	45.4
4.51	1.76	39.7	0.22	12.1
4.49	1.66	37.5	0.69	40.8
4.67	1.62	35.3	0.76	46.2
5.23	1.94	37.7	0.98	49.5
5.14	1.84	36.3	0.69	36.9
5.37	1.91	36.0	0.83	42.9
5.05	1.91	38.3	0.81	42.0
4.92	1.87	38.6	0.87	45.7
6.15	2.01	33.2	1.03	50.4
6.04	1.98	33.2	0.83	41.4
6.08	2.00	33.3	0.81	40.2
6.15	2.01	33.2	0.90	44.2
6.04	1.87	31.4	0.94	49.5
7.20	2.14	30.2	0.92	42.5
6.71	2.08	31.5	0.78	36.7
6.93	2.14	31.3	0.81	37.5
6.35	1.89	30.2	0.89	46.2
6.82	2.19	32.6	1.16	52.0
7.51	2.05	27.7	1.21	58.3
7.44	2.26	30.9	0.90	39.4
7.42	2.26	30.9	0.81	35.4
7.80	2.39	31.1	1.05	43.3

Web Offset ink transfer to a clean blanket

Ink Film Thickness on Plate grams/m²	Ink Film Thickness on Blanket grams/m²	Percent Transfer	Ink Film Thickness on Paper grams/m²	Percent Transfer
1.81	0.93	52.0	0.65	69.2
2.68	1.18	44.6	0.54	45.4
3.58	1.66	46.9	0.83	49.5
3.71	1.69	46.3	0.56	32.6
3.87	1.67	43.9	0.72	42.5
3.51	1.59	45.8	0.76	47.2
3.82	1.57	41.7	0.81	51.1
4.05	1.82	45.5	1.09	58.8
5.41	2.00	37.5	0.89	43.7
4.74	2.01	43.1	0.94	46.0
4.36	1.85	43.1	0.53	27.9
4.72	2.07	44.4	0.74	35.3
4.27	1.94	46.2	0.65	33.0
5.10	2.60	51.8	0.96	36.3
5.41	2.23	41.8	0.62	27.2
5.14	2.10	41.5	1.63	76.3
5.05	2.17	43.7	0.71	31.9
5.75	2.30	40.6	1.14	48.8
5.41	2.37	44.5	1.03	42.8
5.77	2.55	44.8	1.01	39.2