PHOTOPOLYMER PRINTING PROBLEM RESOLUTION AT U.S. GOVERNMENT PRINTING OFFICE

George J. Collins* and William T. Strahan*

Abstract: The U.S. Government Printing Office has converted its magazine presses used to print the Congressional Record and Federal Register from stereo plates to steel backed photopolymer plates of the same dimension mounted on magnetic saddles. This paper details some of the unexpected problems that have accompanied this conversion and the practical solutions developed which could be helpful to others using photopolymers.

Introduction

In 1979 Mr. John R. Werner of the New York Times reported on their effective combination of laser platemaking with both offset and letterpress equipment. The Times had decided to postpone the day for surplusing their multimillion dollar investment in letterpress equipment by switching from stereo plates to photopolymers. Automation of one of our major products, the Federal Register, forced the U.S. Government Printing Office into a similar decision. The Register does not require laser platemakers but is produced from computer tape fed into the GPO high speed Videocomp phototypesetting equipment which produces negatives ready for plating. Our second major product, the Congressional Record, was then being produced by hot metal composition by techniques perfected over many years of service to Congress. We faced the situation that our conversion from stereo to photopolymer had to integrate with both a hot metal and photocomposition prepress operation.

The many restrictions created by the conflicting requirements of the old and the new prepress processes forced us to make some compromises in the selection of a photopolymer plate and how to attach it on the plate cylinder. The details of these studies are given in the United States

*U.S. Government Printing Office

Government Printing Office Technical Report No. 13 published August 12, 1977. While Technical Report No. 13 details how many of our problems were solved, it was not the end of our story. In spite of efforts to anticipate all eventualities by running the new plates on some presses and our stereo plates on others side by side, we had some surprises. Long after the conversion was completed and the stereo plate operation was phased out, we continued to experience unexpected difficulties.

Inks for Plate Printing on Newsprint

The December 6, 1979 issue of the Wall Street Journal carried an interesting front page article, "Ay, There's the Rub: Big Stink Over Ink Makes Press Rethink," by Daniel Machalaba. Mr. Machalaba's primary concern was the apparent rise in complaints about newspapers ink smudge which they concluded could be differences between stereo and photopolymer plates. Our work does not support that conclusion.

Prior to our press studies most of our news inks suppliers suggested that the only concession that needed to be made for the use of magnetic saddles and photopolymers plates was to filter out any iron and other magnetic particles from the ink. Inks of different densities, viscosities, and tacks were tested to insure print quality and to determine if better quality could be achieved. A panel subjectively, visually ranked the print quality.

TABLE I

	Ink	Tack "Tacko Meter" (gm at 400 & 900 rpm)	Viscosity (Brookfield) (Centipoises)	Density (MacBeth)	Visual Print Quality Rank
1.	Stock News Type	4.5-9	1220	(1.10-1.16)	8
2.	H.S. Offset Black	4.5-10	232	(1.30)	9
3.	#31 Special	5-11	530	(1.22)	7
4.	#1 Special	3.5-7.5	216	(1.30)	3
5.	Commercial	13.5-23	-	(1.10-1.51)	10
6.	#22 Special	4-8.5	340	(1.40)	2
7.	Offset Black #1	9-16.5	10,000	(1.30)	4
8.	Offset Black #2	14.5-23	10,000	(1.40)	6
9.	Stock Web Book	2-5	348	(1.16)	5
10.	Safety Blue	9.5-18	-	(.66)	1

Table I lists the salient feature of the inks used for this press test. Tack and viscosity were the parameters that we assumed might be significant. It was interesting that for this test the press was extremely tolerant of these differences and no dramatic differences in print quality were found. We would discover that longer running time uncovered other variables which will be discussed in detail later. Since differences were minor we selected a small panel of experienced technologists to rank the signatures for print quality from best to 10 worst. As you can see, our standard or stock ink merited only an 8 while number 1 was given to a special safety ink. The safety ink combined a high tack with a low viscosity. The inks ranked 2nd and 3rd were more conventional formulations but flow was not the only variable that led to a higher print quality rating. More highly toned inks including those of much higher viscosity received respectable ratings.

The density of the inks was measured on the signatures and the lower figure represents that obtained at normal packing and ink feed settings. Higher readings were obtained by increasing either or both of these. Thus, in every case a higher pressure increased ink transfer and produced somewhat higher density with some embossing and increasing the ink feed produced higher density with some fill in. Neither approach was acceptable to production. In addition, the higher pressure led to plate movement while the higher ink levels led to smudge problems in handling or in extreme cases build-up on folder bars and tracking.

In a further effort to confirm the ratings of our print quality panel, the prints were also evaluated on our Omnicon Image Analyzer for percent coverage.

The unexpected finding was that all of the prints were exactly identical in percent coverage. In other words, none of the inks had actually covered any more area of the print than another. The finding would be acceptable if there were no voids, but ink was simply not being transferred from many areas of the plate and the variations observed were in the depth of color, not coverage.

Inasmuch as the study had included a wide range of tack, viscosity, and inks of several different solubility characteristics, it appeared quite unlikely that changing ink

alone would lead to any significant improvement. The standard news ink was deemed to be the best choice for regular work since it was commercially available and economical. Formula 22 was however selected as the ink of choice for higher quality work.

FORMULA 22

"Urethane alkyd" (300P)	35.0
70% solids Oleoresinous varnish (#9 Viscosity)	25.0
Co/Mn drier	0.5
Polyethylene alkyd compound	4.0
Carbon Black Blue shade	20.0
Wax compound	0.125
"Solvent 470"	11.325
	100.0

We were prepared to stop studying ink at this point. The differences had been marginal and changing to softer plate materials and other papers showed much greater promise for improved quality. The pressroom continued to use the standard ink and newsprint and on April 10, 1979 the last press had been converted to use photopolymer and our stereo plate operation was phased out. But all was not well. A new but elusive problem had appeared in February. Paper dust was periodically building up on some press units printing from photopolymer plates and was causing lost production time. The same paper performed well in our offset operation and moisture measurements did not support the supposition that the paper was dry. The build-up was not noted on stereoplates. The fact that a new shipment of ink was involved led to a close check of the ink but nothing unusual was found.

However, there was the hope that the problem might be minimized by a change in ink. The problem was randomly periodic which complicated analysis, but a pattern ultimately emerged that showed one ink performing markedly better than others. The problem was that under standard Q.C. test conditions that were employed the "good" and "bad" inks matched exactly in tack and were judged equivalent in all other tests. Since standard conditions showed no differences we decided to test at press conditions.

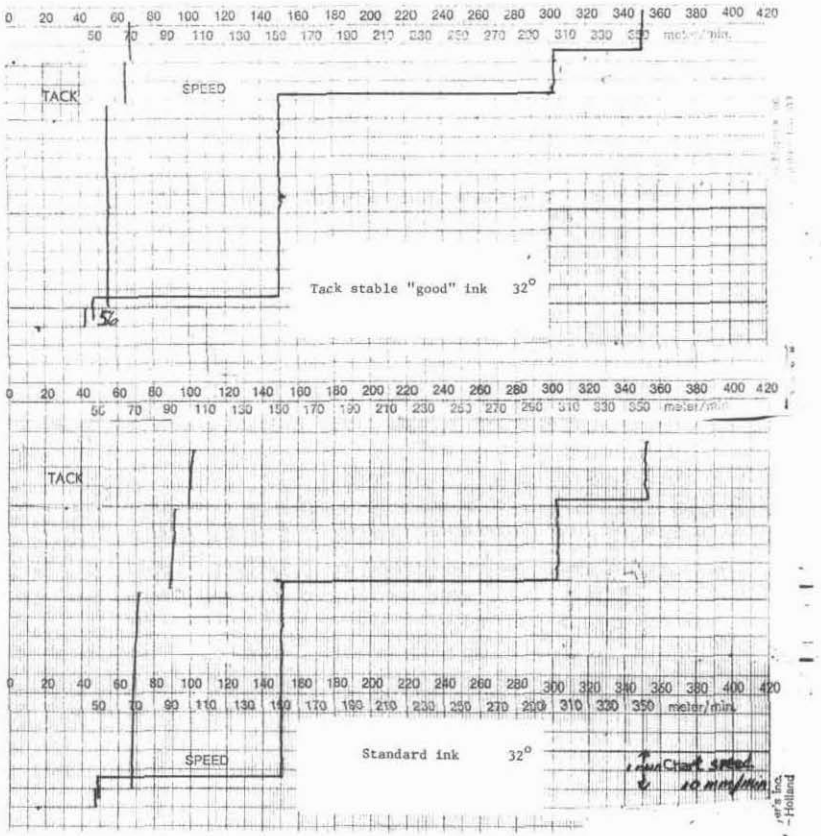

Figure 1. Tack stability compared under standard conditions - 32° C

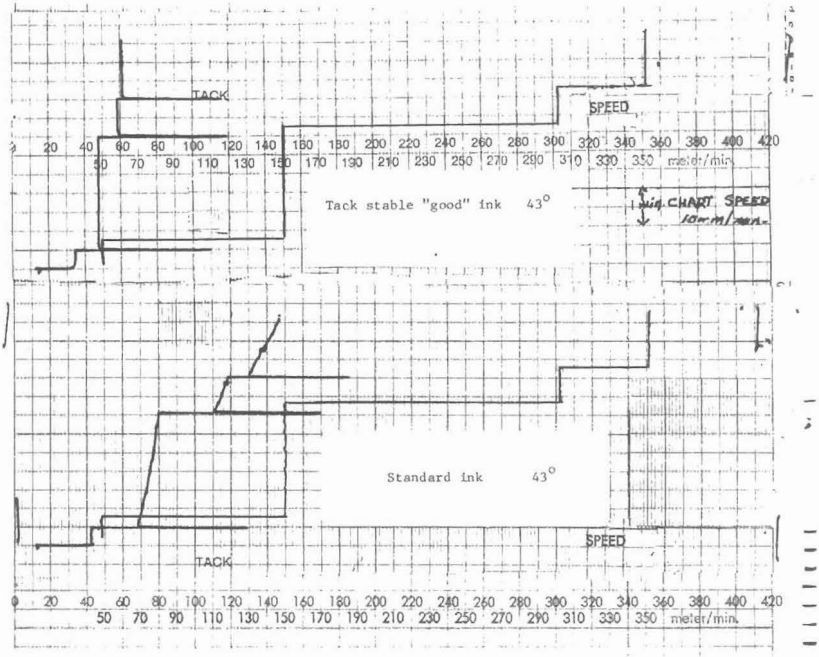

Figure 2. Tack stability compared at press conditions 43° C

TABLE II

Press Surfaces Temperature
during Operation

Form Rollers	102° F
Steel Rollers	104° F
Magnetic Saddles	100° F
Photopolymer Plates	99° F

This proved to be the critical parameter. Tackoscope readings (Figure I and II) showed that the inks with no problem also had no tack gain at elevated temperatures while the standard ink showed considerable gain in tack. The interesting fact was that the "bad" standard ink had given no problems during more than three years on presses equipped with stereo plates but encountered serious difficulties when the entire press was equipped with photopolymer plates. Other factors may also be at work since the static charge generated exceeded 50,000 volts as measured on a 3M StaticMeter. Such a charge could be dissipated through metal conductors but not plastic non-conductors. But the findings were clear, the tack stable ink did not give the problems. In all cases (including printing with stereo) paper dust feeds back into the fountains but only led to problems with plugging when the ink tack was not temperature stable. The tack stable "good" ink formula is as given. Several ink companies are now supplying an equivalent ink against our specification.

TABLE III

Specifications for Record News Ink, Black GP-162

1. Printing Characteristics

The ink is used with magnetic-saddle mounted nyloprint and stereotype plates and shall give clean sharp prints at speeds up to 21,000 impressions per hour. It shall give adequate coverage for both line cut and text matter.

2. Drying Characteristics

A. On the Press

The ink shall not dry on the press while running and on presses standing from one shift to another without wash-ups.

B. On Paper

The ink shall be quick drying and suitable for use on newsprint and on hard surface papers such as chemical wood Writing and Machine-Finish Book. There are no dryers on the press.

3. Press Characteristics

The ink shall not track or build up excessive deposits on the second cylinder. The press uses varsol wipers on the second side impression cylinder. The ink shall not create deposits on bars or idlers as web traverses folder thus resulting in smears or streaks sufficient to impair the quality of the finished product.

4. Tack Characteristics

The ink shall not have a tack greater than seven at 1200 rpm on the Inkometer nor shall it cause picking of fibers with subsequent fill-up of the type. On the Tackoscope the ink shall exhibit no change in tack over a three minute period at a speed of 350 meters per minute and at an elevated temperature of 43° C (110° F) which simulates press conditions.

5. Misting

Ink misting that occurs shall be slight or none at all.

6. Odor

The ink shall have no objectionable or injurious odor.

GPO RECORD NEWS

Predispersed Carbon Black	70
Mineral Oil	30
	100%

Studies on Other Paper Stocks

Our previously published press studies (Technical Report #13) showed that we could achieve superior print quality on most of our stock papers by utilizing a hard smooth packing and high pressure with photopolymer plates such as BASF Nyloprint. In actual practice this approach worked best on slower flat bed and sheet fed rotary presses but faced severe limitations on the Cottrell webs. On our webs high impression pressures caused plate movement and ink set off on the back cylinder packing. Consequently, additional studies were made on techniques to overcome these limitations.

Tests made on the Prufbau printability furnished proof of the prediction that a less rigid printing surface would require less ink and pressure resulting in better print quality (See Table IV). Other studies have reached the same conclusion (Ref 2).

Table IV

Volume of Ink	Pressure of Print	Print Form Type	Density
0.06 cc	11 Kp/cm*	blanket	1.11
0.06 cc	22 Kp/cm	metal	0.88
0.09 cc	11 Kp/cm	blanket	1.28
0.09 cc	22 Kp/cm	metal	1.14
0.12 cc	11 Kp/cm	blanket	1.38
0.12 cc	22 Kp/cm	metal	1.28

*1 Kp = 9.81 Kg m sec^{-2} = 10 N

Obviously then the most promising parameter to improve performance was to modify the plate. We then experimented with developing and exposure techniques that would produce variations in the photopolymer. It was possible to introduce a micro cellular pattern on the plate surface or to underexpose to produce a softer plate. While such plates gave a higher fidelity print they lacked durability and were not practical.

In this work we follow a procedure suggested by NAPIRI (at the SPSE Conference 1978) and utilized a Sward rocker to discriminate the relative differences in plate hardness. The softest plate averaged 12 oscillations in 14 seconds, and the hardest 70 oscillations in 20 seconds.

However, substituting an elastomer plate for the harder polymer under the same press conditions produce a dramatic improvement. These findings support the observations by Deshpande et al TAGA 1977 that elastic plate surfaces will improve the fidelity of impression.

Unfortunately, the only available steel backed elastomeric plates are too expensive for our use, and we were faced to strive for lower cost alternatives.

Thus left the ink as the only variable lending itself to easy modification. Deshpande's analysis indicated ink rheology would be a factor only at low periodicities which represent the microstructure of the system. Nonetheless, both Deshpande and a study by Cozzens suggest an ink that would permit higher print film thickness would be beneficial. The following formula modification gave significant improvement in this regard particularly on paper stocks with higher ink holdout such as MF Book.

FORMULA #102

Predispersed Carbon Black	69.0
Urethane Alkyd (500 P)	20.0
Alkyd (10 P)	10.0
Drier	1.0
	100.0

Process Problems

The conversion from metal to photopolymer led to several other unique problems. While we could continually recycle type metals the photopolymer materials cannot be recycled. Used photopolymer plates proved to have a no market value and have to be discarded in a process such as landfill acceptable to environmental authorities. In our system the ethyl alcohol wash out solution was redistilled leaving a sludge which posed a tough disposal problem.

If the distillation is carried to dryness it is difficult to remove the solid polymer. Thus, the distillation is interrupted and the syrupy residue poured off into a drum. Eventually the residue skins over, but it still contains 40-50 percent alcohol by weight. Although it is in a gel state it is easily ignitable and burns freely with a nearly invisible flame.

One of the characteristics defining a hazardous waste in the proposed EPA regulations is ignitability. (Subtitle C of the Resource Conservation Recovery Act of 1979.) For this reason District of Columbia solid waste officials would not allow the sludge to be disposed of in a landfill. A treatment method was then devised in which three parts hot water was mixed with two parts sludge using a small ink disperser. The water extracted the alcohol causing the polymer to precipitate.

The solution is then decanted leaving a non-ignitable alcohol-free solid acceptable to landfill authorities.

Acknowledgements

The authors wish to acknowledge the significant contribution to this work and the preparation of this manuscript from Dr. A. Materazzi, V. Corrado, J. Gouin, C. Wong, and R. Praskievicz of our Quality Control and Technical Department and the fine cooperation of the craftsmen in our Press Division.

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