

THE PHYSICO-CHEMICAL PROPERTIES OF WATER BASED
FLEXO NEWSINK AS COMPARED TO CONVENTIONAL
FLEXO AND OIL NEWSINK

-O. Wasilewski and P. Ernest-

ABSTRACT:

The physico-chemical properties of commercial flexo printing inks based on both solvent and water were characterized. The results are compared with water based flexo newsink currently supplied for the new Anilox newspaper printing process.

Comparative data from conventional oil based newsink is also presented and compared. The overall results indicate that water based flexo newsinks must be unique in properties in order to satisfy the requirements of the newspaper industry.

INTRODUCTION:

Installation of the first flexographic press in a newspaper press room in 1981 signified the beginning of a new era for newspaper printing. However, the requirements of newspaper printing are so vastly different from those of other flexographic markets, that a completely new approach in the design of the press, printing plate and formulation of the printing ink was necessary.

In the early days of development, it became quite apparent that due to the complexity of the newspaper printing process, a systems approach was needed to eliminate a multitude of persistent problems. In the few years following the first flexo press installation, we have seen extensive and unprecedented

collaboration among the companies representing all segments of flexo technology. This effort produced substantial gains in the runnability of the press and quality of print. It is reassuring that the atmosphere of cooperation in developing this new technology still continues. Only under these conditions can flexography in newspaper printing sustain the necessary future growth. With this growth, the shared data and experience will guarantee the needed process improvements.

In the last four years, we have seen a continuous evolution in the performance qualities of the presses, photopolymeric plates and printing ink. This evolution has reached a stage where commercially accepted quality can be produced during daily production runs. A flexo printed newspaper is the best testimony to the commercial status of this new process.

Just recently we have introduced a new waterbased flexo newspaper ink which in all trials conducted under various production conditions yielded improved print quality and higher print densities. The improved performance was sufficient to warrant a full evaluation of the physico-chemical properties of this ink in order to correlate its printability with characteristic and measurable parameters. The lack of laboratory test methods, which can provide this sort of correlation, is a serious hindrance in the ink development process. A trial and error approach provides an obvious element of risk in that the modification made to the ink may not necessarily yield desired and positive results. This situation further underlines the need for close cooperation between the user and supplier of an ink.

In our study, the physical chemical properties of a new and improved waterbased flexo newsink has been compared to a previous generation ink. It was also interesting to compare the obtained results to properties of other flexo inks supplied to mature and long existing

flexo markets, such as corrugated and polyethylene film printing.

Since both the flexo and letterpress printing processes utilize, in principle, similar relief printing plates, we have also included in the study a conventional oil based newsink. After all, both of these inks are printing on the same substrate and at exactly the same speed. Comparison of properties between these two products may be of interest.

Experimental:

Inks selected for this study represented three distinct market areas of flexographic printing. All samples were black and were production batches of commercial products which underwent a routine quality control test and were found to be within specifications. Concentrations of pigments in these inks were similar, but the chemistry of the binder or vehicle varied. The viscosity of all flexo inks with Zahn #2 at 25 deg. C was 25 sec. \pm 2 sec. Table I lists inks included in this study .

Table I

Description of Inks

1. W/B F Newsink Standard
2. W/B F Newsink Experimental
3. S/B F for PE film
4. W/B F for PE film
5. W/B F Corrugated Ink
6. O/BL Newsink

Both solvent and oil based inks represented products used for a long period of time, hence their formula and performance have been optimized. They both have a long history of commercial success and their rheology could

have value as a model. The other water based inks, although much newer, are large volume products with an established reputation of well balanced performance properties.

Surface tension of inks was determined with the Du Nouy surface tensiometer. Results are listed in Table II.

Table II

Surface tension of flexo inks at 25 deg. C in dynes/cm.

1. W/B F Newsink standard	-	39.0
2. W/B F Newsink experimental	-	37.4
3. S/B F for PE Film	-	22.3
4. W/B F for PE Film	-	36.0
5. W/B F Corrugated Ink	-	27.6

It was interesting to note that the surface tension of the polyethylene inks varied substantially. Yet both inks printed and wet treated polyethylene film satisfactorily. Since both W/B F newsinks printed at all commercial speeds without second impression cylinder set off, it can be inferred that their surface tension is adequate to wet and penetrate the newsprint. It was observed, however, that the wetting of some photopolymer plates was occasionally borderline. It is evident that the low surface free energy of these cured photopolymers creates a wetting problem for water based inks. In extreme cases, it may lead to a mottled appearance of solids.

Due to relatively high printing speeds, any information about the dynamic or non equilibrium surface tension would be much more important. In our laboratory, the only available instrument for dynamic surface tension measurements operates on the principle of measuring the air pressure

required to form bubbles at a given frequency. The pressure is proportional to the dynamic surface tension. This instrument, although very valuable, is difficult to operate with pigmented and resin containing systems. Better techniques to facilitate dynamic surface tension measurements are needed to gain a more intimate knowledge of the ink-plate and substrate inter-reaction at high printing speeds.

Lowering the dynamic surface tension, even by a few dynes/cm., is not as easy a task as it might seem. Most surfactants are very effective in lowering the equilibrium surface tension, but they become progressively less efficient with increased printing speed. This deficiency to some extent can be compensated with concentrations of carefully selected surfactants, but inadvertently may lead to a foaming problem. In the best case, balance between these properties is a compromise rather than a satisfactory solution to a problem. It is obvious that better print quality can be achieved when the surface properties of the ink and plate are matched properly.

A few experiments conducted in our laboratory with various flexo inks indicate that the dynamic surface tension of water based inks is higher than previously thought. Although more work has to be done in order to confirm initial observation, it is believed that under high speed printing conditions it is not far from that of pure water.

The apparent viscosity of inks at various rates of shear was measured with the Haake RV-100 viscometer. The instrument has a series of cones and bob and cup attachments for liquid inks. A dedicated computer operates this instrument in various modes, providing information about the thixotropy and the shear thinning of inks. Figures 1 and 2 illustrate the log log plots of apparent viscosity of inks obtained with bob and cup in the shear range of 1.5 to 15 sec.⁻¹ and 30 to 300 sec.⁻¹

ranges respectively. The apparent viscosity of both W/B F newsinks is shown in Figure 3. These curves were obtained with the cone and plate attachment at shear rates from 20 to 2500 sec.-1.

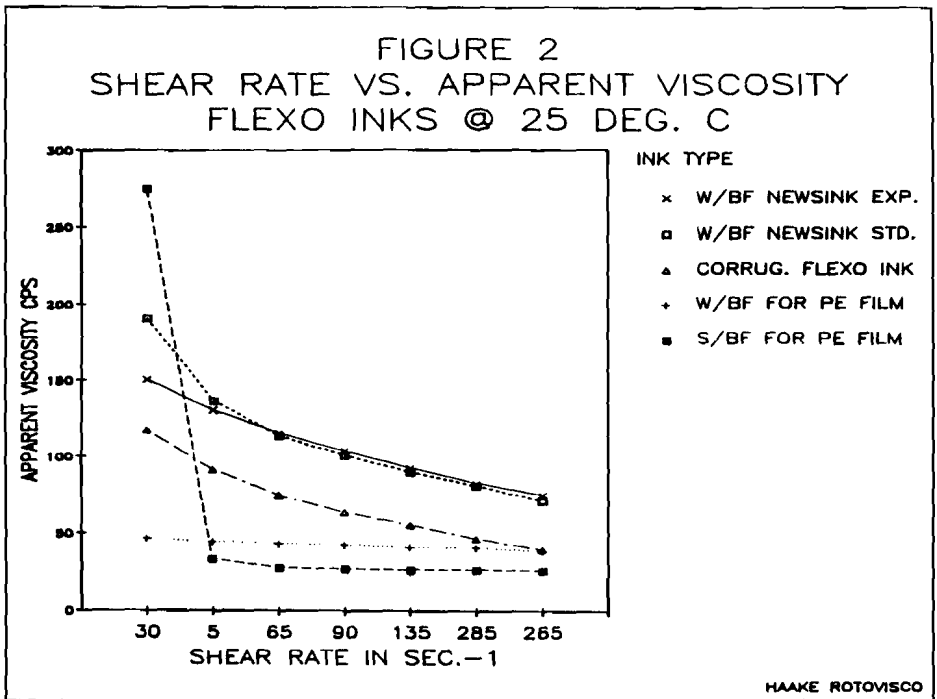
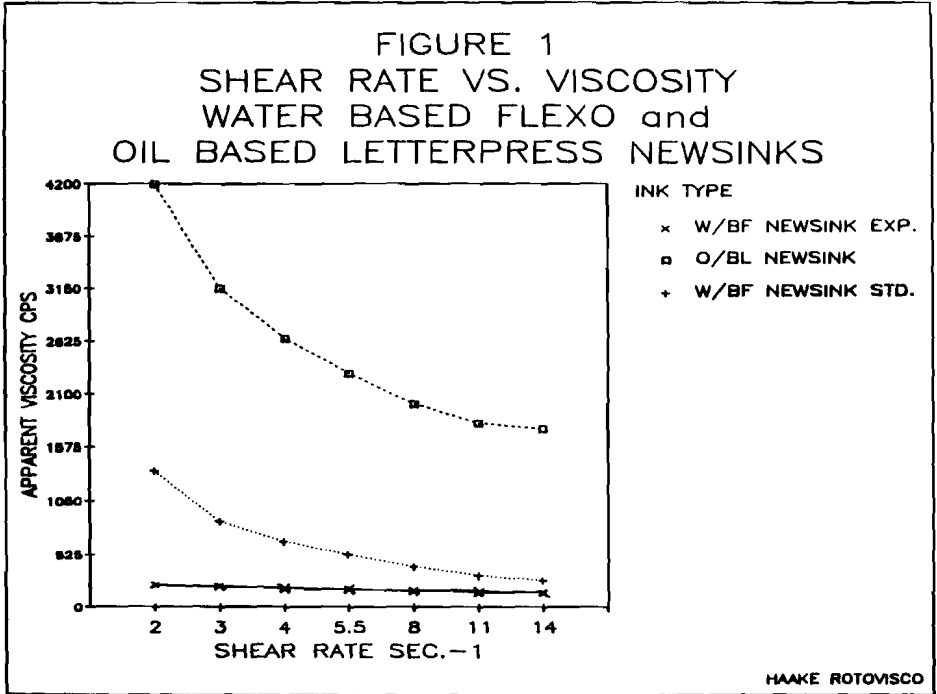
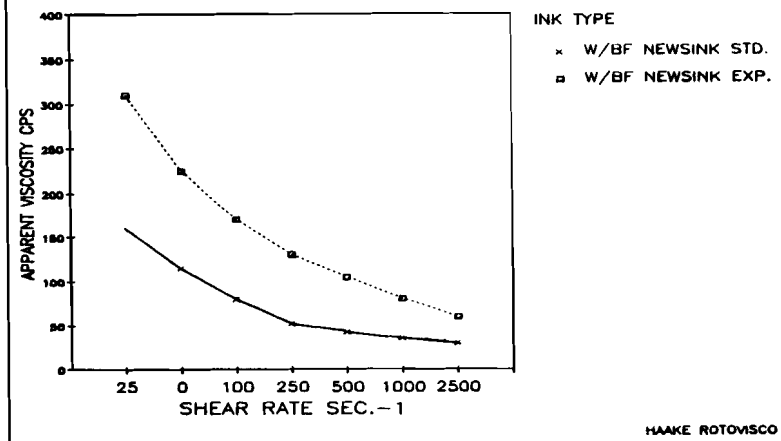


FIGURE 3
SHEAR RATE VS. APPARENT VISCOSITY
WATER BASED FLEXO NEWSINKS
@ 25 DEG. C



It was not feasible to measure all inks selected for this study in all shear rate ranges. However, a review of obtained results indicates special interesting properties.

Figures 1, 2 and 3 depict various shear thinning effects of all inks. For the W/B F newsinks, this effect extends beyond 2500 sec.-1 as can be observed in Figure 3. At that shear rate the apparent viscosity of the newspaper inks was substantially higher than that of other flexo inks.

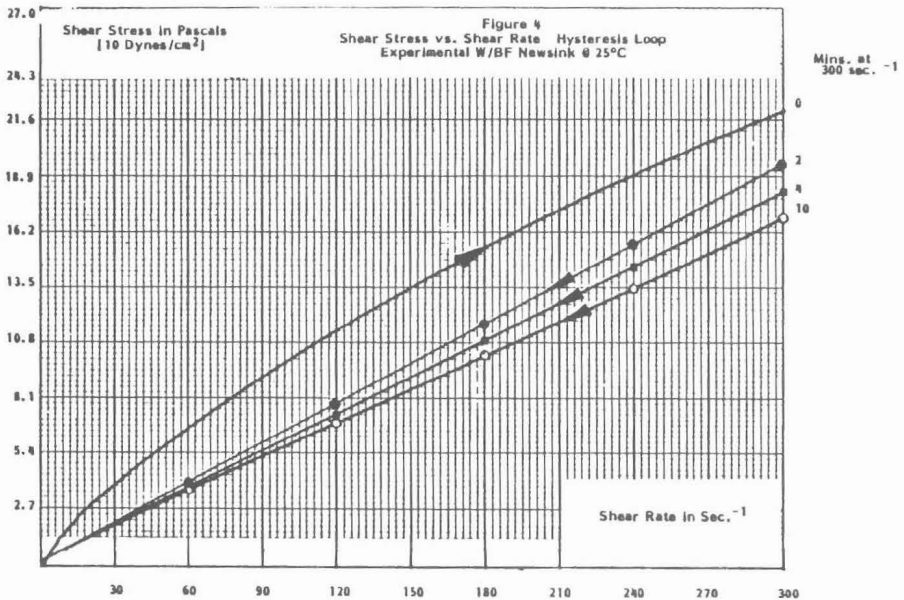
Beyond 60 sec.-1, both polyethylene inks approach nearly Newtonian character. This property indicates an excellent flow characteristic of ink after only mild agitation or applied shear. These properties were specifically formulated in order to provide adequate leveling and gloss on the smooth and impervious polyethylene film. Substantially higher viscosity of the solvent based ink at the low shear rate provides a useful purpose. It impedes pigment settling, thus providing more shelf stable inks.

The viscosity of oil based letterpress newsink in the low range of shear was an order of magnitude higher than for all other flexo

inks. At the higher shear range, the viscosity of this ink was completely off scale.

The thixotropy of inks was measured by applying shear from 0 to 300 sec. ⁻¹ and maintaining a constant shear rate for 2, 4 and 10 minutes at 300 sec.⁻¹. The drop in apparent viscosity at that point is a measure of an ink's thixotropy. Applying this procedure to all inks revealed that only the water based flexo newspaper inks possessed thixotropy. The shear rate/shear stress curves indicating thixotropy of these inks are shown in Figure 4 for W/B F newsink experimental and in Figure 5 for the standard ink. These results are further summarized in the bar chart of Figure 6.

Review of these results, in conjunction with Figures 1, 2 and 3 indicated a very interesting property. The experimental flexo ink is less shear thinning, but at the same time more thixotropic. The standard ink has reversed properties. Thus it shows more shear thinning and less thixotropy. Both of these inks illustrate that thixotropy and shear thinning are two independent properties of inks and dispersions. The thixotropy of these inks is also very useful since it prevents pigment settling.



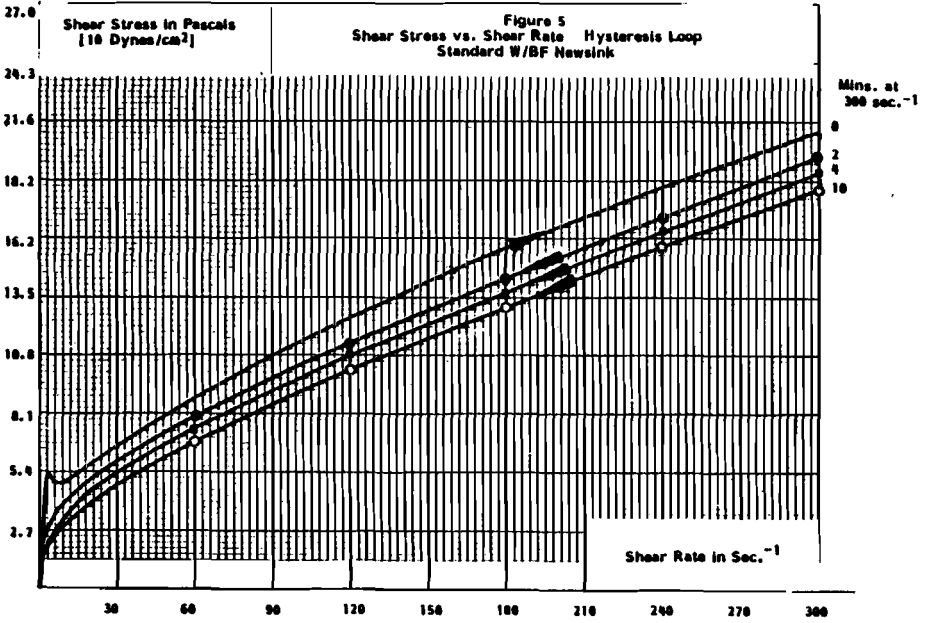
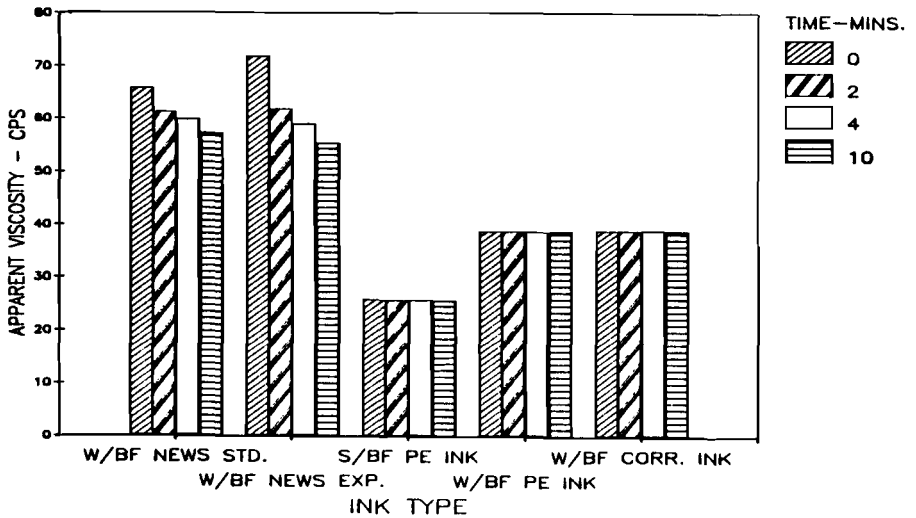


FIGURE 6
APPARENT VISCOSITY OF INKS IN CPS
AT 300 SEC.-1 AFTER APPLIED SHEAR
FOR 0, 2, 4 AND 10 MINS.



Examination of the curves in Figure 5 indicates the presence of a yield value. An expanded shear rate/shear stress graph for a lower shear rate region is shown in Figure 7. This expansion enabled us to calculate yield values more precisely and it was used for all flexo inks. Calculated values are listed in Table III

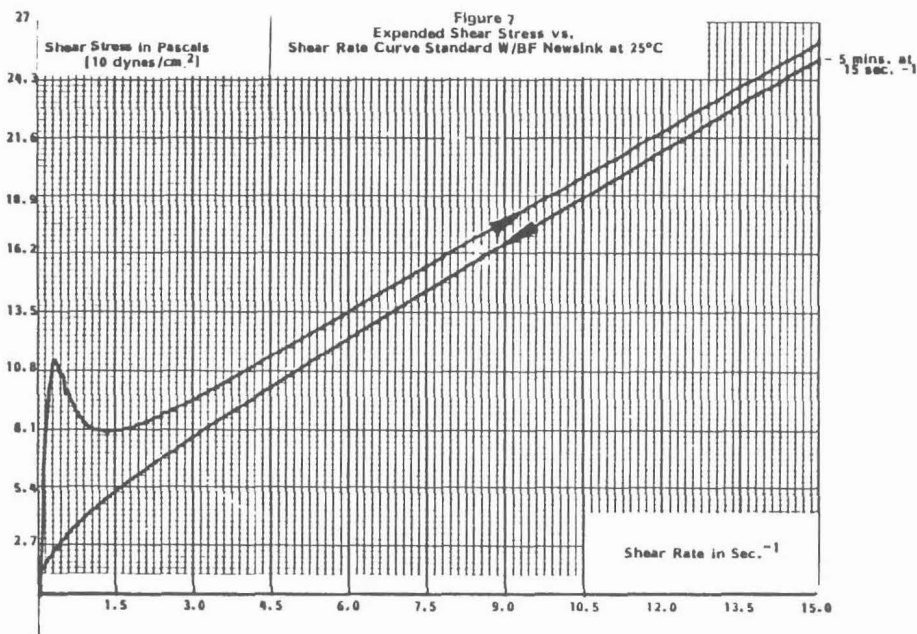


Table III

Yield Value in Dynes/sq. cm. of Flexo Inks

W/B F Newsink standard	-	3.0
W/B F Newsink experimental	-	1.5
O/BL Newsink	-	14.0

As with the viscosity of the O/BL newsink, the yield value is also substantially higher than that of flexo inks. Both these properties necessitate higher printing pressure to secure transfer of an ink. An adequate transfer of

the W/B F newsink is usually accomplished at appreciably lower pressures.

CONCLUSION:

An experimental W/B F newsink has a unique set of properties which are quite different from all other tested flexo inks. A low yield value indicates that it requires relatively low shear stress to achieve good flow. It retains its thixotropy beyond a shear rate of 300 sec.⁻¹. This range of shear rate is beyond those produced by simple mixing or recirculation. Apparent viscosity of this ink above 60 sec.⁻¹ was higher than that of all other flexo inks. It was also less sensitive to shear thus retaining its apparent viscosity much better than other inks, with the exception of corrugated ink.

Abbreviations

W/BF Newsink = Water Based Flexo Newsink

S/BF for PE Film = Solvent Based Flexo Ink for Polyethylene Film

O/BL Newsink = Oil Based Letterpress Newsink