The effect of blanket packing configurations on image reproduction in lithographic printing

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Abstract

Different packing configurations of the offset blanket in lithographic printing can affect the quality of the printed dots on the substrate. An experimental investigation has been performed to investigate the extent to which different configurations affect parameters, such as slur. Results showed small differences in both solid density and tonal reproduction for two blanket packing configurations with the densities for which the plate was packed below the bearer having higher densities than when the plate was packed to the same level as the bearer. This was observed for both low and high speeds. Assessment of dot slur showed that rounder dots were printed when the plate was packed below the bearer. This was attributed to the presence of microslip for the case where the plate was packed to the same level as the bearer, which resulted in both compressive and tensile shear forces as the plate passed through the nip.

Introduction

Packing of the plate and blanket in offset printing can have a large effect on the quality of the final printed image. Packing the plate and blanket is the primary means by which the impression pressure is controlled and varied, due to the presence of bearers on the ends of both cylinders. However, unless the plate and blanket are both packed by equal amounts, with the final thickness greater than that of the bearers, a speed differential will result with the cylinder with the greater diameter having a greater surface speed.

In order to assess the effect of any speed differential between the surfaces of the plate and blanket, an experimental investigation was performed. The objective of the investigation was to assess how solid density and tonal reproduction was

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affected by the different surface speeds as well as to quantify any effects on dot slur.

Background theory

Different packing conditions are used in offset printing to control the amount of slip that exists between the plate and the blanket, due to the speed differential. If the press prints simultaneously on both sides of the web, then in order to achieve the desired impression pressure between the blanket and the substrate, the blanket must be packed above the bearer.

Different packing configurations have previously been presented in [1], which discussed how varying the packing levels between the plate and the blanket will induce slip into the system. Two types of slip were discussed; macroslip and microslip. Macroslip relates to the physical relative movement between the plate and the blanket through the nip due to large differences in surface speed. Microslip however, relates to the generation of compressive or tensile shear strain through the nip, which whilst not resulting in any physical relative movement between plate and blanket, can generate large forces on the ink as it is transferred from the image carrier to the compressible blanket.

Methodology

The trials were performed on a web-fed coldest offset press. Two packing configurations were considered; the first was configured so that the plate was packed under the bearer and blanket packed over the bearer, whereas for the second trial, the plate was packed to the same height as the bearer and the blanket packed over the bearer, but to a lesser extent than for the first experiment. For both sets of experimental conditions, the overall engagement between the plate and the blanket was maintained. Each experiment was performed at two speeds, designated as ‘Low’ and ‘High’. The two packing configurations are summarised in Figure 1 and Table 1, with the experimental outline shown in Table 2.

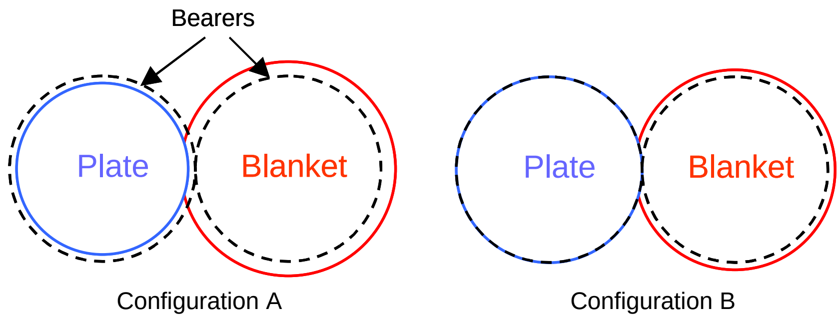

Figure 1: Schematic of packing configurations for experimental trials

Table 1: Plate/blanket packing configurations for experimental trials

	Configuration A	Configuration B
Plate above / below bearer	-75μm	0μm
Blanket above / below bearer	+175μm	+100μm
Engagement	+100μm	+100μm

Table 2: Outline of experimental trials

Experiment No.	Configuration	Setting
1	A	Low speed
2	B	High speed
3	A	Low speed
4	B	High speed

The blankets used during the trials were 4 ply compressible blankets with a thickness of 1.68mm. The plate was a digitally imaged plate, which consisted of a series of tonal strips across the repeated across the image, for which a black ink was used. Data from four tonal strips from across the image measured optically using a spectrophotometer, from which solid density and tonal information was gathered. The tone gain was determined using the Murray-Davies equation [2].

To determine how the slur of the halftone dots was affected by the packing configurations, a physical analysis of the dots was performed, using image processing techniques. For this part of the analysis, only one halftone strip was considered. The halftone dots from the 10% and 30% coverages were measured under a microscope and the images captured using a CCD camera, connected to a computer. Binary thresholding techniques were then applied to the image, to differentiate between the printed dots and the unprinted substrate. Analysis software was then used to determine the major and minor axes of each dot, i.e. the axes in the direction of and perpendicular to the print direction. A slur ratio was then calculated, according to equation 1. For each halftone patch considered, five images were taken, and an average determined for that patch.

$$\text{Slur ratio} = \frac{\text{Minor axis}}{\text{Major axis}} \tag{1}$$

Once the slur ratio of all the dots measured in a given patch had been determined, classification of the dots' slur ratio was achieved by producing a histogram. The dots were categorised into eleven groups according to their slur ratio, which were; <0.50, 0.50-0.55, 0.55-0.60, …. 0.95-1.00.

In order to determine the number of printed copies it was necessary to measure, to produce an accurate result, a statistical analysis of the samples was performed. The 10% halftone patches from twenty two consecutive samples were measured and analysed using the image processor and the slur ratios of all the dots in each patch were determined. The standard deviation was then determined according to equation 2, where 's' is the standard deviation, 'x' is the sample value, '$\overline{X}$' is the sample mean and 'n' is the number of samples. Once the standard deviation had been determined, the Standard Error could be determined, using equation 3.

$$s = \sqrt{\frac{\sum (x - \overline{X})^2}{n - 1}} \tag{2}$$

$$\text{Error} = \frac{s}{\sqrt{n}} \tag{3}$$

By varying the sample size 'n' in equation 3, it was possible to determine the errors that could be expected from only analysing that number of copies.

Results

The results from the statistical analysis, Figure 2, show that for very low sample sizes, the Standard Error is high. The largest errors exist for dots with a slur ratio between 0.90 and 0.95. The lowest errors were for those dots with poor slur ratios, i.e. ratios of up to 0.75. Figure 2 shows that as the sample size increased, the Standard Error fell. It was concluded that a sample size of 10 was sufficient for the investigation, as although the error did continue to fall for larger sample sizes, the benefit of using a larger size was not sufficiently large to justify the increased time required to measure and analyse the extra samples.

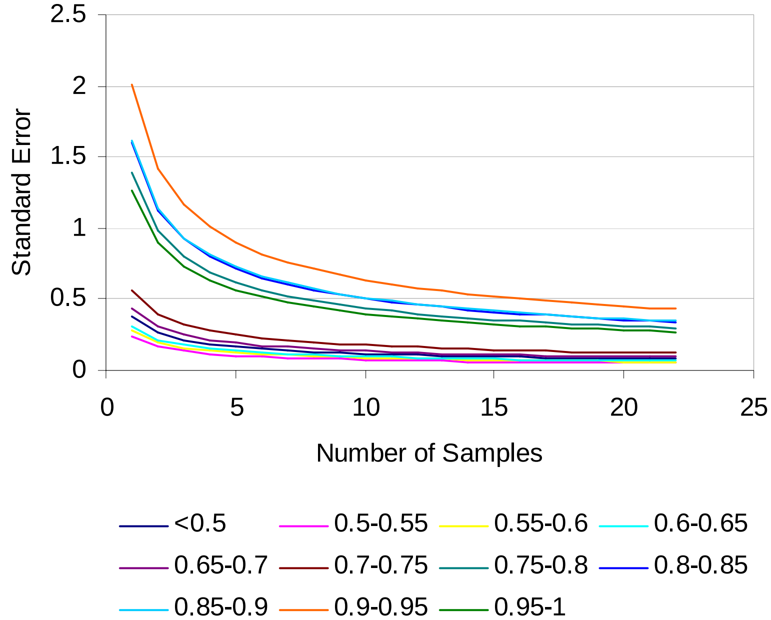

Figure 2: Variation in standard error with sample

Results for the solid density are shown in Figure 1. There is little variation in density between the two configurations, with configuration 'A' giving a slightly higher density for both low and high speeds (0.03 difference at the low speed, 0.02 difference at the high speed).

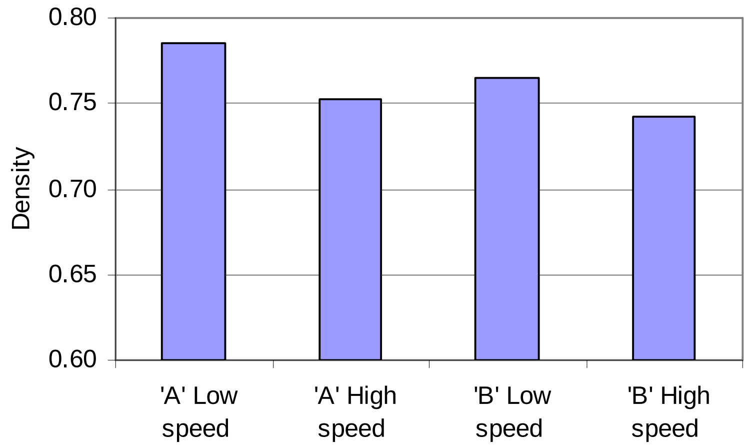

Figure 3: Variation in solid density for different configurations and speeds

The variation in tone gain is shown in Figure 4. At high speeds there is little difference between the two configurations for coverages up to 40%. As the coverage increases further, configuration 'B' exhibits slightly higher tone gain. At low speeds however, the trend was reversed with configuration 'A' having greater tone gain. This was shown in the highlight and midtone regions only, with little difference in the tone gain between the two configurations in the shadow region. The results in Figure 4 demonstrate that configuration 'B' shows greater variation in tone gain than configuration 'A', as speed is varied, having the larger gain at high speeds, but smaller gain at low speeds.

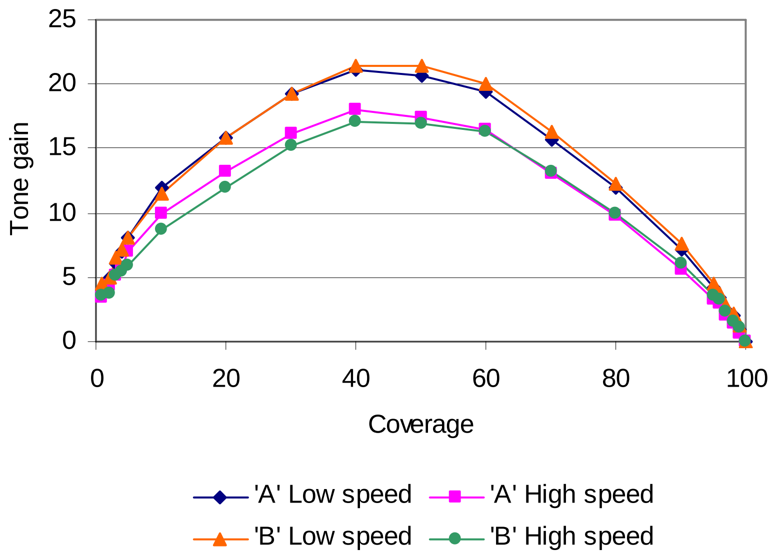

Figure 4: Tonal results for different packing configurations and speeds

The histogram results for the 10% halftone dots are presented in Figure 5. Results are only plotted for slur ratios of 0.80 and above, as the results for lower ratios were very low in comparison with the results for higher ratios. The largest grouping of slur ratio occurs for ratios between 0.90 and 0.95, for all four experimental conditions considered. The next highest grouping was for dots with a slur ratio of between 0.85 and 0.90. For the 0.95-1.00 and 0.90-0.95 groupings, configuration 'A' gave the highest slur ratios, therefore producing the roundest dots. For both experimental conditions, the slur ratio deteriorated as speed increased, however, for both the 0.95-1.00 and 0.90-0.95 groupings, the slur ratio of 'A' at high speed was still greater than 'B' at low speed. As the slur ratio decreases below 0.90, configuration 'B' gives the highest results. This was due to the greater proportion of dots for configuration 'A' having slur ratios of greater than 0.90.

The results for the histograms for the 30% halftones are shown in Figure 6. The results show a greater proportion of dots in both the 0.95-1.00 and 0.90-0.95 groupings, and a very low proportion of dots having a slur ratio of 0.80-0.85. This result shows that the dots are rounder at the 30% coverage than the 10% coverage. The figure also shows that little difference exists between the four experimental conditions. However, configuration ‘A’ did produce slightly rounder dots in the 0.90-0.95 range than configuration ‘B’.

The better slur ratios for the 30% halftones than the 10% halftones were attributed to the greater diameter of the dots for the 30% halftone. Any difference in diameter for the larger dots will be a smaller proportion of the overall diameter and will therefore have less of an effect on the slur ratio. This also explains the reduced differences between the two experimental conditions and the two speeds considered.

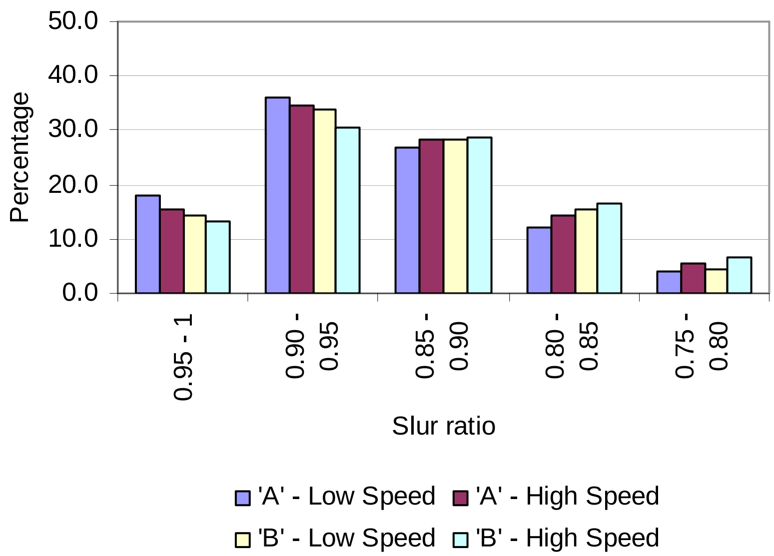

Figure 5: Histogram of Slur ratio distribution for 10% halftone dots

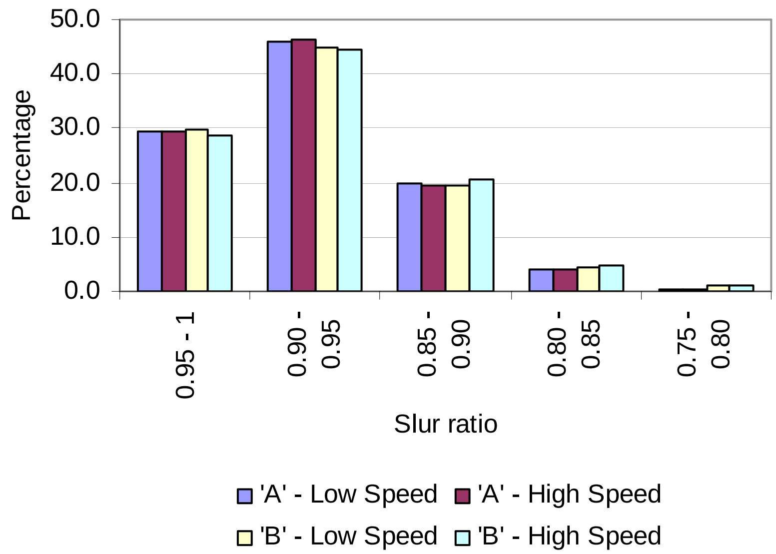

Figure 6: Histogram of Slur ratio distribution for 30% halftone dots

Discussion

During the investigation, a greater solid density was observed for configuration 'A' (Figure 3). Although the experimental trials were developed so ensure a constant engagement between the plate and blanket cylinders, the greater overall diameter for the blanket for configuration 'A' resulted in a greater impression pressure between the blanket and the substrate, than was observed for configuration 'B' and not due to any effects of differences in packing configurations. Although impression pressure does not affect ink transfer by splitting [3], the absorption of ink into the substrate is affected and so the density will increase as impression pressure increases.

Although there was little difference in tone gain between the two packing configurations considered, configuration 'B' was shown to be more affected by changes in speed than configuration 'A' (Figure 4). As for the solid density results, this was attributed to the higher impression pressure between the blanket and the substrate and not due to packing effects. As the tone gain was determined optically, based on the solid density, the dot sizes were larger for configuration 'A' than for 'B', although this was not reflected in the tone gain curves due to the higher solid density for 'A'. Therefore, as the dots were already enlarged for configuration ‘A’, any physical change in the dot size as speed increased would have a reduced effect on the optical gain.

Whilst different packing configurations were not responsible for the changes in solid density and tone gain, it was possible to attribute differences in dot slur to plate and blanket packing. For configuration ‘A’, the plate surface speed is generally running at a slower speed than the surface of the blanket, which is also slower than the nominal press speed. However, as the blanket passes through the nip, the blanket experiences a compressive shear strain, which results in it travelling at the same speed as the plate surface. Once the blanket has then exited the nip, it recovers, experiencing a tensile shear strain. This results in the dots remaining round during the transfer process from the plate to the substrate. For configuration ‘B’ however, as the plate is packed to the same level as the bearer, its surface speed is the same as the bearer surface speed. As the blanket compresses against the plate through the nip, it also runs at the same speed as the bearer. For this configuration, there is an imbalance in the shear forces experienced by the blanket, with a compressive shear force before the centre of the nip and a tensile shear force after the centre of the nip. This imbalance in the shear forces of the nip results in microslip, which causes greater slur on the dots than was observed for configuration ‘A’. A summary of the shear strains experienced by the two configurations is presented in Figure 7.

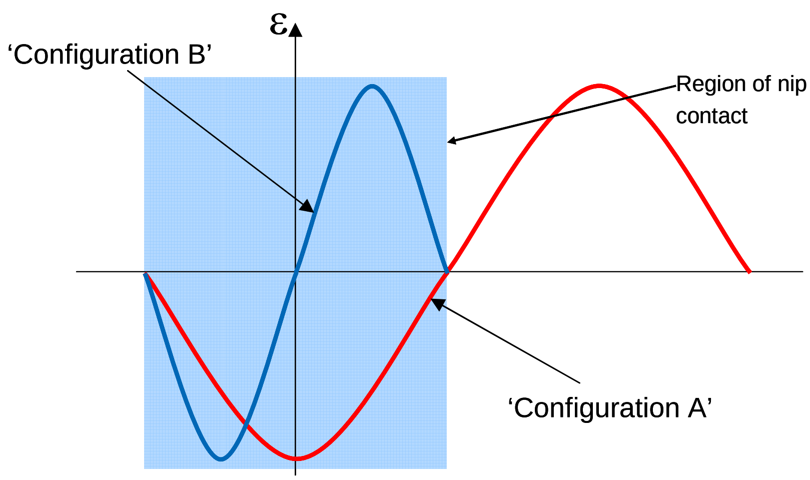

Figure 7: Shear forces experienced by the two packing configurations

Conclusions

As a result of the investigation, the following conclusions have been drawn:

- Configuration 'A' provides a greater solid density than configuration 'B', due to the greater impression pressure against the substrate.
- Little difference in tone gain exists between the two packing configurations. However, configuration 'A' showed less variation in tone gain as speed was varied. This was attributed to larger dot size for a given coverage, than for configuration 'B', due to the greater blanket to substrate impression pressure.
- Dot slur is reduced when the plate is not packed to the same level as the bearer. This prevents an imbalance in the shear strain as the blanket passes through the nip. As the current investigation concentrated only on two packing configurations, further investigation is required to determine if the dot slur ratio could be further improved if the plate was packed above the bearer.
- The 30% coverage dots were more round than the 10% dots, with a greater percentage of the dots having higher slur ratios. This was observed for both packing configurations. Further investigation is required of the remainder of the tonal range, to quantify how other coverages are affected by dot slur.

References

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