THE EFFECT OF SURFACE ROUGHNESS OF OFFSET PRINTING BLANKET ON INK TRANSFER

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Abstract :

In offset printing process, it is generally regarded that the surface of offset printing blanket affects considerably on the print quality. In order to study this effect, we prepared five kinds of test blankets which have identical compressibility, layer structure and surface rubber compound, but have respectively different surface roughness. The smoothest among the test blankets may be classified in the very smooth surface category of commercially available blankets, while the roughest may belong to the very rough surface.

It has been found that in the region of fine pattern images such as highlight dot and fine line, the rougher surface blanket gives less fill - in, while it makes the fringe of images more irregular. This fact lead us to conceive that the rougher surface blanket has more microscopic valleys and mountains, and these mountains act as a barrier which disturb the moving of ink layer, while the valleys, at the same time accelerate the spread of ink layer along the valleys, and thus causing fringe irregularity.

It has become apparent that the texture of solid ink image on blanket is affected by the surface texture of blanket. Regarding the solid ink image on paper, the rougher surface blanket causes more uneven solid image and more white micro spots (unprinted spots). Under the printing conditions of this study, the fringe irregularity of fine pattern images and the unevenness of solid images are both affected to the most by surface roughness (Rz) of blanket when it exceeds approximately 6 micrometers

It is suggested that when the offset printing was continuously carried out under the constant ink volume supplied to PS plate, the total ink amounts transferred from PS plate to

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paper through the blanket is almost constant among the test blankets. It is found that the total ink amounts transferred from PS plate is independent on the surface roughness of blanket, but the surface roughness of blanket affects on the morphology of transferred ink image.

Introduction

The physical and chemical properties of offset printing blanket are generally regarded to have an effect on the printability. These properties are surface roughness, compressibility, layer structure and surface wettability, above all. However, there have been a few reports which deal with specific one of these properties in term of its relationship with the quality of transferred images.
It is generally said that the print quality is greatly affected by the surface roughness among the properties of blanket. Therefore, in order to clarified the relationship between the surface roughness of blanket and ink transfer in offset printing process, we has studied by preparing test blankets which widely vary in the surafce roughness alone, while being identical in the other properties.

Experimental

1 . Test blankets

Five kinds of compressible type test blankets having different surface roughness on identical layer structure and layer materials were prepared. Figure 1 shows the cross sectional microphotograph of these blankets. They mainly consist of four fabric layers, a rubber sponge layer and a surface rubber layer. Microphotographs of the surface texture of test blankets are shown in Figure 2 . Average roughness depth Rz* are shown in Figure 3 . When compared with commercially available blankets, the test blanket SS (Super Smooth) can be classified in very smooth surface category, S blanket in smooth surface, M blanket in medium surface, R blanket in rough surface, and SR (Super Rough) blanket in very rough surface category.

* Measured according to ISO R 468

2 . Printing conditions

The printing test were run on a sheet fed press under the following conditions :

Printing press : Ryobi 500 K
Test chart : Brunner control strip ® and GATF ladder target ®
Plate : Presensitized plate (Fuji film FPD)
Ink : Process color offset ink magenta (Toyo ink Mgf.Co.,Ltd.)
Paper : Art coated paper (70.5kg/m²)
Fountain solution : Acid type (pH 5.5～6.0)
Printing pressure : between plate and blanket 0.17mm
between blanket and paper 0.19mm
Optimum solid density : 1.3～1.4
(measured by Cosar 61 J Densitometer)
Printing speed : 5000 impressions / hour

Various printing tests were carried out with the fixed volume of ink supplied to the plate, the volume being so fixed that the optimum density of solid area can be obtained on a M blanket which has medium surface roughness.

3 . Samples and measurements

When the printing was continuously carried out on the condition of getting constant image quality, the test samples were obtained by the following procedure, which is the same procedure shown in the reference 1 .

(1) Ink image on plate

Ink images on the plate just transferred from ink form rollers were obtained during continuous printing by releasing all form rollers and cylinders of printing press, at the moment ink was transferred from ink form rollers to the plate. Residual ink images on the plate just after transferred to the blanket were obtained in a similar manner. The ink images on the plates were observed by optical microscope and microphotographs were taken under the bright field illumination. After drying the ink images on the plates enough, the surface profiles of non - image and ink image area on plates were measured by scanning the skid of the surface roughness measuring instrument from non - image area to solid ink image area.

(2) Ink image on blanket

In a similar way, the blankets were obtained during continous printing when ink was just transferred from the plate and when ink was just transferred to paper. The images were observed by scanning electron microscope and optical microscope, and microphotographs were taken.

(3)Ink image on paper

The printed paper were obtained during continuous printing. The images on paper were observed by optical microscope and microphotographs were taken under the dark field illumination. Irregularity in the fringe of image and white microscopic spots (unprinted spots) were evaluated by digitizing through the image processing.

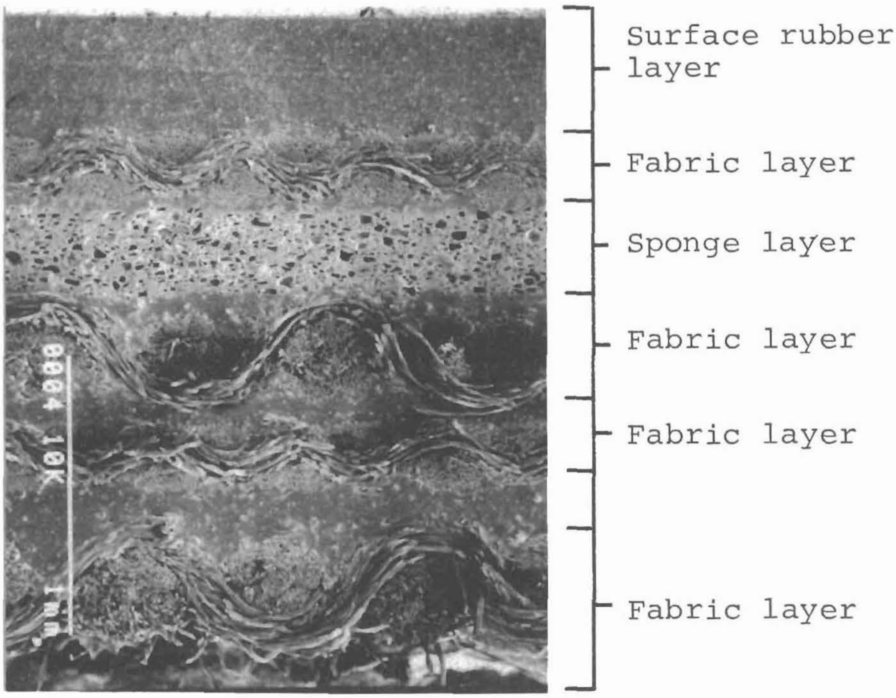


Figure 1 The layer structure of test blanket

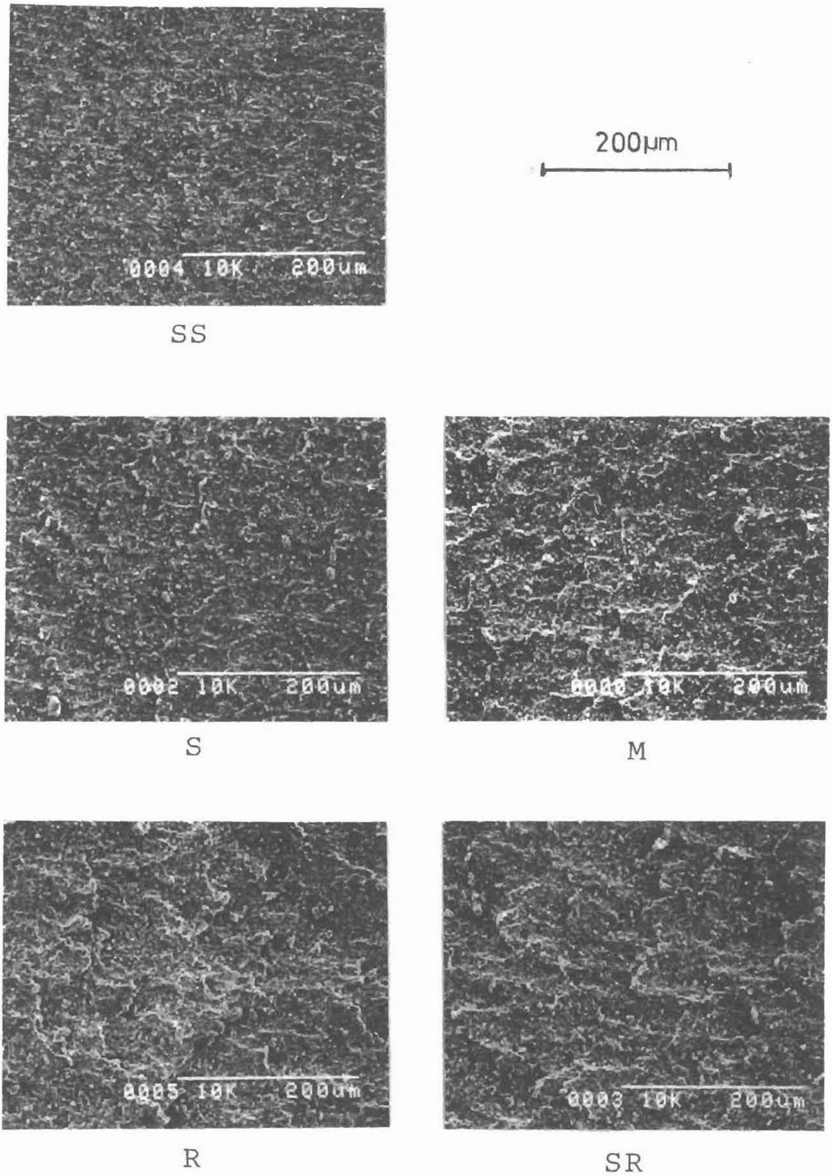


Figure 2 Scanning electron microphotographs of the surface of test blankets

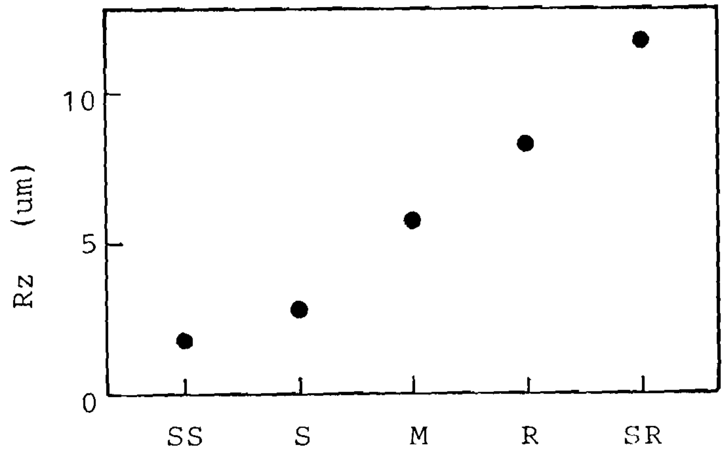


Figure 3 Surface roughness of test blankets

Results and discussion

1 . Fine pattern image

Microphotographs of dots and fine lines in the fine screen patch are shown in Figure 4 . It is shown clearly that the rougher the surface of a blanket becomes, from SS to M and then to SR, the more irregular the fringe of a dot and a fine line becomes.

The density profiles of fine lines were measured by the microdensitometer. The degree of fringe irregularity is expressed numerically as the symbol F_{ir} which is the standerd deviation of the micro density profiles.
The F_{ir} values of images printed by test blankets are shown in Figure 5 , wherein both the SS and S blankets having smoother surface are lower in F_{ir} values. This means that the SS and S blankets cause less irregularity in the fringe of images, while the R and SR blankets having rougher surfaces give higher F_{ir} values and accordingly more fringe irregularity. Since the F_{ir} value varies markedly at the M blanket, the result suggests that the fringe reproductivity of the fine line and dot images is affected by the surface roughness of test blankets in the range of approximately 6 micrometers in Rz.

Microphotographs of the cross line images in the fine screen patch printed by the SS, M and SR blankets are shown in Figure 6 . It is observed that the surface of blanket becomes rougher from the SS to M and then to SR, more missing parts appear in the small cross line images. Since the rougher surface blankets have more microscropically deep valleys on the surface (see Figure 2), they may be the cause of the missing parts in the fine pattern images. The large cross line image printed by the SS blankets was deformed, and as the surface of blanket becomes rougher, the deformation of image becomes less. From the phenomenological viewpoint, the ink transfer model of cross line images from the plate to the blanket can be described as Figure 7 . In case of the SS blanket, when the ink image is transferred from the plate to the blanket, the ink image spreads out easily, but is then deformed by the vertical transfer pressure because of its smooth surface. On the other hand, in case of the SR blanket with very rough surface, its microscopic mountains act as a barrier and disturb ink image to spread out by the vertical transfer pressure during ink transfer process from the plate to the blanket, and therefore deformation of image becomes slight. But at the same time, ink layer moves along the microscopic valleys, to make the fringe of image irregular.

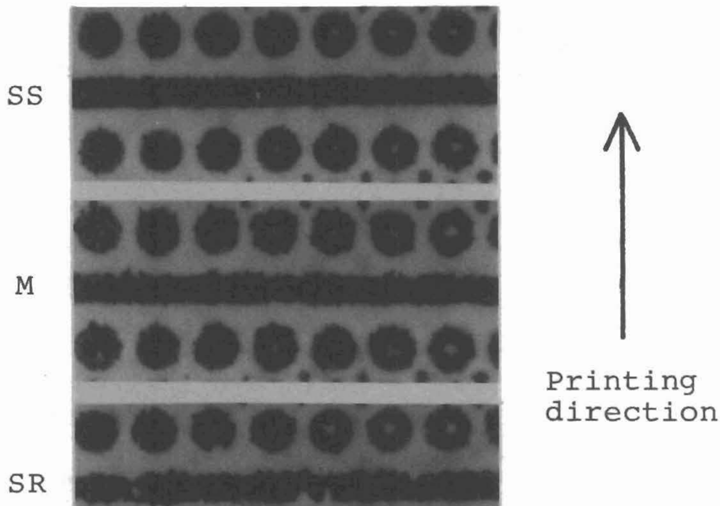


Figure 4 Microphotographs of fine pattern image on paper printed by test blankets

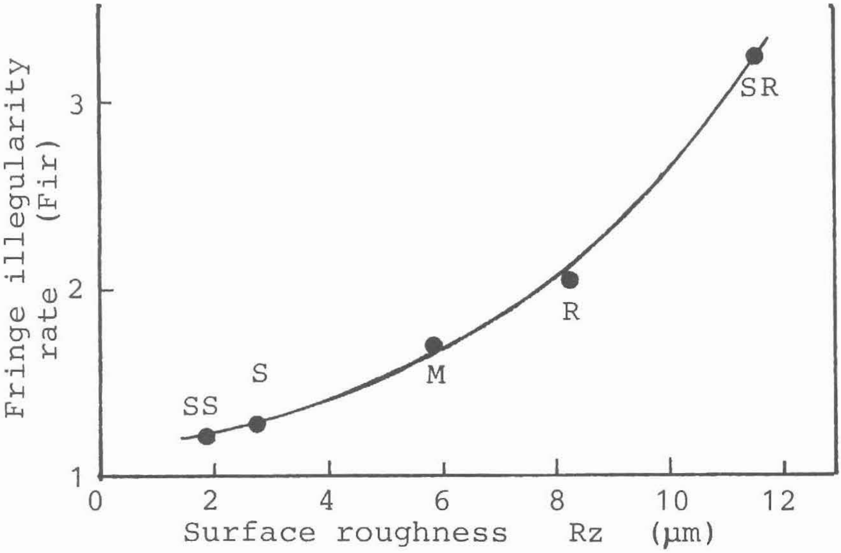


Figure 5 Relationship between surface roughness of test blanket and fringe illegularity of fine line

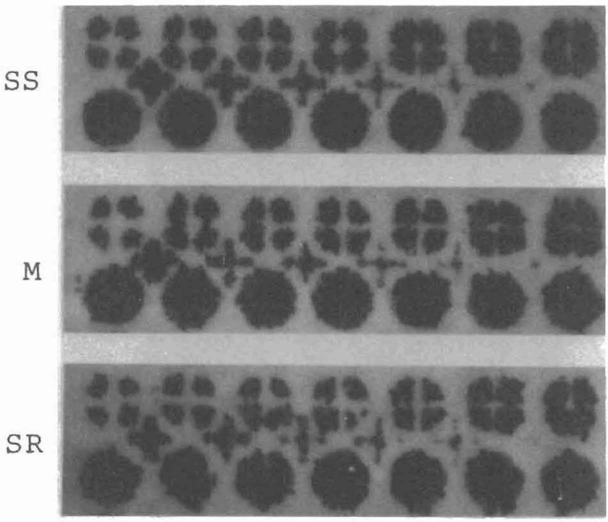
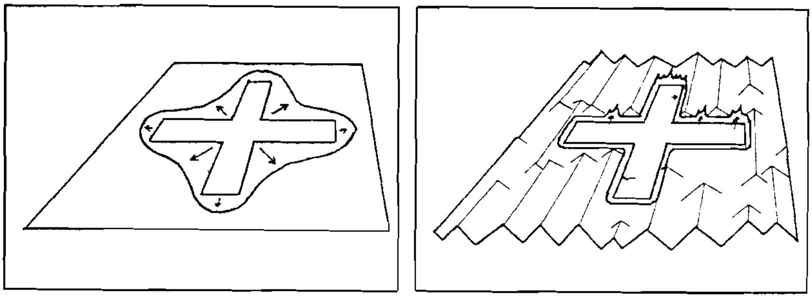


Figure 7 Microphotographs of cross line images on paper printed by test blankets



SS SR

Figure 7 The ink transfer model of cross line from plate to blankets

2 . Slurring image

Microphotographs of the ladder target images printed by the S, M and R blankets are shown in Figure 8 .
Irregular spikes are noticed particularly in each of line fringes printed perpendicular to the printing direction of paper travel on all of the blankets, with irregularity move emphasized on the rougher surface blanket.

Figure 9 shows the microphotographs of perpendicular line image on the R blanket where (a) images on the blanket just transferred from plate and (b) image of the mirror image on the paper exactly corresponding image to (a). Both (a) and (b) are bilateral symmetry images each other. It is observed in (a) that the ink image is transferred onto the microscopic valley of the R blanket which is the arrow marked.
It is found when this image is transferrd to paper, it becomes the spiky image on paper which is shown in the arrow marked position of (b).

The widths of the many points in parallel and perpendicular line images on the plate and the paper were measured from the microphotographs of images. It is thought that the difference in the width of the parallel line between the plate and paper are the gain values caused by the vertical transfer pressure during printing process, and the gain values on paper caused by this pressure must be same between the parallel and perpendicular lines, so that the difference of each narrowest line width is the slur value which is the results of the microslip caused by the difference of peripheral velocity between the plate and the blanket. The models of the perpendicular line images on papers printed by the S and R blankets are conducted from the above viewpoint and are shown in Figure 10 . It shows that the differnce of line images between the S and R blankets is the shape and size of the spikes existing at the fringe. Therefore it can be considered that the surafce roughness of blanket has relation to the generation of the spiky images, resulting in the increase of the slur value.

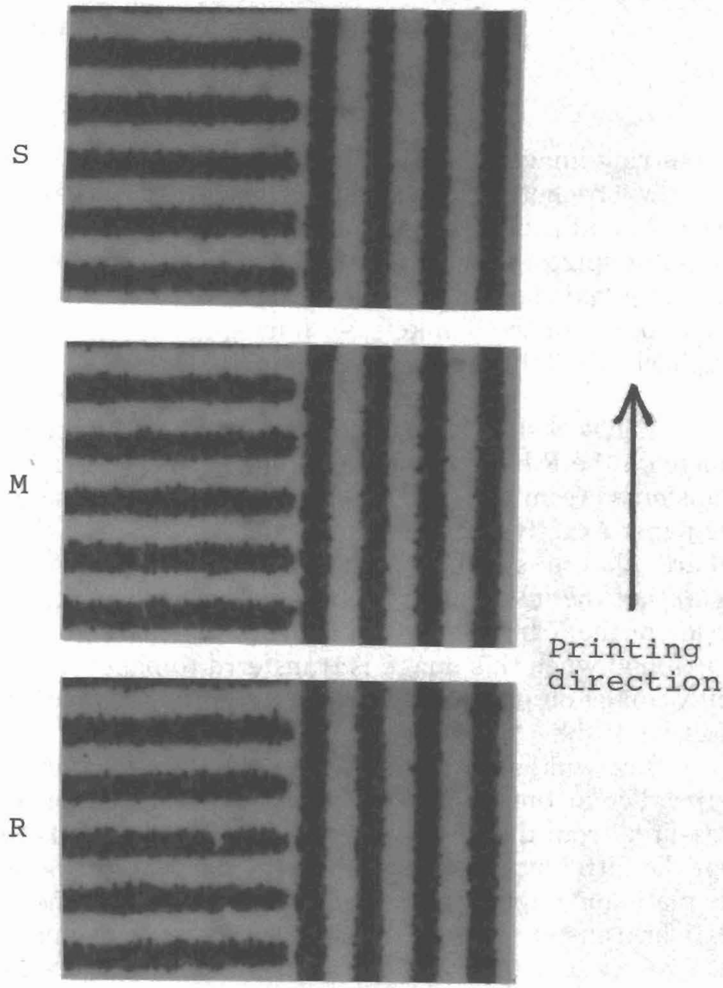


Figure 8 Microphotographs of ladder target on paper printing by test blankets

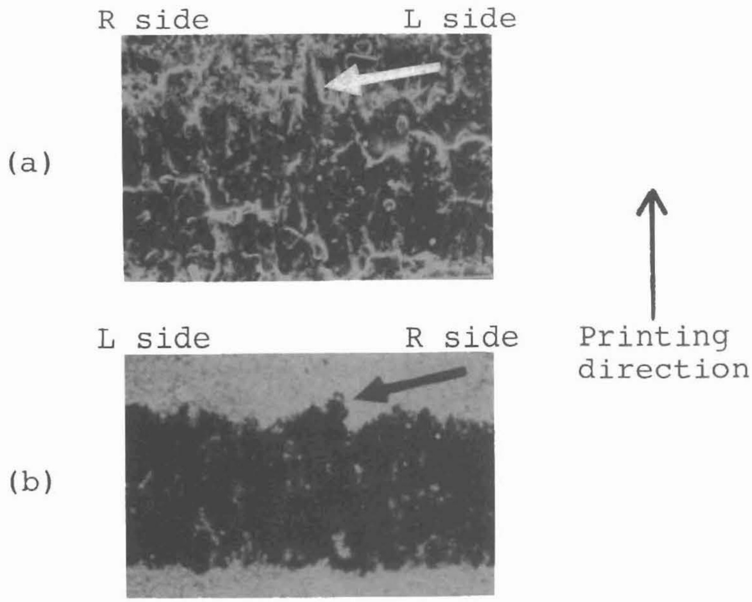


Figure 9 Scanning electron microphotographs of perpendicular line images of ladder targets
(a) image on R blanket
(b) mirror image on paper

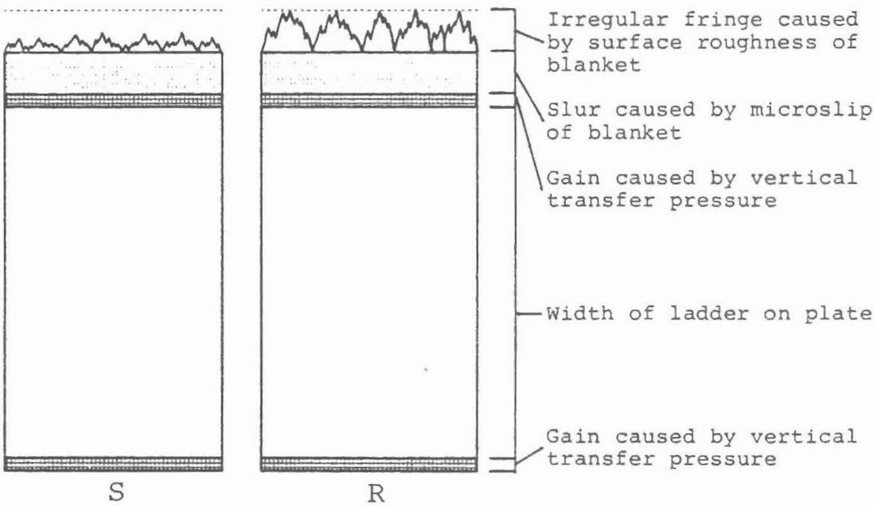


Figure 10 Model of perpendicular line image of ladder target on paper printed by S and R blankets

3 . Solid image

Microphotographs of solid images on the SS, M and SR blankets just transferred from the plate are shown in (a),(b) and (c) of Figure 11 . Microphotographs of solid images on papers printed by the SS, M and SR blankets are shown in (d), (e) and (f) of Figure 11 . Comparing with the surface of no inked blankets(see Figure 2), it is found that the surface texture of the solid image on each blanket is very similar to that of each no inked blanket. This result suggests that the morphology of solid ink image transferred to the blanket is affected by the surface texture of the blanket. Comparing among the solid images on paper, it shows clearly that the rougher the surface of blanket becomes, from SS to M and then to SR, the more the white micro spots(unprinted spots) in the solid image appear, and the more uneven, the solid image becomes. Many micro spots without having ink layer are observed in the (C) in Figure 11 which is the the solid image on the SR blanket, and it is suggested that these spots on the blanket are the cause of the white spots on paper.

The percentage of white micro spots in solid images on paper, measured by digitizing through the image processing, are shown in Figure 12 . It shows the same tendency as the results of visual evaluation from microphotographs.
The percentage of white micro spots increases as the blanket surface becomes rough. When the surface roughness of the blanket exeeds about 6 micrometers in Rz, the percentage apparently increased, and this tendency is very similar to the case of he fringe irregularity of fine pattern.
Therefore it is thought that the specific surface roughness of the blanket which is approximately 6 micrometers in Rz may be regarded as the threshold roughness which affects on the generation of the fringe irregularity in the fine pattern image and white micro spots in solid image.

Both ink images on the plate just transferred, from the ink form rollers, and to the blanket were dried enough, and the surface profiles of non image and ink image area on both plate were measured by scanning the skid of surface roughness measuring instrument. After scanning, it was confirmed that there was no scratch on the surface by the skid. The profiles are shown in Figure 13 . The difference in the height between the non - image area and solid image area can be regarded as the thickness of the solid area which is the total of the thickness of the ink layer and resist.

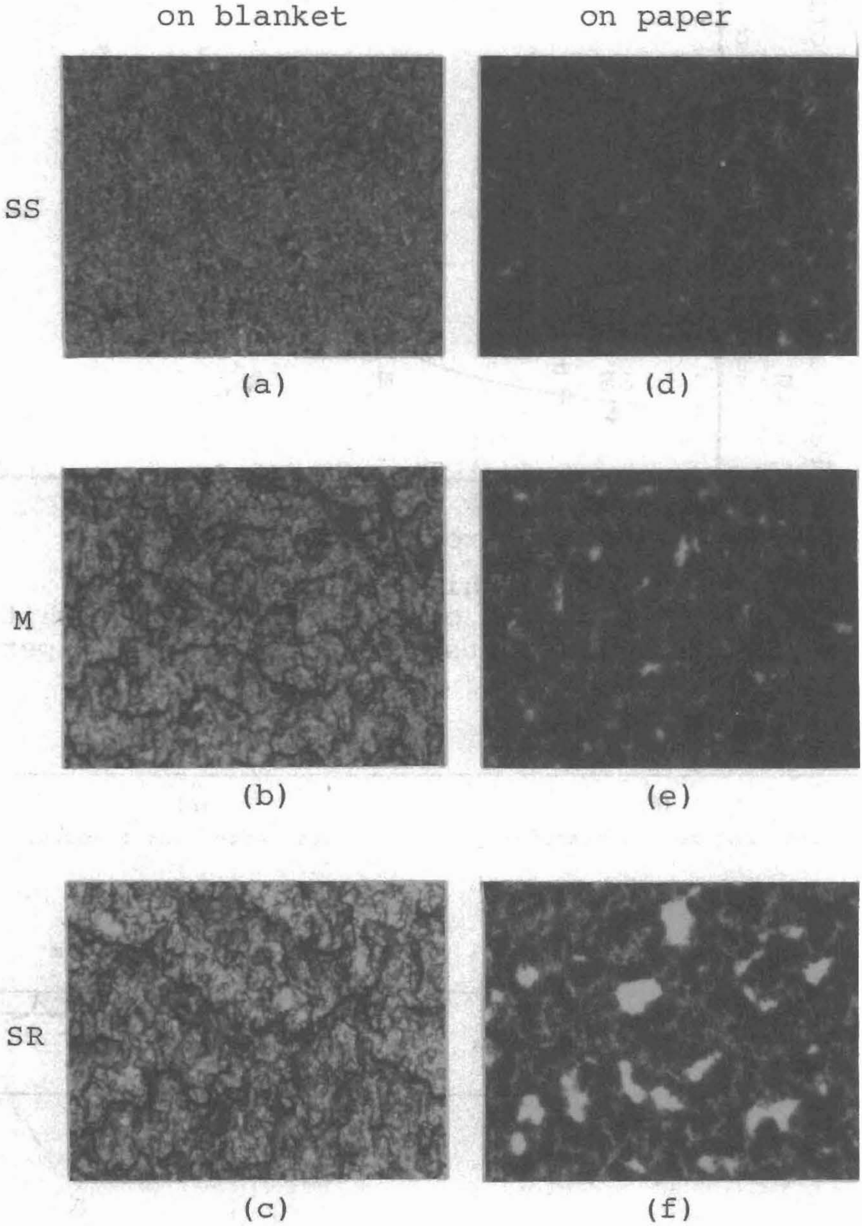


Figure 11 Microphotographs of solid image
(a)-(c): image on blanket just transferred from plate
(d)-(f): image on paper transferred from blanket

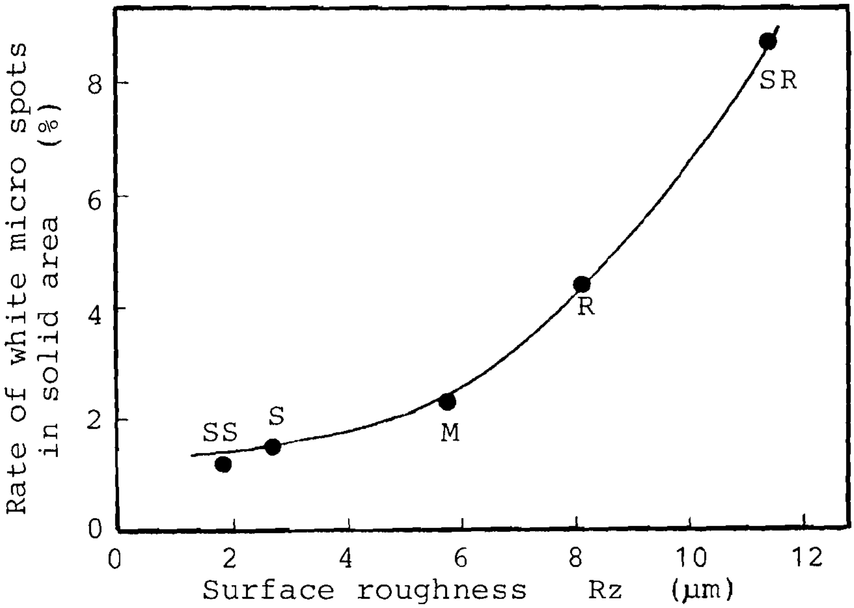


Figure 12 Relationship between surface roughness of test blanket and white micro spots in solid area on paper

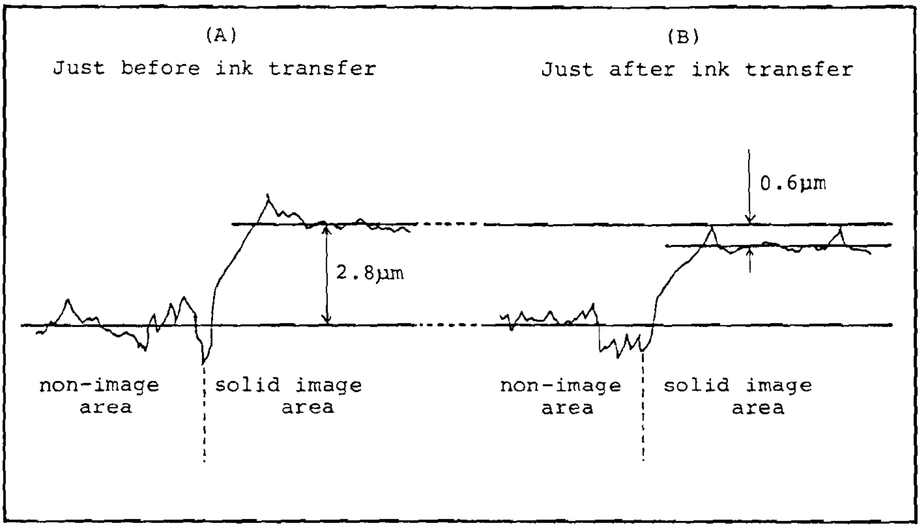


Figure 13 Surface profiles of non-image area and ink image area on PS plate (M blanket)

Under the continuous printing, the ink volume transferred to the form rollers must be the same as that transferred to the paper, otherwise the ink piling on the plate or on the blanket would occur, or the density of ink image on paper should increase. Therefore the difference in the thickness of the solid areas between just transferred from the ink form rollers, and just transferred to the blanket can be regarded to be the total ink volume transferred from the plate to the paper through the blanket.

The total ink volume transferred to the paper under the continuous printing by the S, M and R blankets with the fixed ink volume supplied to the plate were calculated from the results of the measurement of surface profiles as shown in Table 1 .
Since the ink volume transferred to the paper among the S, M and R blankets is almost same each other, it is suggested that under the condition of fixed ink supply to the plate, the total ink volume transferred from the plate to the paper through the blanket may be constant and independent of the surface roughness of the blanket.

Table 1 Thickness of ink layer on solid area transferred from PS plate to paper

Blanket	Thickness of ink layer (μm)
S	0.7
M	0.6
R	0.6

Conclusion

In the region of the fine pattern image, the rougher surface blanket gives less fill - in, while it makes the fringe of images more irregular. In the solid image, the rougher surface blanket causes more uneven solid image and generates of more white micro spots. It is found that under the printing conditions of this study, the threshold roughness which affects on the generation of the fringe irregularity in fine pattern image and white micro spots in solid image may be regarded to be approximately 6 micrometers in Rz.
Under the continuous printing with the fixed ink supply to the plate, the total ink volume transferred from the plate to the paper through the blanket is constant, and accordingly, it points out the fact that the surface roughness of the blanket will have less effect on the volume of transferred ink to paper but apparently affects on the morphology of transferred ink image.

Reference

(1) Takahashi,Y.,etal, " Ink transfer mechanism in offset printing process " , Proceeding of TAGA, 545(1984)