Measuring of anilox rolls during production

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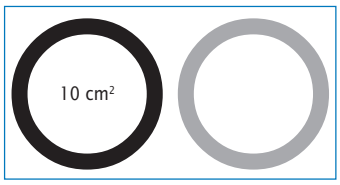
Is one method/system for measuring the ink film thickness on the surface of an anilox roll more accurate than another? This topic was raised during a discussion with a customer. At about the same time TONY SULLIVAN from Symbotics and I were developing software for analysing data related to the ink film thickness on screen rolls. We had a long discussion about the most appropriate statistical representation of this data. Let us have a closer look at the methods for measuring the ink film thickness on anilox rolls. I will not judge the systems because that would require having them all available for testing which is not the case. Thus the following article is not about the accuracy of the different systems but about the danger of applying statistics to the data collected.

The basics

On the surface of an anilox roll is a thin ink film which is the average of the accumulated ink volume of the individual cells on the surface of the anilox roll over an area. Thus the unit for ink film thickness on an anilox roll is volume per area (m^3/m^2). The resulting unit is that of length (m). We are measuring a thin ink film and so putting µ (micro) in front makes the numbers expressible in 2 digits. The ink film available on an anilox roll in the flexo print process mostly ranges between 2 µm (micron) and 20 µm.

Only a part of the ink film available on the surface of the screen roll is transferred during the print process. This has to do with, for example: the cell shape, the ink release characteristics of the screen roll surface and the shearing of the ink.



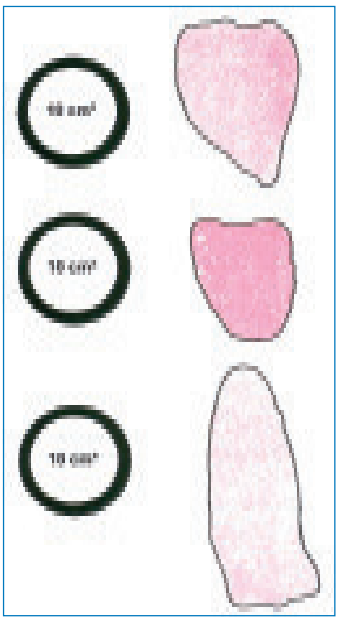


Figure 1 and 2.

Methods for measuring

The measuring method most commonly used to measure ink film thickness is to use a pipette to apply a known volume of ink to the surface of the anilox roll and then to doctor the ink over the surface of the anilox roll. We then blot the ink on paper and measure the area of the blot. Dividing the volume of ink applied by the area measured for the blot gives an indication of the ink film thickness available on the surface of the roll. It is claimed that this system is inaccurate because of the human effect on the amount of ink applied, the doctoring of the ink and the measuring of the blotted area.

Usually, the volume of ink applied is 10 mm^3 (10 µl = 0.01 cm^3). If this ink volume covers an area on the screen roll of 10 cm^2 (0.001 m^2) then the ink film thickness on the surface of the roll is: 10 cm^3/m^2 (6.45 bcm) or 10 µm.

Evaluating an area of 10 cm^2 on a roll engraved with a screen of 100 l/cm (254 lpi) results in 100,000 cells being filled with ink.

Another method used for measuring the ink film thickness roll uses a laser scan microscope or a light interferometer microscope. Due to the dimensions of the optics, only an area involving between 25 to 250 cells is used for determining the ink film thickness. The scanning of the individual cells by these systems is very accurate. The dimensions of the cells are analysed statistically to estimate the potential ink film thickness on the surface of the roll. Further, cell depth and screen count can be determined

What is the accuracy of the first method?

The errors affecting the first method of applying a fixed amount of ink are:

1. Preparing the pipette with a precise volume of ink. The pipette I use has an accuracy of better then 2%.
2. Doctoring of the ink on the surface of the screen roll. How much ink is left on the doctor blade after the doctor step? A visual check of the doctor blade shows whether the step was done correctly or not. Is the ink doctored over the surface of the roll filling the cells or is air locked in the cell of the anilox roll? This mostly

depends on the cell shape. Think of narrow, deep cells or wide, shallow cells.

3. Measuring of the blotted area. I recommend highlighting the edge of the blot area.

To illustrate the effect of error 3 I conducted the following test using *IFT Analyzer*, a software package developed by *Symbotics*. First, I printed the right picture – black and grey circles (*figure 1*) – 12 times.

I then highlighted the outside of the right (grey) circle using a fine-liner thickness 0.5 mm. After this image has been scanned or digitally photographed, *IFT Analyser* is able to detect the edge of the two circles and determine their area. To minimise any error I used a high resolution scanner. Following are the results of the right circle relative against the left circle highlighted with a fine-liner on the outside: 9.95, 10.02, 9.96, 9.92, 9.97, 9.95, 9.98, 10.01, 10.00, 9.99, 9.97, 10.00.

The average of all values is 9.98, the target was 10.00. All values are within 1% of the target value.

The problem

Figure 2 is a scan from three blots made left, centre and right on the surface of an anilox roll. The roll was not in a very good state. *Table 1* below provides the results of the individual measurements – again using *IFT Analyzer*.

The arithmetic average of the three ink film thickness measurements is 6.93 µm. But if we calculate the ink film thickness from the total amount of ink applied and the total area covered then we get a different answer – in this case 6.51 µm.

Why this difference?

It took some time before I understood it. Let me explain. The average calculated from the individual calculated ink film thickness values assumes that all three values are equally important. If you first average the three area values measured and then calculate the ink film thickness then you are including a weighting factor. Thus the larger area (the low ink film thickness), is affecting the average more than the smaller area (the high ink film thickness). The result is that the average ink film thickness for the calculation based on first averaging the measured area values is lower.

This »weighting factor« is in principle wrong because we do not know how representative each of the areas is for the total roll. It would be better not to apply any statistics to these readings and just leave them as they are. The large difference between the readings is already sending the message that the roll needs replacing or cleaning. The average value would not provide this information.

All this still leaves un-answered questions about the results achieved using interferometer scanning. The number of cells involved in one scan of the interferometer method is probably 4000 times less than using the plot method. Although the scan is very accurate one needs to make a relative high number of measurements to avoid the risk of just having scanned a non-representative position on the roll. This is a little bit like the problem discussed before. It means that achieving a reliable value is probably more labour intensive using the interferometer method.

	Ink volume applied in µl	Area covered in cm²	Ink film thickness in µm
Measurement 1	10	15.60	6.41
Measurement 2	10	10.72	9.33
Measurement 3	10	19.76	5.06
Total	30	46.08	20.80
Average IFT = 20.8 ÷ 3			6.93
IFT from Totals = 10 × 30 ÷ 46.08			6.51

Table 1.

Conclusion

One should be careful when applying statistics on ink film thickness data. Calculating the average does not always provide meaningful information. In the discussed problem it is actually hiding a major error. The usefulness of an ink film thickness estimate is not only determined by its accuracy, it is also determined by the size of the area to which it applies.

Recommendation

Ink film thickness variation has a large influence on printed colour variation as discussed in my article »Colour difference during production« (Flexo & Gravure Int'l 2-2006, p. 10). It is therefore important to regularly measure the ink film thickness of your screen rolls and keep a history of the data. The *Symbotics IFT Analyzer* software is a useful tool for this. The print customer wants colour consistency after all. To understand the accuracy of measuring systems requires controlled testing and evaluation of all systems under equal conditions. ■

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