Understanding The Anilox, Part 1 of 3:

**Anilox Volumes**

- OR -

**Should it be...Ink Film Thickness Transferred?**

By: Christopher Harper
Consulting Technologist, Harper Corporation

Perhaps the greatest mistake flexo converters make is the printing of a job with the ‘line screen’ of an anilox roll. Typically heard is, “this job is an 800 line, or 550, or that solid should be printed with a 440.” Strangely through a print job has never been printed with a line screen, but rather the ‘volume’ of ink it delivers.

Nevertheless, mistakes are made daily by installing an 800 line anilox and not getting the color results achieved the last time the job was run. Consequently, the press doesn’t run until another, or perhaps several 800 anilox are tried in order to achieve the same color needed for customer approval. This common mistake cost thousands of dollars in downtime – and can easily be prevented with a better understanding of the anilox’ ink carrying volume.

It’s understandable that such terminology is common as perhaps the one thing most understand about an anilox what really does the printing is the ‘volume numbers’ of surface. An anilox’s volume is what drive the printed is the primary number both management and press concern themselves with – providing an excellent way to downtime.

Ink volume on an anilox is calculated like one would cubic square footage in a room. Yet instead of using feet as a measure, cubic square microns are used. These microns are the ‘space available’ (volume) in the cells square inch (or square centimeter for metric), on the anilox surface that will contain the ink – ultimately producing the ink film with which you print. In the same way if you took the cubic square footage in the room for which you’re sitting and filled its available space with ink, you determine how much ink it would hold through the measure of cubic square footage or cubic square meters for metric.

“This common mistake cost thousands of dollars in downtime – and can easy be prevented with the right understanding of the anilox.”

line screen is roll. However, an anilox’s color and thus crews should prevent figure the cubic square cubic square within one
In the case of an anilox’s roll surface volume, we have to keep things on a microscopic level. (See Anilox Graphic) This requires us to calculate using microns as our unit of measure, as it is the only thing small enough to use, though metric. A micron is one-millionth of a meter, and there are 25.4 microns in one-thousandth of an inch, and the only way to determine the available area in the cells of an anilox that will contain the ink. Thus in one cubic thousandth of an inch, there would be 645.16 cubic microns of space available to hold ink. This is further factored into an area on the anilox using one square inch of surface area, which quickly becomes a very big number, This is then expressed in the billions of cubic microns or in short: BCM’s.

BCM’s is then the area of cubic ‘anilox cell space’ available for carrying ink within one square inch on an anilox roll. And perhaps more clearly – on an 800 line, hexagon pattern anilox roll, it is the available space, or cubic area available, for carrying ink within the 736,000 cells that are within one square inch of surface area. This ‘available space’ within a 800 line screen will typically range from 1.6 to 2.2 billion cubic microns (BCM’s). Expressed in actual numbers it looks like this: 1,600,000,000,000 cubic microns.

Determining Anilox Volume
Anilox suppliers typically have two ways to determine the available space available for carrying ink on an anilox roll. The first is the historical method, still used by some, using a microscope. The volume is determined by analyzing the space available in a single cell – or a sampling of cells on the anilox roll. Then assuming the rest of the cells, 222,640 of them in the case of a 440 line screen roll, are basically the same. Needless to say, it can be said that this produces a highly theoretical number – and the second method proved this to be the case.

The second method was adopted in the 1990’s and uses a microscopic mapping modality called interferometric light technology. Interferometer employs what is called a multimode waveguide interferometer, or MWI, whereby a single light beam enters a waveguide formed by two parallel mirrors, where it propagates as a combination of many different modes. Because these modes are following many paths simultaneously to reach their destination, they interfere with each other. This interference pattern can be used to obtain a measurement of the distance traveled. These distances are then captured and computer modeled into a microscopic surface topographical map – which in turn is used to calculate the available ‘space available’ that can carry ink on the anilox roll surface.

Through extensive research in the late 1990’s, Harper Corporation determined that physical measurement, beginning with an individual (the human factor) determining the microscopic opening, depth and shape of an individual anilox roll cell, was the biggest area of potential
problems with the historical method. Variations of cell depths to the tune of plus or minus 15% could easily be made – depending on the person’s perceptible vision in focusing a microscope.

Compared to the inferemetric system, this variation was cut virtually in half – thus meriting a large investment and conversion in manufacturing and quality control technology. The reason to Harper was appearance: If Flexography was to be predictable in color reproduction, then anilox volumes more predictable. Thus, today, it’s the standard procedure in both setting up the rolls for laser in quality control.

Anilox Volume and Color Control
It is commonly known that the anilox cells volume (or sizes) drives the ultimate color achieved on press. This is caused by sizes ability to be changed. This in turn will change ink film’s thickness transferred - to darken or lighten how is color control verses the anilox cell volume they really? Or perhaps better still, how can an 800 print a stronger color than a 600 line anilox – where would indicates that the lower the anilox line screen count, the stronger the color on press.

To better understand how anilox changes colors seen at press side irrespective of cell count, we have to take ‘anilox volume’ and convert it to ‘ink film thickness.’ To determine this, we would then calculate the answer to this question: If all the ink, as measured in BCM’s, were transferred out of these cells of an anilox roll, how thick would this film of ink be? To determine this, we convert the ‘cubic square area’ (BCM’s) into ‘actual micron film thickness’ that would result if every cell transferred 100% of its ink. The conversion calculation is: BCM / .65 = Available ink film thickness. As show in Chart A, anilox BCM’s converted to available ink film thickness actually are far less than most imagine – as represented by a 8.0 BCM having available slightly less than ½ thousandth of an inch if all is released.

This answer then produces another question: How much ink is actually transferred from the anilox roll surface to the printing plate, and then to the substrate? Answering this question took years. The technical explanation will be the subject to our next article. Again, surprising to many, the amount is approximately 50% transferred from the anilox surface to the plate and then 50% of the plates ink goes to the substrate.

"Making a point to educate your operators as to these small, but critical color control numbers can easily save you thousands of dollars every year.”
Therefore, if you have 3.0 BCM’s ‘available’ to carry ink within the cells (or on the surface) of an anilox roll, the resulting film thickness ‘available’ for transferred would be calculated as: 3.0 / .65= 4.615 Microns. In other words, a 3.0 BCM anilox roll has a 4.615 ink film thickness available for transfer. Of this thickness, only ½ is transferred at most or just 2.307 microns of ink. Taken to the substrate, we calculate only ½ transferring from the plate to the substrate, or an infinitesimal amount of 1.155 microns.

Knowing this, we can easily see that a given thickness of red ink will go pink if the anilox cells are filled (dirty) by only 15%. In this case, a 4.615 micron ink film thickness is available, but reduced by 15% would make this 3.9 microns. This difference will create big differences of color on press, particularly with certain colors.

These facts further illuminate the need for standard cleaning and maintenance of an anilox roll’s surface. Otherwise, it will be the heart of massive downtime, heartache and a lot frustration in any pressroom. Making a point to educate your operators as to these small, but critical color control numbers can easily save you thousands of dollars every year.

To put to work this information in your pressroom, classification of your anilox inventory by volume would be the best place to start. Considering the logic that volume or the ink’s film thickness is actually what you print with – not line screens on an anilox - adopting some language changes may be in order. To change this in your shop, it’s suggested you start with being sure that every place where anilox is referenced, you insure that volume is added with it. This should begin with your anilox charts and tags - ending with your customer order records. And if you don’t reference it on the latter, it’s paramount to downtime prevention that you do. To go a step further, it’s suggested you chart you inventory using volumes and line screen as the second number to simply help identify the roll. If there just isn’t time to do it right, it is well worth the expense to have someone come in and audit your inventory first and then chart, list, identify your color drivers – to prevent guessing at every job each time it returns to press.

While we advocated that anilox volume is king in the Flexographic color control equation, line screen is a secondary driver for optimum success in color reproduction on press. This we will cover in our second article in this series of three – outlining how line screen selection of an anilox roll becomes the stabilizer of the perfect ink film we’re wanting to transfer.

<table>
<thead>
<tr>
<th>Measured Anilox Volume In BCM'S</th>
<th>Calculated Ink Film Thickness &quot;In Microns&quot; Available</th>
<th>50% Transferred To Plate</th>
<th>50% Transferred To Substrate</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.0</td>
<td>12.3</td>
<td>6.154</td>
<td>3.077</td>
</tr>
<tr>
<td>7.0</td>
<td>10.8</td>
<td>5.385</td>
<td>2.692</td>
</tr>
<tr>
<td>6.0</td>
<td>9.2</td>
<td>4.615</td>
<td>2.308</td>
</tr>
<tr>
<td>5.0</td>
<td>7.7</td>
<td>3.846</td>
<td>1.923</td>
</tr>
<tr>
<td>4.0</td>
<td>6.2</td>
<td>3.077</td>
<td>1.538</td>
</tr>
<tr>
<td>3.0</td>
<td>4.6</td>
<td>2.308</td>
<td>1.154</td>
</tr>
<tr>
<td>2.0</td>
<td>3.1</td>
<td>1.538</td>
<td>0.769</td>
</tr>
</tbody>
</table>

Chart A