

The information and data contained in this document were prepared by a technical committee of the Association. The committee and the Association assume no liability or responsibility in connection with the use of such information or data, including but not limited to any liability under patent, copyright, or trade secret laws. The user is responsible for determining that this document is the most recent edition published.

Identifying anilox roll volume measuring equipment

Scope

The technical information contained herein identifies the various types of anilox roll volume measuring equipment and devices that anilox roll manufacturers use to produce anilox rolls.

Safety precautions

There are no safety precautions applicable.

Definition

Anilox roll volume is defined as the amount of ink or liquid carried by a given area of engraved surface of an anilox roll. In North America it is usually expressed in “Billion Cubic Microns” (BCM) per square inch. In Europe and much of Latin America it is expressed in “cubic centimeters per square meter (cm^3/m^2).

Optical measurement

For a mechanically engraved and chrome plated roll the calculation of volume is made through a mathematical formula. These anilox rolls are engraved using a tool designed by a die maker using his own design as to the angle of the interior walls and all other dimensions. When anilox rolls are mechanically engraved and chrome plated, a single anilox cell is measured using an optical measuring device known as a “Gravurescope.” All of the interior dimensions on a particular cell are taken: depth, opening, wall (land), and bottom. The anilox line count must be known. If the line count is unknown, the top of the opening plus the width of a single wall separating each cell are added. This total is divided into 25,400 (there are 25,400 microns in a linear inch) and the answer is the number of cells or “lines per inch” (LPI), or the line count. Once all of the anilox cell dimensions have been made a simple geometric formula can usually be used to calculate the cell volume. Below is the formula for a quad cell:

$$D/3 [(O^2 + B^2) + (O \times B)] \times \text{line count}^2 = \text{BCM}$$

Optical measuring systems have proven to be moderately accurate with later editions of the gravurescope becoming computerized and connected to a video monitor. The volume formulas are internally programmed and provide volume information instantaneously. But all gravurescopes rely upon the measured differences of focus points (top of the wall vs. bottom of the cell) to determine depth. This is somewhat operator sensitive since no two people are likely to focus at either point exactly the same. [Prior to the development of the TV monitor hookup, it was difficult for several individuals to agree on the cell dimensions. This was due to viewing the cell individually through the eyepiece and the difference of focal length from operator to operator. Operator technique in reading and identifying the actual cell bottom is difficult because the human eye cannot distinguish finite measurements such as a micron. This is one of the reasons that led to the video monitor and computerized programming.]

Optical techniques measure only a single cell with the assumption that all of the cells are identical. It is important to note that when a mechanically engraved anilox surface is ceramic coated rather than chrome plated the

perfect geometry of the cells is reduced and the very smooth surface is lost so it becomes therefore impractical to make the precise optical measurements necessary for accurate volume calculation. In that case liquid displacement techniques are usually employed.

In the case of the laser engraving process a laser beam is used to literally burn a cell directly into the ceramic material cell. Unlike mechanically engraved cells the laser cells created are not perfectly identical due to the nature of the cell formation which is created by the molten ceramic. So a sample area should be viewed and all cells within that sample measured. Furthermore the laser engraved cell has no flat surfaces inside the cell and no corners – everything is rounded so it is impossible to make accurate optical measurements of a single cell. In the case of both the mechanically engraved ceramic and the ceramic coated laser engraved screen the ceramic material absorbs light further hampering a direct optical reading of cell measurements. Laser engraved ceramic surfaces are measured with liquid displacement techniques, interferometry or 3D Scanning Microscope.

Liquid displacement volume measuring system

This system can be used to measure mechanical engraved ceramic coated rolls, laser engraved ceramic rolls and even chrome plated anilox rolls. It operates on the principle that a known volume of fluid will spread only as far over an engraved surface as the surface texture or cell structure allows it. Cell volume is therefore a function of the area covered by the liquid. Higher volume permits less spread (because the cells are bigger and deeper and so “consume” more liquid. Lower volumes permit spread over a greater area because the cells are smaller and shallower.

The liquid volume measuring system uses a pipette (either 10 mL or 25 mL) to place a measured amount of a liquid (usually a special dye) onto the face of the anilox roll. The liquid is then spread around the circumference with a hand held doctor blade device. A sheet of white bond paper is then placed over the liquid smear, transferring the liquid to the paper so that a footprint of the smear is obtained. The outline of the footprint can then be fed into a computer. Internal programming measures the area of the footprint or “blot” and calculates the cell volume. While this computerized process is patented, there are also methods commonly used to manually measure the “blot” circumference and calculate the volume. The device used for manual reading the “blot” is called a planimeter.

This system, whether using the computer or manual calculation, has proven to be very useful to the converter. It is fairly easy to use, both on and off the press. It is open to inconsistencies however. These can occur in the measuring out of the liquid (loading and unloading the pipette), the surface tension and other properties of the liquid, the inability of the human arm to duplicate speed and pressure when spreading of the bead, possible “loss” of liquid due to its adherence to the blade and manual measurement of the “blot” area. To add, the porosity and surface energy of the ceramic plays a role in the accuracy and repeatability. A 5% error factor is estimated when a single experienced operator does the entire test. From operator to operator, the error factor can be as high as 10% to 15%. This results in having to take several readings from a typical anilox roll and using an average of all the readings as the volumetric carrying capacity of that roll.

A recent modification of the liquid displacement process addresses the inconsistency that arises from measurement of the liquid and adherence of the liquid to the blade. This process involves a pre-measured capsule of liquid contained on a card which is attached directly to the roll surface and is then spread without the blade coming into direct contact with the liquid. The card has a printed scale on it which directly indicates cell volume based on the size of the “blot” thus also saving the time and inconsistency of measuring the area of the “blot” and calculating the volume.

Vertical scanning interferometry

A more scientific approach has been taken by most of the anilox roll manufacturers to address the volume issue for laser engraved anilox rolls. It was made possible by incorporating technology used on computer discs, fiber optics and other critical surfaces. This technology was used in several space programs by the United States Government to transmit data from the skies and operates in nanometer accuracy.

A 3-D scanning head is positioned on an anilox roll while connected to a computer and TV monitor. The device scans all of the cells in the field of view, taking some 60,000 measurements in 13 seconds. This is done by first splitting a beam of white light in two. The first is sent directly to a sensor. The second is sent down to the roll surface and is from there reflected back up to the sensor to rejoin the first. But because the two beams have traveled different distances they are now out of phase with each other upon arrival at the sensor. Programmed with the proper algorithm, the computer then measures the interference and creates a statistical profile of the engraved surface from which it then calculates the volumes of all the cells in the sample and averages them to determine the cell volume.