Four-Color Process Inks: Why Are They So Different?

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Impressions Magazine
November 1994

As it becomes easier and easier to print four-color process, more ink manufacturers are introducing improved process color inks. What makes each ink set different, and which should you be using? This month we will take a look at the characteristics that should be included in an ink set. There are definite attributes which yield superior printed images. There are also characteristics that cause you great amounts of grief.

Color capability

The first category that we should investigate is color capabilities of the ink. Even under the very best circumstances process color inks will print only an approximation of the original full-color image. Many of you have been led to believe that four-color process can give accurate full-color reproduction. This is definitely not the case. While in theory we can achieve full-color reproduction, the natural contamination of pigments we use defeats our ability to get accurate full-color replication. If you have an understanding of what color aspects are desirable, it is easier to choose an ink that you will be successful with.

Transparency

Transparency is a primary factor in any good ink set. Because process color is based on the overlaying of transparent color to achieve secondary and tertiary colors, the clarity of inks we use directly determines the colors we can reproduce.

When it comes to the transmission of light, the three categories we must consider are opacity, translucency, and transparency. An opaque color will not transmit light–it reflects it. Opaque inks will not produce satisfactory overprint colors. Very few ink companies sell opaque process colors.

Translucent colors are those that transmit diffuse light. It would be similar to the light you see from a light table. Light and color are transmitted, but you cannot look through the surface to see what is behind it. Many process inks fall into this category. There are a variety of reasons why inks are translucent. Regardless of the reason, it is not desirable. As with opaque colors, the ability to achieve good overprint colors is limited.

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Transparent colors are ideal for process color reproduction. They allow a much greater amount of light to pass through. Transparency is similar to stained glass, or looking through sunglasses. We can see perfectly what is behind the lens. All the shapes are defined, but they are influenced by the lens color. The more transparent the color, the greater the range of secondary and tertiary colors we can achieve. This means that to a large degree the amount of ink transparency determines the quality of oranges, reds, greens, blues, violets, greys, and browns.

To judge an ink, smear a small amount of color on a metal can lid or a stainless-steel spatula. If the color is transparent, the metal surface will be clearly visible behind the color. The color itself will have a metallic look. If the ink is translucent, the ink film will appear cloudy and less metallic. The process yellow and black are the most susceptible to this. If the ink is opaque, you will not be able to see any metallic behind the color. Generally, the more expensive the ink, the more transparent the color. Good permanent transparent colors are expensive.

Color Trapping

Closely related to transparency is color trap. Color trapping is a lithographic term referring to the ability of primary process colors to generate overprinted colors. Two process colors will give secondary colors (reds, greens, blues). The overprinting of three colors results in tertiary hues (greys and browns). To evaluate an ink for trapping, print a solid patch of yellow and overprint it with cyan; the result will be green. Now, reverse the print order and compare the resulting green that you achieve with yellow over cyan. They should be very close to the same color. If the first green is darker, and the second much lighter, it is a good indication that the inks you are working with are not transparent enough. Do the same test for yellow over magenta, and magenta over cyan.

Hue error and greyness

Hue is another name for color. The primary color positions for process color reproduction are yellow, magenta, and cyan. Hue error refers to the error of actual ink away from the ideal position. All process inks have a hue error. Yellow is generally the least, and magenta the most. This is because ideal positions are based on physical numbers calculated from wavelengths of light. In actuality, we have to find pigments that are as close as possible to those co-ordinates. In some cases they simply do not exist in nature. We have to make do with what we can get. The closer we get to ideal numbers, the more expensive the inks become. The hue error component of inks should be as low as possible. The actual hue error number represents the amount of contamination of the dominant color. For example, a magenta with a hue error of 58Y represents a 58% contamination of yellow in the magenta pigment. This is typical for magenta and is one of the reasons why your reds look orange.

Greyness represents the level of contamination of the other two process colors in any color. For example, a greyness value of 15 in cyan means that the cyan has a neutral grey component of 15%. Neutral grey is composed of 15% yellow, 15% cyan, and 15% magenta. The lower the greyness value, the cleaner your colors will be. Colors with a high grey value are also known as muddy, dirty, or dull.

It is very important for your color separator to know the hue error and greyness values of the inks that you are working with. They will separate to those values. If they do not know what they are, they will most likely use SWOP values.

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this; may be acceptable for noncritical work, but for exact match you must know the values. This mismatch of values is a primary reason why you often have a hard time matching the color proof provided by a separator. The film and proof may be fine, but your ink is the culprit.

Color density

Out-of-the-can color strength is extremely important for good reproduction. It is also one of the most difficult factors to control. Printers in our industry like to have ready-for-use (RFU) formulas so they can go to the shelf and get the ink–no muss, no fuss. Unfortunately, when you are printing transparent colors, there is no easy way to get the correct color strength right out of the can. The mesh count, mesh tension, squeegee durometer, sharpness, pressure, and a number of other factors control how much color goes down. The ink maker picks a value and hopes it is high enough. It can never be perfect. The better you get at printing process color, the higher the color density you can use. If your dot gain is high, you will generally use a lower color strength. This helps with dot gain, but destroys your ability to achieve good print contrast. The result is images look dull and washed out. You lack dark blacks and shadow definition.

High color strength is necessary to obtain good print contrast. It is better to start off too high and cut back with clear halftone base than to be too weak and not be able to get your contrast. If your inks are too weak, make sure that there are toners available to boost the color strength. If you have a densitometer, the correct color strengths for each color are:

Yellow	.75 - .90
Magenta	1.10 - 1.20
Cyan	1.20 - 1.30
Black	1.30 - 1.40

If you do not know what your ink density or color strength is, you will need to work with your separator to determine it. This can be done at the same time you test for dot gain.

Printing characteristics

The printing capability of the ink you use is just as important as the color aspects. Process color inks must be manufactured to print a very precise dot and keep that dot at a predetermined size. If the dot is too big, the color it represents will be too dark. If the dot is part of a secondary or tertiary color, the resulting color will be shifted away from its desired final color. The tendency for a dot to grow is known as dot gain. The area of the dot is gaining or growing. This is not a desirable situation.

It is very important for you to know that all printing processes have dot gain. It is not necessarily bad, unless we cannot manage it. Dot gain ranges from a low of 25% to over 50%, depending on the ink. Most inks in our industry are in the 35%-45% range. This means that a 50% value will grow to 85%-95% when printed. If you have midtone values, they will print as solids. The lower the dot gain, the better–this allows for better print contrast and greater shadow detail.

Two characteristics necessary to achieve low dot gain are the realogy of the ink, and more specifically, the thixotrophy of the ink. Realogy is the overstudy of flow properties of the material and thixotrophy is the specific flow property that helps to control dot gain.

Thixotrophy is the characteristic of a material to be solid at rest and liquid under shear force. This means that a thixotrophic ink will be stiffer when it is in the can than when it is being printed. Opaque white inks are very thixotrophic. Once you stir them, they liquify and

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remain runny for a long time. In process color inks we want thixotrophic characteristics that have yield and recovery properties.

Yield means that an ink will stay relatively stiff until a certain amount of shear force has been applied to it. At the yield point the ink viscosity drops off and it flows much easier. The recovery rate is the amount of time, in seconds, for the low viscosity ink to recover to its resting higher viscosity. You want a quick recovery as this is what helps to limit the dot gain factor. Ideally, you want an ink that has a moderate yield point, a fairly quick drop in viscosity, and a very rapid recovery rate. This means that ink in the screen will be somewhat pastelike, dropping to a printable liquid during the squeegee stroke, and recovering almost immediately to the higher resting viscosity as soon as the ink is on the garment.

Higher viscosity on the garment helps to keep the dot from growing on its own and helps to retard growth when the next colors are printed wet-on-wet on top of each other. It is desirable to print very thin deposits of highly colored ink as these are the least subject to dot gain.

Build-up

The last area that I want to focus on is ink build-up. This is the characteristic of the process ink to touch off and build up on the back side of subsequent screens. In printing conventional flat color separations this is time-consuming and annoying. With process color it can have very negative effects on the ability to control color.

There are two areas where this is a problem. The first is "lift-off", where the initial ink film is pulled off the garment when it adheres to the following screen. This will cause a color shift away from the desired target color. For instance, cyan being lifted off yellow by the black screen will cause a color shift toward light green as there is not sufficient cyan left on the garment. Higher tension will help here, but resins, fillers and plasticizers used in the ink are the main causes.

The second aspect of build-up is one of mesh blockage. If you have highlight dots (the smallest type of dot) overprinting a large color field, there is a tendency to fill in small dots with creeping build-up on the back side of the screen. This would happen if you were printing a very fine 10% cyan dot in a solid yellow area to make a very light green. The build-up of excess yellow pigment and resin on the back of the cyan screen will soon begin to creep and migrate into the small dot openings, eventually blocking them. Your nice light green will soon look splotchy and eventually become yellow as the holes are blocked.

The degree of build-up determines how much color shifting you experience, and how fast you notice it. Some colors are more prone to color shift than others. If you have large amounts of light secondary colors (aqua, mint green, orange, violet, blues, beiges), be particularly careful. Like pigment or color quality, better inks will cost more. If you want consistent color, you must consider this.

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