A Computer Technique for the Establishment of Color and Strength Standards for Liquid Inks

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ABSTRACT:

Present techniques for controlling the quality of color of liquid inks are generally unsatisfactory. Storage of wet standards has caused color and strength drift, viscosity build and flocculation. After a short period, wet standards may be no longer useful. A method was needed to store standard color data and use it as a reference in determining color strength and hue.

Many methods have been proposed which require prints of standard inks using a proofing press. The prints are read on a spectrophotometer and the data stored. Viscosity, press speed, substrate, impression pressure and operator variability prevent prints from being reproducible. This has caused concern among those who wish to use computer stored data.

The proposed method uses a spectrophotometric evaluation of wet ink to provide data to the computer; thus avoiding the above problems. A technique was developed using a sealed liquid cell with bleaches of the standard inks, which allows reproducible data to be obtained. Studies of the effect of time on "flooding" were also done.

INTRODUCTION:

Spectrophotometric analysis of color has proven to be an accurate method for assessing strength and hue. With the advent of the color

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computer to generate and evaluate spectal data, many companies have utilized such data to specify color hue and strength. Liquid inks such as gravure and flexo pose some unique problems to ink chemists, who have tried to achieve reproducible color samples of ink, to be read on the spectrophotometer. These inks are extremely volatile, inherently low in viscosity and the pigments may be unstable after long periods of storage. Gravure and flexo prints are affected by different substrates, viscosity, cell configurations and press speed. The above variables often prevent reproducible color data from being obtained on a spectrophotometer. Without good spectal data, the color computer analyses are questionable and may even be totally irrelevant. The proposed method utilizes sealed glass spectrophotometric cells that are filled with bleached ink. The wall of the cells are then read by reflection on the spectrophotometer. This eliminates printing variables and ink properties (ie. volatility) from affecting results significantly.

DISCUSSION:

Bleach tests have been used in the ink industry for many years to assess color strength of inks. A simple procedure of adding a small measured amount of color base to a standard white ink, thoroughly mixing the sample and then drawing the ink down with a Mayer Rod side by side with a standard, is a normal way of comparing color strength. Unfortunately, inks often have to be made in duplicate and a reliable wet standard ink is needed to produce a fresh bleached standard every time. The reliability of the wet standard ink can be questioned after it is several weeks old.

In the new method, a glass cell is filled with the wet bleached standard ink and read on the spectrophotometer. The resulting data and curve is then stored in the color computer memory. A batch of ink of unknown strength is bleached in the same way as the standard and also read on the spectrophotometer. Once again, the data and curve are stored in the memory. To determine strength, the computer compares the two

color curves and selects the wavelength of maximum absorbance (minimum reflectance). The ratio of the absorption coefficient (K) to the scattering coefficient (S) is calculated using the Kubelka-Munk equation:

$$K/S = (1-R)^2/2R$$

K = absorption coefficient
S = scattering coefficient
R = reflectance fraction

The computer then calculates percent strength of the batch as follows:

$$\text{percent Strength} = \frac{K/S \text{ Batch}}{K/S \text{ Standard}} \times 100$$

Color differences can be determined by interpretation of the curves or by any of the standard color difference equations. Be aware that if there is a significant color difference, the accuracy of the strength comparison may be doubtful. Also the color difference data should be used as a guideline for undertone only, since it is not representative of the masstone color of a print. It is only feasible to obtain spectral data on masstones from a print.

Utilizing this method, most of the problems associated with obtaining reproducible sample exhibits for the spectrophotometer are eliminated. Printing problems previously mentioned are nonexistent, while changes in ink properties are minimized by use of a sealed glass cell.

Bleach White

The gravure bleach white used consists of TiO_2 and clay filler, metal resinate as the binder and xylene as the solvent. Of course the bleach white must be compatible with whatever ink system you choose to test. These experiments were based on publication gravure vehicles and the above formula worked well. Due to the design of the glass cell, a low viscosity bleach worked

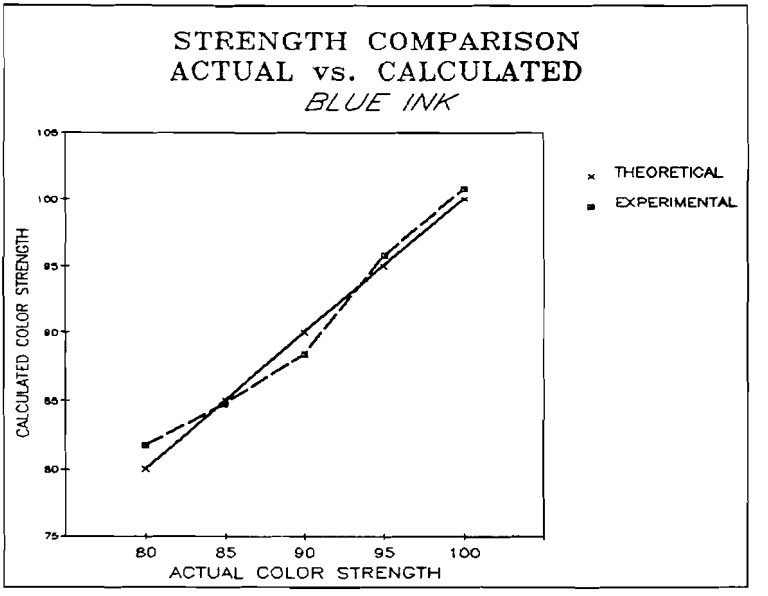
well, especially in facilitating clean up. In these experiments, the bleach viscosity was approximately 6-7 centipoises. As you might suspect, "flooding or floating" can be a problem, and this will be covered later. The bleach white used must also be standardized to accurately compare future batches of ink. This will also allow controlling succeeding batches of bleaching white. A procedure known as reverse bleaching can be used. The method uses a standard, stable color base to compare the batches of bleach white. These reverse bleach tests are measured spectrophotometrically and then stored in the computer. In this way, the "bleaching" power of the white is standardized for subsequent batches.

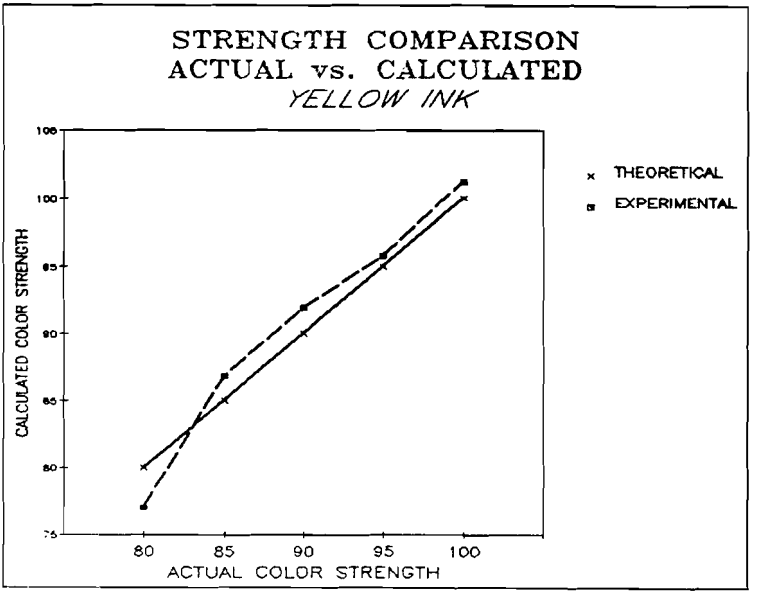
Color Measurements

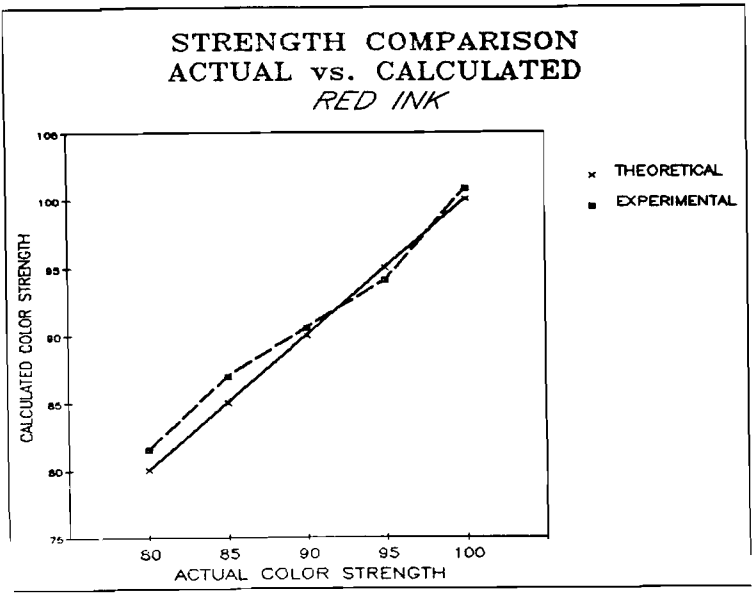
All spectrophotometers have some limitations. These must be accounted for or the readings may be misleading. Most spectrophotometers lack sensitivity at the extreme ends of the visible spectrum. This can be a problem when you are attempting to measure certain yellow or blue color bases. In these instances the wavelength of maximum absorption is 400 nm or 700 nm, respectively. It is best in these cases to refer to the spectral curves themselves and choose another wavelength close to the one of maximum absorbance, for instance 420 nm instead of 400 nm and 680 nm instead of 700 nm. This will greatly minimize any potential inaccuracy.

Another problem may occur due to the strength calculation itself. As previously mentioned, the K/S term is composed of an absorption coefficient K divided by the scattering coefficient S. The scattering coefficient of the bleach, if not sufficiently large, will not override the scattering of the colored pigment. This is easily overcome by adding sufficient bleach white so the scattering of the color is insignificant compared to the white. In general, the percent reflectance at the point of maximum absorbency should be at least 30-40 percent for best results. Reductions of the colors were made to simulate a 5 percent, 10 percent, 15 percent and 20 percent reduction

in color strength, the only difference was the amount of base added to the bleach. The following graphs show the difference between calculated and actual strength using the method outlined.

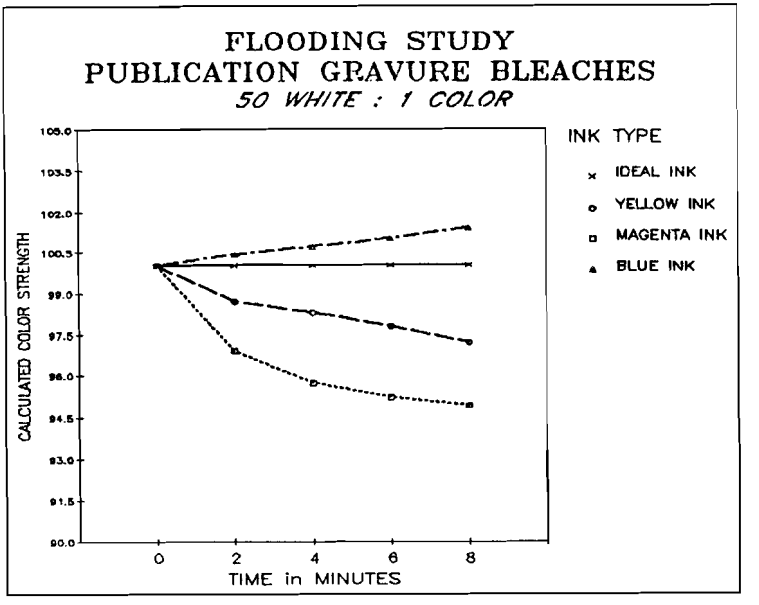






Careful placement of the glass cell in the instrument is vital so that all of the surface is viewed by the spectrophotometer. In order to avoid misplacement, place an unfilled cell over the viewing port and make sure it is centered. Then mark the wall of the instrument with a pencil to aid in placing the filled cell in the correct position.

An important cause of false readings is flooding or floating. Due to the low viscosity of the bleach white and specific gravity differences of the pigments, they tend to separate on standing. Some may float to the surface, while others settle toward the bottom. Other physical/chemical properties can also affect flooding or floating. Therefore, constant agitation by shaking of the sample is required to prevent flooding/floating from affecting your readings. To illustrate, the following graph shows how this condition can affect the readings. All of the bleaches were allowed to sit undisturbed in the cell for given time and then read on the spectrophotometer. All initial readings were at 100 percent immediately after stopping agitation.



The use of anti-floating/flooding agents was considered as a bleach white additive but disregarded. It was felt that such additives may influence some pigments more than others and produce inconsistent results.

Care and Cleaning of the Glass Cell

Since all of the measurements are taken using these cells, they must be cleaned thoroughly between each use. A few rinses using an appropriate solvent is all that is usually needed to keep the cells clean. The low viscosity of the bleach white simplifies the cleaning operation. Once the cell has been rinsed clean, all of the solvent has to be removed. If not, any remaining solvent will decrease the strength of a subsequent bleach and yield a false low reading. It has been found that a final rinse of acetone and a stream of compressed air is sufficient to assure a clean, dry cell.

The shape of the cell and the shaking method previously outlined may cause the cell wall to be contaminated with fingerprints. Wiping with a lintless disposable towel will remove them easily and assure an accurate reading.

CONCLUSION:

1. The procedure outlined provides a useful method of determining the strength of color bases or inks to within ±3 percent of a computer stored standard.

2. The spectral data generated also affords a useful measurement of color shifts from the standard, as well as drifting of the standard with age.

3. Repeatability of a single sample was within ±1 percent for color strength with a dE of .25 or less.

4. The flooding studies indicate the importance of prompt measurement after agitation and that apparent strength may either increase or decrease on standing, depending on the type of colorant.

ACKNOWLEDGEMENTS:

The authors are endebted to Mr. Robert Bassemir for his support and encouragement and to Lucas Loucopoulos who was responsible for gathering much of the raw data.

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