THE INVESTIGATION OF EFFECT OF PIGMENT RATIO IN INK ON COLOR GAMUT

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Abstract: *Color printing is important for every printing method in the Printing Industry. When it comes to obtaining the right colors, visual beauty and cost factors comes into prominence. In order to reduce the printing cost, it is necessary to obtain the maximum possible number of colors from the mixture of these colors by using less colors and plates. For this purpose, it is tried to reach the widest color gamut that can be reached in printing by interfering with the L*a*b* values of standard CMYK colors or by using additional colors. In the study, offset printing CMYK inks were prepared using mono pigments. Then, the ink pigment ratios were increased by 25% and the obtained inks were printed on 135 g/m^2 glossy coated paper. The density values, L*a*b* values of the prints were measured and the ΔE_{00} differences were calculated. By measuring the color values of the prints, the effect of the inks on the color universe was examined. It has been determined that increasing the pigment ratio has a positive effect on the color gamut.*

Keywords: *offset printing, ink, pigment, color gamut*

INTRODUCTION

Print media is still a part of everyone's daily life and remains very important for everyone. Offset printing system is one of the most used printing techniques. Offset printing system is a preferred printing system in terms of keeping up with the developing technology and printing quality. [1-2] The development of printing materials manufacturers and the great developments in ink and paper production have increased the print quality day by day. [3-4]

One of the most important reasons for the increase in print quality today is the use of inks with high dyeing properties. [5] The layer thickness of these inks used during printing should be 2 μm or less. The critical point is that the thickness of the ink directly affects the print quality and color space. Absorption of ink by the paper and drying are other factors [6]. In every printing process, the interaction between the paper surface and the colorant or pigment is an important factor in determining print quality. [7]

Ink-paper interactions, including ink transfer, setting and drying processes, play an important role in print production as they affect both print quality and runnability. Sheet-fed offset ink is made of three main ingredients: Pigment, Vehicle and Modifiers, it also contains catalytic desiccants, antioxidants, wax particles and other additives [8].

If we want to improve the print quality, one of the main ways is to develop new highly pigmented inks that have a better ability to coating the substrate, unlike the inks used so far.[6]

When using a standard ink, it may be necessary to create a higher ink thickness to cover the paper surface. This can be over 2 microns, which is the standard printing thickness of the ink. However, when using highly pigmented inks, a better dyeing can be achieved with the thickness of the standard ink layer. For this reason, in this study, the effect on printing parameters was investigated by creating inks with high pigment content.

EXPERIMENTAL PART

Materials and Methods

In the study; Oil-based offset printing inks are used. Inks; It was prepared by using mono pigments by increasing the standard pigment ratio and 25% pigment ratio. (The reason for using a precise ratio of 25% in pigmentation is planned to have a direct effect on the test result) Test prints were made on 135 g/m^2 coated glossy paper. Test prints were made in accordance with the ISO 12647-2 standard. X-Rite manufacturing standards are used for all spectrophotometric and densitometric measurements (according to 0/45º geometry with 2º observer angle with D50 light source in the range of 400-700 nm and 23°C +/- 1°C temperature, 40-60% RH). The difference between the colors of the prints is calculated according to the formula (1) (according to the CIEDE 2000 standard, ISO 13655). Chromix ColorThink Pro 3.0 Color Gamut Volume Measurement Software was used to calculate color gamut volumes.

$$\Delta E^{*} = \sqrt{\left(\frac{\Delta L'}{k_L S_L}\right)^2 + \left(\frac{\Delta C'}{k_C S_C}\right)^2 + \left(\frac{\Delta H'}{k_H S_H}\right)^2 + R_T \frac{\Delta C'}{k_C S_C}\frac{\Delta H'}{k_H S_H}} \quad (1)$$

RESULTS AND DISCUSSION

As a result of the studies, all printing parameters were examined. The density values and CIE L a*b* values of the prints made with Standard Pigment Ratio ink, Pigment Ratio +25% ink and ISO 12647-2 Standard were measured and compared with each other. Delta-E values were calculated according to the CIE L a*b* values. The dot gain values were compared for each color separately. The results of color gamut and color gamut volumes were calculated. All results are shown below in tables and graphics.

Table 1: Solid Density Values

	ISO 12647-2 Standard	Standard Pigment Ratio ink	Pigment Ratio +%25 ink
Cyan	1,55	1,48	1,58
Magenta	1,5	1,42	1,46
Yellow	1,45	1,43	1,42
Black	1,8	1,81	1,8

When Table 1. is examined, it is seen that the solid density values of the prints are within the standard values.

*Table 2: CIE L a*b* values for ISO 12647-2 Standard and all printed papers*

ISO 12647-2 Standard	L	a*	b*	Standard Pigment Ratio ink	L	a*	b*	Pigment Ratio +%25 ink	L*	a*	b*
Cyan	55	-37	-50	**Cyan**	58.4	-35.31	-50.12	**Cyan**	55.87	-34.73	-51.28
Magenta	48	74	-3	**Magenta**	51.08	73.02	-5.41	**Magenta**	46.91	73.68	0.05
Yellow	89	-5	93	**Yellow**	89.94	-4.89	93.41	**Yellow**	89.05	-4.41	95.92
Black	16	0	0	**Black**	16.48	1.Feb	0.52	**Black**	18.03	-1.02	0.9
Red	47	68	48	**Red**	49.32	65.29	48.13	**Red**	46.34	68.2	47.05
Green	50	-68	25	**Green**	50.19	-64.34	29.45	**Green**	49.11	-63.69	30.63
Blue	24	17	-46	**Blue**	25.43	19.39	-44.19	**Blue**	22.73	23.58	-40.59
White Paper	95	0	-2	**White Paper**	94.66	0.73	-4.75	**White Paper**	94.97	0.72	-5

Table 3: Density and ΔE values

	Cyan	Magenta	Yellow	Black
Standart Pigment Ratio ink	3,2	4,8	0,9	1,2
Pigment Ratio +%25 ink	2,7	3,3	3	2,7

When the Delta-E values of all printed papers are examined, it has been determined that the ink values with both pigment ratios are in the acceptable range, that is, below 5.

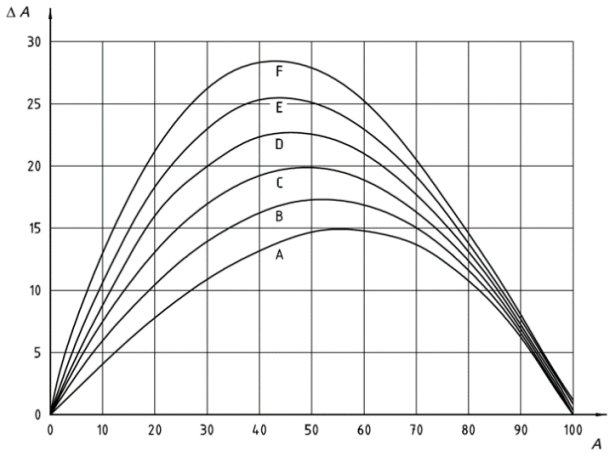

Figure 1: Tone value increase according to Process Standard Offset-ISO 12647-2 [9]

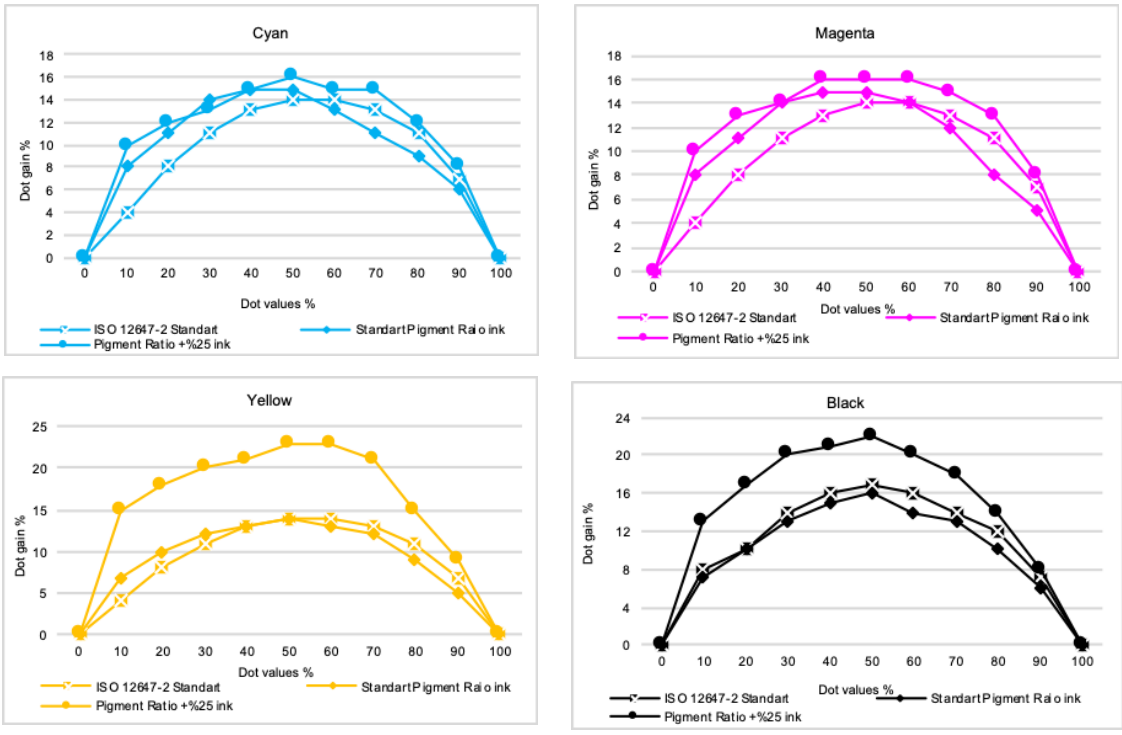

Figure 2: Tone value increase for all printed papers

When the dot gain values are compared, it is seen that the dot gain values in Cyan and Magenta colors are within the standard values. It was determined that the Pigment Ratio +25% values in black and yellow colors were higher than the standard values.

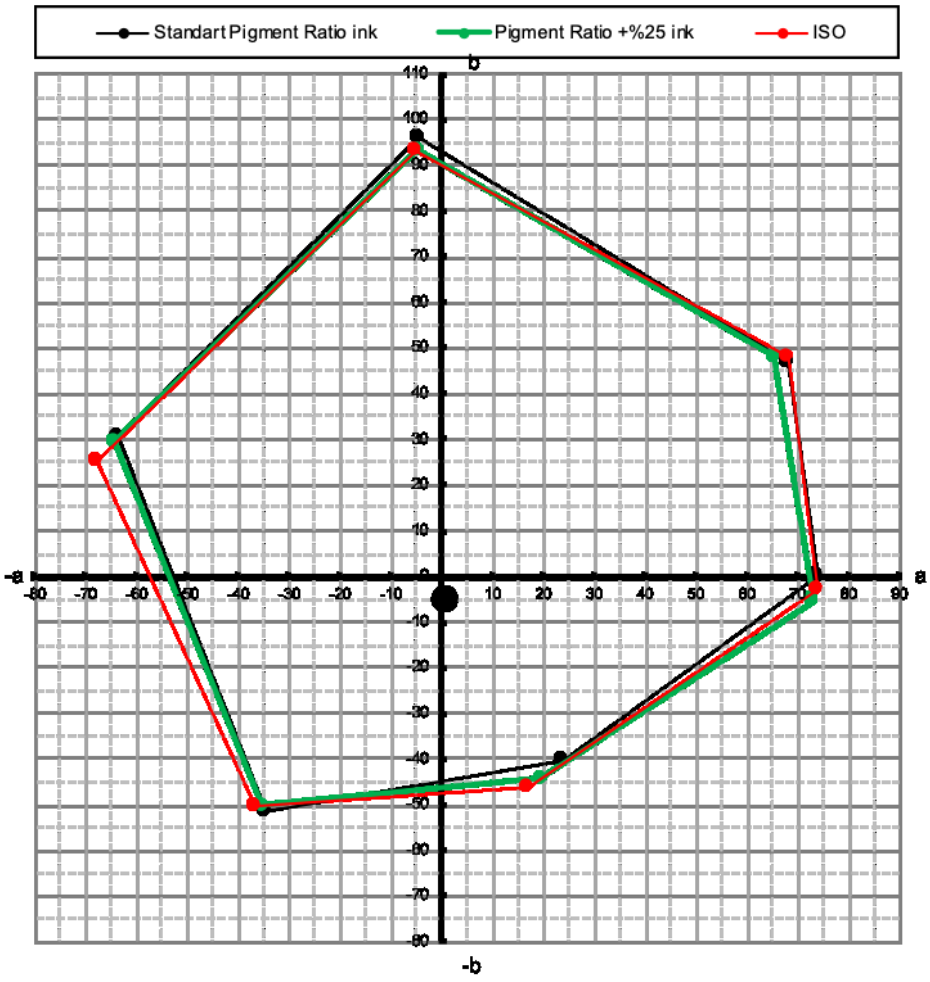

Figure 3: Color gamut diagram for all printed papers

When we look at the color gamut diagram, it is seen that the color gamut obtained with both Standard Pigment Raio ink and Pigment Ratio +25% ink values is narrower in the light blue-light green regions and red regions compared to the ISO 12647-2 Standard value color gamut.

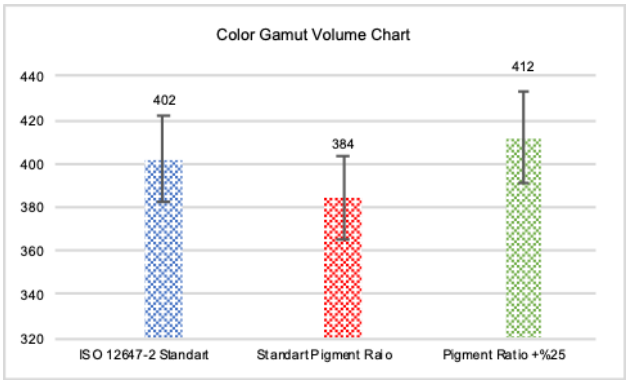

Figure 2: Color gamut volues for all printed papers

Color gamut volume values show that Pigment Ratio +%25 ink values have the highest values among all values. Although the Pigment Ratio +25% ink color gamut diagram appears narrower in the color universe diagram, the Color gamut volume value was found to be 7.29% higher compared to the Standard Pigment Raio ink, and 2.48% higher when compared to the ISO 12647-2 Standard value.

CONCLUSIONS

In order to obtain print quality and a wider color gamut, offset printing ink with increased pigment ratio has been prepared. Prepared inks are printed on glossy coated paper. The printing parameters of all printed inks were examined. No expansion has been achieved in the two-dimensional color universe diagram.

However, when the color gamut volumes are compared, it has been determined that Pigment Ratio +25% ink has a volume of 7.29% more than the Standard Pigment Ratio ink value. When compared to the ISO 12647-2 Standard color gamut volume, it has been found to have a 2.48% wider color gamut. This has led to the conclusion that the Pigment Ratio +25% ink is more successful in half tone values than the others.

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