

Effect of Ink Sequence In Sheet-fed Offset Print Quality

Vikas Solanki, Ambrish Pandey, Anil Kundu

Abstract— This document proper discuss about the variation in density, LAB values, and contrast of colors in different ink sequence. The sequence of colors is very important for the print quality in the Sheet-fed Offset. While CMYK and KCMY are the standardized sequences for offset lithography but there is possibilities of printing work carried out by five different color sequences namely CMYK, MYCK, YMCK, KCMY and KYMC. In order to identify the effect of ink sequence in Sheet-fed Offset print quality, prepared a master and done printing in the local printing press of repute. Our aim was to find the effect of different ink sequence in printing and further to choose best out of them.

Index Terms— Ink Sequence, Density, Contrast, L*a*b* Value, Print Quality.

I. INTRODUCTION

Ink sequence is the concept in which the process color inks are printed consecutively in the four-color printing process. It is also referred to as the Ink lay down Sequence. In four color printing, Cyan, Magenta, Yellow and Black inks are printed on the paper in very thin layers approx. (2-4 micron). Most of the press operators establish and maintain strict sequences for printing each of the colors at their establishments. The sequence is very important due to several practical reasons. Many printers prefer a substandard printing sequence of Black(K) ink in the first printing unit, Cyan(C) in the second printing unit, Magenta(M) in the third and Yellow(Y) in the fourth printing unit. In another system, Black (K) ink from the first printing unit is shifted to the fourth printing unit, if the press operator requires a high coverage of Black (K) ink. By study, it is found that ink sequence play a crucial role in achieving print quality in Flexography as reported by Sachi Patel¹ in her thesis. She determined the effect of ink sequence for process colos in Flexography. Out of the five sequences that were tested, no one sequence was better than another in all sequences. Out of the five sequences, four sequences (CMYK, YMCK, KYMC And MYCK) produced moire-like pattern in shadow or heavy ink coverage regions that uses Black and Cyan inks, while KCMY was the only sequence that trapped well and did not produce any moiré-like pattern. Therefore, in Offset Printing process also, the ink sequence can significantly affect print quality on different substrates. By studying different literatures we came to this conclusion that we will examine the effect of different ink sequences on print quality in Sheet-fed Offset printing on Art paper.

Mathematically, by using four process colors (Cyan, Magenta, Yellow, and Black), 24 different ink sequences are possible. In this study, five of these 24 sequences are tested. Opinions of four industry experts were taken about the sequence predominantly used by them for printing process colors. The next two sequences were selected based on this informal survey; they are YMCK and MYCK. The other two sequences (CMYK and KCMY) were selected because they are the standard sequences for offset lithography; hence, they were selected to make a comparison between the two processes. The fifth sequence, KYMC, was selected, as it was one of the two sequences suggested by the first, the other was YMCK. The order in which the press run was performed YMCK, MYCK, CMYK, KCMY, and KYMC, with the printing units interchanged to change the sequence of inks.

II. RESEARCH METHODOLOGY

For this study, first of all a suitable master was prepared. The printing work was carried out in Dora Offset Printing Press, Hisar. The pressroom condition in the Dora Offset Press is accurate and as according to the printing parameters. The design of master is such as in which the value of density and other values can be measured easily in effective way. After preparing the master, plate was prepared and then we took prints with five different sequences (CMYK, MYCK, YMCK, KCMY and KYMC) on Art Paper. The relative humidity of pressroom was about 45 percent and the temperature about 28°C. Then density, LAB values, and contrast of different samples were measured with the help of spectrophotometer (X-Rite 528) at ACIRD, Yamunanagar, Haryana and this data was analyzed with suitable statistical, quantitative methods and tools.

III. DATA COLLECTION & ANALYSIS

Density Value at 90%

	CMYK	MYCK	YMCK	KCMY	KYMC
Red	1.08	1.15	1.57	1.21	1.26
Green	0.82	0.78	1.08	1.02	1.06
Blue	0.97	1.02	1.06	1.06	0.95
Brown	0.43	0.44	0.56	0.54	0.53
Violet	0.29	0.33	0.32	0.31	0.28
Orange	0.86	0.9	1.26	1.07	1.07
Purple	0.65	0.7	0.77	0.81	0.61

Table: - 1

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Vikas Solanki, M.Tech. (GJU S&T, Hisar)

Ambrish Pandey, Associate Professor (GJU S&T, Hisar)

Anil Kundu, Teaching Associate (GJU S&T, Hisar)

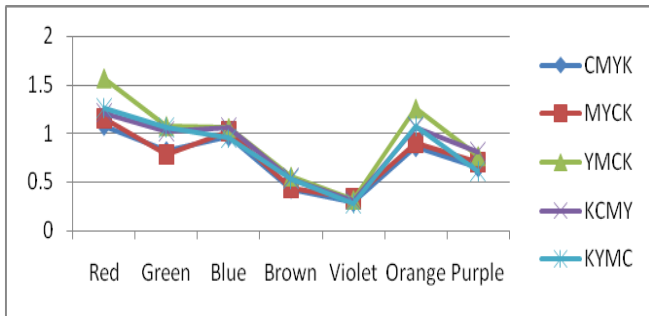


Figure: - 1

- The value of density of 'Red' is higher in all sequence as compare to other color.
- The value of density of 'violet' is lower in all sequence as compare to other color.
- The density value of Brown & purple in all sequence is higher than violet and lower than all other.

Density Value at 70%

	CMYK	MYCK	YMCK	KCMY	KYMC
Red	0.68	0.68	0.97	0.83	0.79
Green	0.57	0.48	0.74	0.59	0.64
Blue	0.66	0.67	0.73	0.76	0.66
Brown	0.3	0.29	0.38	0.41	0.35
Violet	0.2	0.24	0.21	0.23	0.23
Orange	0.57	0.61	0.84	0.77	0.72
Purple	0.45	0.51	0.55	0.48	0.43

Table: - 2

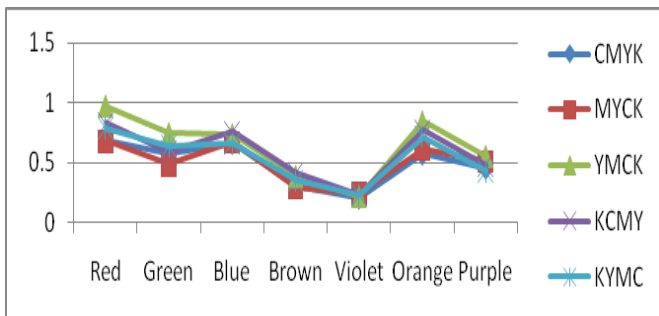


Figure: - 2

- The value of density of 'Red' is higher in all sequence as compare to other color.
- The value of density of 'violet' is lower in all sequence as compare to other color.
- The density value of Brown & purple in all sequence is higher than violet and lower than all other.

Density Value at 40%

	CMYK	MYCK	YMCK	KCMY	KYMC
Red	0.42	0.41	0.58	0.5	0.48
Green	0.34	0.28	0.42	0.4	0.41
Blue	0.4	0.43	0.42	0.48	0.43
Brown	0.17	0.18	0.24	0.23	0.23
Violet	0.12	0.14	0.13	0.13	0.12
Orange	0.32	0.38	0.48	0.41	0.43
Purple	0.28	0.3	0.35	0.32	0.27

Table: - 3

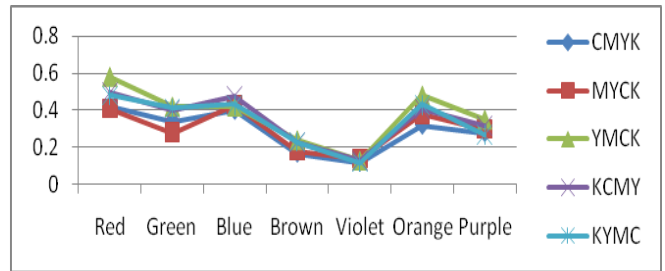


Figure: - 3

- The value of density of 'Red' is higher in all sequence as compare to other color.
- The value of density of 'Violet' is lower in all sequence as compare to other color.
- The density value of Brown & purple in all sequence is higher than violet and lower than all other.

Density at 15%

	CMYK	MYCK	YMCK	KCMY	KYMC
Red	0.21	0.22	0.27	0.27	0.25
Green	0.17	0.14	0.22	0.24	0.2
Blue	0.21	0.2	0.22	0.23	0.23
Brown	0.1	0.11	0.13	0.09	0.13
Violet	0.06	0.08	0.08	0.06	0.07
Orange	0.16	0.18	0.22	0.22	0.21
Purple	0.14	0.15	0.2	0.15	0.14

Table: - 4

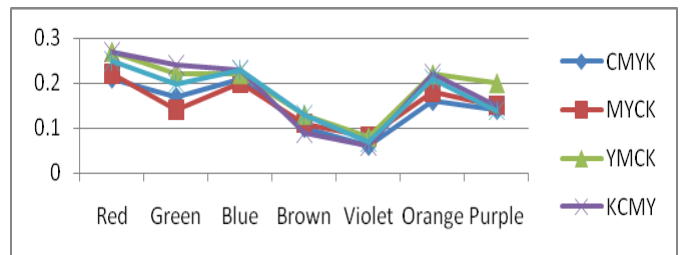


Figure: - 4

- The value of density of 'Red' is higher in all sequence as compare to other color.
- The value of density of 'violet' is lower in all sequence as compare to other color.
- The density value of Brown & purple in all sequence is higher than violet and lower than all other.

Contrast at 90%

	CMYK	MYCK	YMCK	KCMY	KYMC
Red	28%	25%	23%	28%	27%
Green	35%	40%	50%	50%	39%
Blue	35%	31%	33%	29%	38%
Brown	32%	30%	31%	26%	28%
Violet	28%	27%	28%	25%	25%
Orange	33%	31%	24%	32%	30%
Purple	29%	30%	31%	29%	28%

Table: - 5

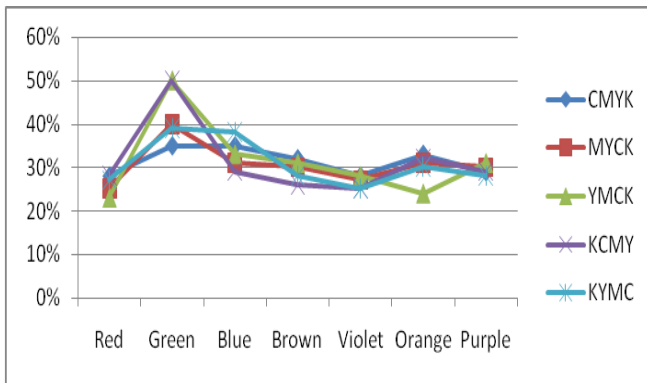


Figure: - 5

- The contrast value of 'Green' in the sequence YMCK & KCMY is higher.
- The contrast value of 'Red' in the sequence YMCK is lowest.
- In all the sequences the contrast value of 'Green' is higher.

Contrast at 70%

	CMYK	MYCK	YMCK	KCMY	KYMC
Red	56%	52%	52%	52%	53%
Green	57%	61%	65%	65%	54%
Blue	54%	54%	53%	21%	57%
Brown	51%	50%	51%	47%	50%
Violet	50%	48%	46%	48%	46%
Orange	55%	53%	48%	51%	51%
Purple	51%	52%	51%	56%	47%

Table: - 6

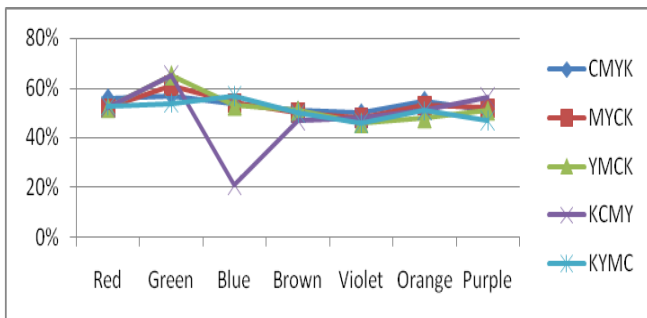


Figure: - 6

- The contrast value of 'Green' in the sequence MYCK, YMCK & KCMY is higher.
- The contrast value of 'Blue' in the sequence KCMY is lowest.
- The contrast value of 'Red' & 'Violet' has not much variation.

Contrast at 40%

	CMYK	MYCK	YMCK	KCMY	KYMC
Red	74%	73%	71%	71%	72%
Green	75%	78%	79%	81%	71%
Blue	74%	74%	72%	54%	72%
Brown	71%	71%	72%	72%	70%
Violet	69%	70%	68%	74%	66%
Orange	73%	79%	69%	73%	70%
Purple	69%	70%	70%	74%	67%

Table: - 7

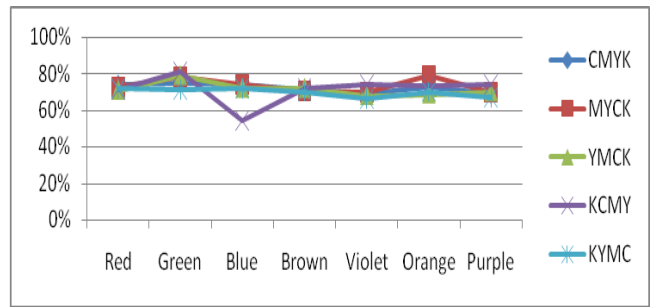


Figure: - 7

- The contrast value of 'Green' in the sequence MYCK, YMCK & KCMY is higher.
- The contrast value of 'Blue' in the sequence KCMY is lowest.
- The contrast value of 'Red' & 'Brown' has not much variation.

Contrast at 15%

	CMYK	MYCK	YMCK	KCMY	KYMC
Red	86%	86%	85%	85%	85%
Green	86%	89%	89%	90%	83%
Blue	85%	86%	85%	78%	84%
Brown	83%	82%	83%	86%	84%
Violet	83%	81%	82%	86%	81%
Orange	86%	86%	85%	86%	85%
Purple	85%	86%	85%	87%	84%

Table: - 8

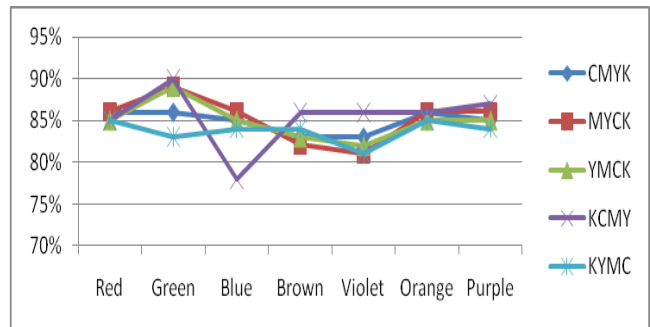


Figure: - 8

- The contrast value of 'Green' in the sequence MYCK, YMCK & KCMY is higher.
- The contrast value of 'Blue' in the sequence KCMY is lowest.
- The contrast value of 'Red' & 'Orange' has not much variation.

ΔE Value

Colors	ΔE	CMYK	MYCK	YMCK	KCMY	KYMC
Red	ΔE	3.38	5.57	16.54	9.39	14.35
Green	ΔE	9.30	4.97	12.60	9.11	6.20
Blue	ΔE	13.76	15.76	15.88	7.72	22.34
Brown	ΔE	32.55	32.96	30.43	30.32	32.68
Violet	ΔE	49.35	47.82	46.71	44.04	49.92
Orange	ΔE	24.29	22.51	15.67	25.12	24.66
Purple	ΔE	19.78	23.63	19.59	19.71	19.02

Table: - 9

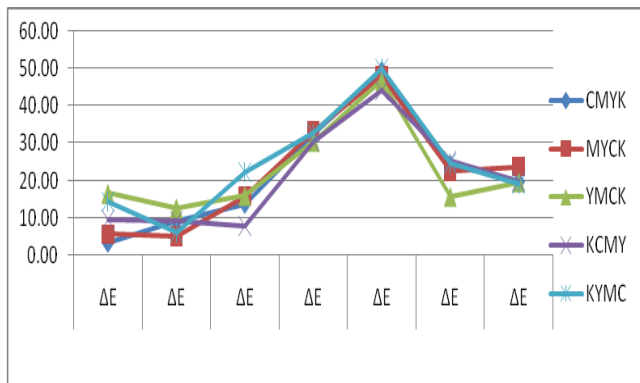


Figure: - 9

- There is not much variation in value of ΔE for Brown color in all sequence.
- Except YMCK sequence the value of ΔE almost same in all sequence for Orange color.
- For Blue color there is much variation as compare to other colors.

IV. RESULT & CONCLUSION

In this research work, it is found that with different ink sequences, the value of density, contrast & $L^*a^*b^*$ varied and the effect as follows:-

Density: At various percentage of density (100, 90, 70, 40, 15 & 3) it is found that YMCK & MYCK sequence respectively gives the maximum & minimum value for Red & Green color. KCMY gives the maximum density value for Blue color and remaining all sequences has almost same value. YMCK & CMYK respectively gives the maximum & minimum value for Brown & Orange color. There is no more variation in the Violet color in all the sequence. YMCK gives the maximum density value & KYMC gives minimum for Purple color.

Contrast: Red color has almost same contrast in all the sequence. KYMC gives the minimum contrast value for Green, Violet & Purple color. CMYK sequence gives the maximum contrast value for Violet and Orange color. Brown color has no more variation in all the sequence. KCMY gives the maximum contrast value for Green and Purple color. KYMC gives maximum contrast value for Blue while YMCK gives minimum value for Orange color.

$L^*a^*b^*$ value: According to the value of ΔE , CMYK, MYCK, YMCK & KYMC sequence are more suitable respectively for Red, Green, Orange & Purple color. For Blue, Brown and Violet color the KCMY sequence is more suitable.

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