TRUE CMYK FOR PRINTING PROCESS

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ABSTRACT

This document discusses finding optimized output from printing process under controlled conditions. Printing processes are divided according to working steps and requirement of end product. The printed product should satisfy requirements on visual aspect, technical aspects and mechanic aspects of product. For performance of product or for impact of product, printing quality is most important factor and for printing quality it necessary to have exact color reproduction in printing. Color reproduction in printing process is controlled on different levels as pre-press calibration, profiling of pre-press for proofing, optimization of image generation process, controlling pressroom condition, standardization of press, standardization of raw material and selection of learned operating manpower. Here we will discuss selection of Ink for printing process and optimization of Complete process according to required end printing output.

KEYWORDS: *Color Reproduction, CMYK Process Colors, Lab Values, Delta E, Color Gamut, Grey Balance, Over Print Trapping, Press Calibration.*

I. INTRODUCTION

In fast growing market in Commercial area, Publication, Packaging, Cosmetics, Food Industry and many other growing areas. Printing expands its service area and get accepted at all levels because of versatile substrate range according to requirement of product, according to substrate diversity in of printing process, development in printing quality, development in image reproduction, real life visualisation of images in printing and wide range of inks as process color, metallic inks, intellectual inks, intelligent product requiring coatings, pigments and coatings are most important factor for expansion of printing service area. For quality output of printing process, A Printing Press or Production house must have coordination of different departments in press. The working procedure and output quality is standardised using different standards used for various departments and their operations. Following are standers used in printing industry.

Briefings of Standards used in Printing Industry. [5,6,7,8,9,10,12]

- ISO 2846-1:2006 - Graphic technology - Colour and transparency of printing ink sets for four-colour printing - Part 1: Sheet-fed and heat-set web offset lithographic printing
- ISO 12218:1997 - Graphic technology - Process control - Offset Plate making.
- ISO 12640-1:1997 - Graphic technology - Prepress digital data exchange - Part 1: CMYK standard color image data (CMYK/SCID)
- ISO 12646:2008 - Graphic technology - Displays for color proofing - Characteristics and viewing conditions
- ISO 12647-1:2004 - Graphic technology - Process control for the production of half-tone colour separations, proof and production prints: Parameters and measurement methods
- ISO 12647-2:2004 and ISO 12647-2:2004/ Amd 1:2007 - Graphic technology - Process control for the production of half-tone color separations, proof and production prints: Offset lithographic processes

- ISO 12647-7:2007 - Graphic technology - Process control for the production of half-tone color separations, proof and production prints - Part 7: Proofing processes working directly from digital data
- ISO 3664:2000 - Viewing conditions – Graphic technology and photography

ORGANISATION

- Finding CMYK
- Sampling of CMYK
- Result and Analysis
- Conclusion
- Future Scope
- References

II. FINDING CMYK [1,11,13,14]

The impact of printed product depends on color representation in other words appearance of colors with reference to visualisation of real object to human eye. Printing inks contains **Pigments** – Pigments are finely ground solid materials that impart color to inks. The nature and amount of pigment that an ink contains, as well as the type of vehicle, contribute to the ink's body and working properties. In old days, most pigments were colored minerals ground to fine powders. They were extremely fast to light, water, and solvents, but opaque, weak in color strength, and very dull. Even when finely ground, they were still gritty enough to cause rapid wear of printing plates. Lampblack, made from natural gas, was the principal black. Other pigments were made from vegetable dyes, such as indigo, madder, and logwood extract, and from carmine dye derived from the cochineal insect. Only a few synthetic pigments were available. Over the years, the texture of pigments has been softened, and their vehicle-wetting properties and uniformity improved. Organic pigments are usually more transparent, brighter, purer, and richer in color than their inorganic counterparts. Developments in chemistry have also led to the production of better inorganic pigments such as titanium dioxide. **Vehicle** – All printing inks consist of a colorant (almost always a pigment) and a vehicle. The vehicle is composed mostly of a varnish, which is a solvent plus resin and/or drying oil, along with waxes, driers, and other additives. The vehicle carries the pigment, controls the flow of the ink or varnish on the press, and, after drying, binds the pigment to the substrate. Vehicles also control the film properties of dried ink, such as gloss and rub resistance. (The word "varnish" [or "overprint varnish"] is also used to describe an unpigmented coating or film.) Vehicles for lithographic and letterpress inks commonly contain low-molecular-weight resins and/or drying oils and nonpolar, hydrocarbon solvents. Inks made from these vehicles have a high viscosity and are called paste inks. Vehicles for flexographic and gravure inks, which are referred to as fluid or liquid inks, have a low viscosity. These vehicles also contain a film-forming resin, a modifying resin, and a solvent. With flexographic inks, the solvent is often a polar solvent such as alcohol or water. The choice of solvent and resins depends on the substrate and end-use requirements of the ink.

Solvent- Solvents dissolve oils, resins, and additives to produce varnishes that carry the pigment. The old rule "like dissolves like" is a useful first approximation. Because of the importance of solvency, scientists have studied it extensively and have come up with sophisticated measurements of solvency. The "solubility parameter" has proven very useful in predicting solubility. Polar solvents, such as alcohol, ethers, ketones, and esters, are useful for dissolving polar resins, such as shellac, cellulose esters, phenolic, and alkyds. The hydrocarbons, which are nonpolar, are suitable for dissolving such compounds as drying oils and rosin- modified phenolic and maleic. The different classes of hydrocarbon vary in their degree of solvency. **Additives** - The suspension of pigment in varnish and/or solvent does not usually provide a satisfactory ink. Many other materials must be added in order to provide good performance. These additives include plasticizers, wetting agents, ant setoff compounds, waxes, shortening compounds, reducers, stiffening agents, anti-skinning agents, and anti-pinhole compounds. **Driers** - Although driers are used only in sheetfed printing, they are so widely misunderstood and cause so much trouble that they deserve special attention. In order to dry in a reasonable amount of

time, inks that contain vehicles or varnishes prepared from drying oils such as linseed or tung oil need a catalyst or drier. Drying of such inks is a complicated chemical process that occurs very slowly, if at all, in the absence of a drier. Inks do not dry in the absence of air, which explains why inks do not dry in a closed can. Double bonds (chemically reactive sites in the varnish molecules) readily add oxygen to form compounds called peroxides or hydroperoxides. Peroxides are not especially reactive at room temperature, and when they do decompose, they often return to the original double bond, releasing oxygen. To get these hydroperoxides "moving" (and in the right direction) the ink manufacturer adds metal salts-cobalt, manganese, zirconium, and others-that decompose the hydroperoxide and form a free radical. The free radical that is formed is called an allylic free radical, and, as free radicals go, it is not especially reactive, although it is a great deal more reactive than the hydroperoxide. This explains why sheetfed inks take several hours to dry, while ultraviolet and electron beam inks, which generate acrylic free radicals, dry in a few seconds.

The basic formula ink shows no. of ingredients in different measures as;

LITHOGRAPHIC INK FOR MAPLITHO PAPER

1. Organic Coal Black pigment (colour)	18.00
2. Quickset varnish	40.00
3. Gloss varnish	15.00
4. Fast setting varnish	15.00
5. Polyethylene wax paste (prevents damage to the film against rubbing)	5.00
6. Anti-set-off paste	3.00
7. Cobalt/manganese driers (catalyst for drying oil oxidation)	1.00
8. 280-320ºC petroleum distillate (solvent)	3.00
Total -	100.00

2.1. Sampling of CMYK [13,14,15,16]

Standard 12647 is base line for all printing ink manufacturing, still according to quality and processing on ingredients gives different values of manufactured products. So considering standard value of Density and LAB from ISO 12647 sampling of Manufacture A, Manufacture B, Manufacture C for CMYK ink for standards Paper grade is done and LAB values are compared using standard viewing condition under Calibrated Spectrophotometer X-rite IOnePRO.

CMYK SAMPLING (ISO 12647) in Standard White Paper (dE 4.1)

Sample	ISO 12647			Manufacture A			dE	Manufacture B			dE	Manufacture C			dE
Colors	L	a	b	L	a	b	≤5	L	a	b	≤5	L	a	b	≤5
1	55.0	-37	-50	55.85	-37.59	-48.11	***2.15***	51.81	-36.93	-47.80	3.88	57.54	-37.66	-44.32	6.26
2	55.0	-37	-50	54.97	-37.83	-47.06	***3.06***	56.49	-34.64	-45.22	5.54	55.19	-37.87	-46.68	3.44
3	55.0	-37	-50	54.80	-37.93	-48.32	***1.93***	59.12	-35.36	-47.73	4.98	53.36	-37.89	-48.35	2.49
4	55.0	-37	-50	53.03	-37.15	-49.78	***1.99***	57.39	-35.73	-48.25	3.22	51.64	-37.58	-49.74	3.42
5	55.0	-37	-50	52.84	-36.88	-50.52	***2.22***	55.51	-35.79	-45.28	4.90	50.64	-37.20	-50.74	4.43
1	48.0	74.0	-3.0	49.93	72.07	-8.68	6.30	46.68	71.69	-6.36	4.29	49.62	73.33	-2.71	***1.78***
2	48.0	74.0	-3.0	47.86	74.65	-6.14	3.21	50.36	76.98	-3.83	3.89	48.71	74.16	-4.18	***1.39***
3	48.0	74.0	-3.0	47.21	75.43	-4.67	2.34	51.28	76.87	-4.78	4.71	47.00	76.22	-3.21	***2.44***

4	48.0	74.0	-3.0	46.03	76.79	-2.00	3.56	50.24	70.84	-3.90	3.98	46.89	75.33	-2.73	***1.75***
5	48.0	74.0	-3.0	45.58	77.36	-0.53	4.82	48.85	70.53	-2.10	3.68	46.06	74.10	-2.93	***1.94***
1	89.0	-5.00	93.0	88.65	-6.29	84.50	8.60	89.86	-5.25	91.27	***1.95***	88.88	-6.02	86.21	6.87
2	89.0	-5.00	93.0	88.32	-6.21	87.60	5.58	89.77	-5.10	91.10	***2.05***	88.84	-5.56	89.49	3.56
3	89.0	-5.00	93.0	88.44	-5.90	92.30	1.27	89.53	-5.34	94.39	***1.53***	88.33	-5.00	94.16	1.34
4	89.0	-5.00	93.0	88.20	-5.33	95.64	2.78	89.31	-5.01	92.08	***0.97***	88.02	-4.55	96.66	3.82
5	89.0	-5.00	93.0	87.93	-4.75	98.59	5.70	89.13	-4.64	91.87	***1.19***	87.96	-4.00	99.46	6.62
1	16	0	0	14.83	1.14	3.23	3.62	19.10	0.26	2.50	3.99	17.38	0.60	2.24	***2.70***
2	16	0	0	14.10	1.10	3.17	3.86	19.74	0.22	1.24	3.95	15.28	0.48	1.40	***1.65***
3	16	0	0	11.97	0.82	2.27	4.70	19.44	0.15	0.97	3.58	15.83	0.44	1.35	***1.43***
4	16	0	0	10.29	0.61	1.61	5.96	19.28	0.15	1.56	3.64	16.43	0.33	0.87	***1.03***
5	16	0	0	9.53	0.51	1.50	6.66	17.41	0.04	1.94	2.40	16.89	0.18	0.47	***1.02***

Comparative table shows 5 sampling result of A,B,C ink manufacturer. Using respective inks set of Cyan, Magenta, Yellow and Black process color under ISO 12647 standardisation and density targets, Test Bar of X rite is Printed having different patches. The comparison of test bar is done by Xrite and it shows print results and resulting Gamut Volume of Inks which reflects no. of ink compositions possible using respective manufacturer's product. During test run pH, Conductivity, machine speed, Pressure, Dot gain etc, parameters are under tolerance level according to standard.

Test Bar –

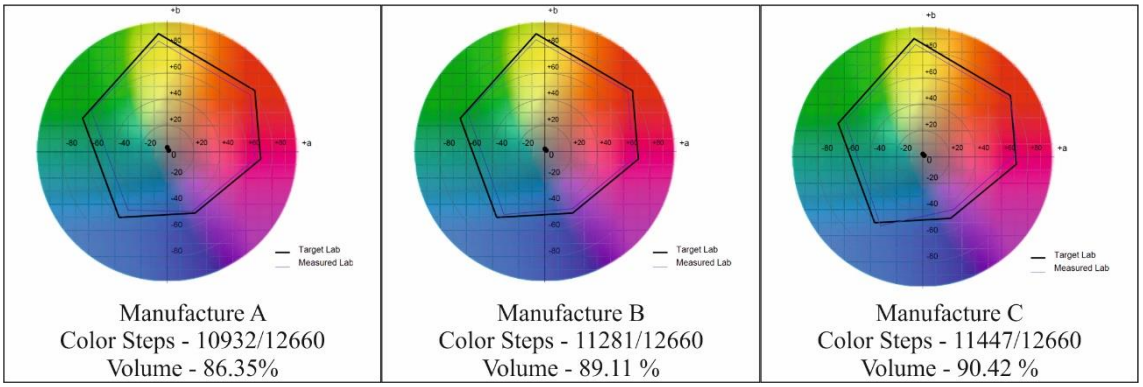
The software generated test bar consists systematic arrangement of different patches having Color primaries- Cyan, Magenta, Yellow, Black, Halftone of Color Primary in 40 percent screening, trapping patches of C + M = Blue, C + Y = Green, M + Y = Red, Grey Balance targets in range of Shadow, Midtone and Highlight and White for paper base value for measurement of readings. All measurements are taken by instruments in LAB basis within tolerance density range which is maintained during printing on machine. Final calculation gives us variation in Color primaries, Grey balance and Tapping. The visual result will appear in color gamut volume with comparison to visual color gamut.

III. RESULT AND ANALYSIS

Comparison of Test bar using X-rite Ione PRO															
	Test Bar			**Manufacture A**			**dE**	**Manufacture B**			**dE**	**Manufacture C**			**dE**
Patch	L	a	b	L	A	b	≤5	L	a	b	≤5	L	a	b	≤5
Cyan	54.0	-36	-49	56.04	-34.61	-49.60	***2.54***	56.04	-32.00	-49.00	***4.49***	57.04	-33.81	-49.60	***3.79***
Density	1.3 (± 0.2)			1.16				1.18				1.21			
Magenta	46.0	72	-5	43.51	76.22	-6.66	***5.17***	50.51	72.22	-5.66	***4.56***	48.10	73.22	-5.15	***2.43***
Density	1.34 (± 0.2)			1.00				1.23				1.28			

Yellow	87.0	-6	90	89.25	-5.92	85.38	***5.14***	89.25	-5.92	91.38	***2.64***	90.25	-5.20	87.38	***4.25***
Density	0.99 (± 0.2)			0.78				0.96				0.86			
Black	16.0	0	0	18.34	1.28	-1.97	***3.32***	19.40	1.80	-1.70	***4.21***	17.40	1.00	-1.56	***2.32***
Density	1.6 (± 0.2)			1.48				1.40				1.58			
Red	46.0	67	47	50.83	62.68	44.29	***7.02***	48.83	66.68	44.29	***3.93***	47.93	69.80	46.90	***3.40***
Trapping	85.0%			92.00				90.00				87.00			
Green	49.0	64.0	26.0	49.75	63.36	24.41	***1.87***	51.75	61.36	24.41	***4.13***	51.75	61.36	24.41	***4.13***
Trapping	85.0%			95.00				92.00				90.00			
Blue	23.0	22.0	-46.0	23.56	21.01	-44.05	***2.26***	24.56	21.01	-42.05	***4.36***	24.80	21.30	-45.20	***2.09***
Trapping	85.0%			88.00				86.00				89.00			
White	92.0	0.0	-3.0	92.40	0.40	-2.87	***0.58***	91.40	0.60	-2.70	***0.90***	92.80	0.10	-3.10	***0.81***
H gr	76.7	0.1	-2.7	78.77	0.53	-1.13	***2.57***	80.77	0.53	-2.13	***4.08***	79.87	0.83	-2.30	***3.23***
M Gr	60.0	0.2	-1.8	61.65	2.86	0.16	***3.70***	61.50	0.86	0.19	***2.69***	60.50	2.90	0.19	***3.40***
S Gr	39.7	-0.11	1.5	46.17	-1.66	3.80	***8.51***	36.17	-1.90	2.80	***5.84***	38.50	-0.94	2.60	***4.35***

Comparison chart shows performance of ink from different manufacturers. It also indicates for better performance in color reproduction we have options from different manufactures for different inks to produce more accurate color value and achieve maximum colour gamut volume. Following ae comparative results of Color volume gamut of Manufacture A,B and C as compared to Visual Color Gamut.



Manufacture A
Color Steps - 10932/12660
Volume - 86.35%

Manufacture B
Color Steps - 11281/12660
Volume - 89.11 %

Manufacture C
Color Steps - 11447/12660
Volume - 90.42 %

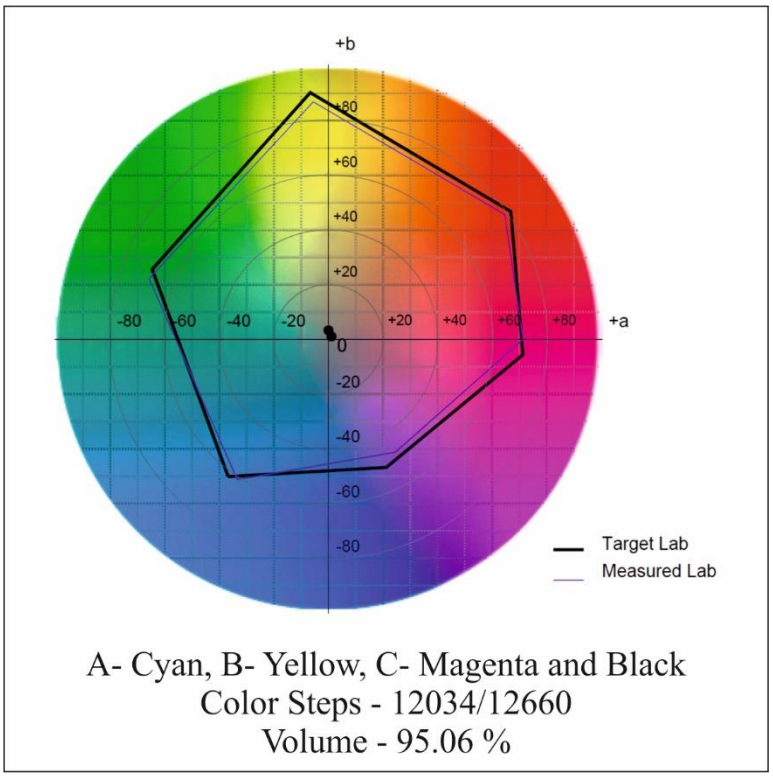
Or concluding results from test results we select Cyan ink of Manufacturer A, Yellow ink from Manufacturer B and Magenta and Black Ink from Manufacturer C. Final test print using selected combination are printed and again examined using X rite instruments. The test shows final Conclusion for find optimised ink set to produce maximum color volume of gamut for color reproduction.

IV. CONCLUSIONS

Result of Test bar on Final selected combination print using X-rite Ione PRO							
	Test Bar			**Result of Combination Ink**			**dE**
Patch	L	A	b	L	a	b	≤5
A - Cyan	54.0	-36	-49	55.10	-37.20	-50.20	***2.02***

Density	1.3 (± 0.2)			1.18			
C- Magenta	46.0	72	-5	47.20	73.50	-4.90	***1.92***
Density	1.34 (± 0.2)			1.00			
B- Yellow	87.0	-6	90	88.40	-6.90	89.90	***1.67***
Density	0.99 (± 0.2)			0.78			
C- Black	16.0	0	0	17.70	0.76	-0.76	***2.01***
Density	1.6 (± 0.2)			1.48			
Red	46.0	67	47	48.75	64.80	46.40	***3.57***
Trapping	85.0%			92.00			
Green	49.0	64.0	26.0	51.20	65.80	25.20	***2.95***
Trapping	85.0%			95.00			
Blue	23.0	22.0	-46.0	25.70	23.70	-44.80	***3.41***
Trapping	85.0%			88.00			
White	92.0	0.0	-3.0	92.20	0.50	-2.70	***0.62***
H gr	76.7	0.1	-2.7	78.90	0.70	-1.39	***2.57***
M Gr	60.0	0.2	-1.8	62.50	0.40	0.21	***3.25***
S Gr	39.7	-0.11	1.5	39.90	-0.12	1.68	***3.19***

With combination of selected inks, we get maximum colour gamut volume and no. of color steps which helps better and higher color reproduction steps in printing.



A- Cyan, B- Yellow, C- Magenta and Black
Color Steps - 12034/12660
Volume - 95.06 %

V. FUTURE SCOPE

The experimental results analysis shows the selection of material on criterial basis gives improved output, and output satisfies requirement of quality process standards. The conclusive output gives some guide lines for future work as for optimised result we need to select raw material and analyse them on initial stages on decided criteria. This exercise will help to choose selective material from manufacturer and use of selective material reduces variations or alternations. As the experimental conclusion shows selection of Proper Cyan, Magenta, Yellow and Black ink from different manufacturers after proper analysis gives better color steps, larger colour gamut volume, better control on ink parameters and resulting in improved printing result. This selection process or this experimental setup must be performed not only for ink but for other production raw material also, on periodic basis in printing house for better and controlled printing results.

REFERENCES

[1]. Color Management Guide-230106-Colour & Colour Reproduction
[2]. Intelligent and Active Packaging, International Journal of Engineering and Management Science, ISSN 2229-600X , Volume 4, Issue 4, 2013
[3]. ISO 2846-1:2006 - Graphic technology - Colour and transparency of printing ink sets for four-colour printing - Part 1: Sheet-fed and heat-set web offset lithographic printing
[4]. Intellectual Reactance of Ink, in International Journal of Science and Research, ISSN 2319-7064, Volume 6, Issue 3, 2017
[5]. ISO 12218:1997 - Graphic technology - Process control - Offset Plate making.
[6]. ISO 12640-1:1997 - Graphic technology - Prepress digital data exchange - Part 1: CMYK standard color image data (CMYK/SCID)
[7]. ISO 12646:2008 - Graphic technology - Displays for color proofing - Characteristics and viewing conditions
[8]. ISO 12647-1:2004 - Graphic technology - Process control for the production of half-tone colour separations, proof and production prints: Parameters and measurement methods
[9]. ISO 12647-2:2004 and ISO 12647-2:2004/ Amd 1:2007 - Graphic technology - Process control for the production of half-tone color separations, proof and production prints: Offset lithographic processes
[10]. ISO 12647-7:2007 - Graphic technology - Process control for the production of half-tone color separations, proof and production prints - Part 7: Proofing processes working directly from digital data.
[11]. Digital Color Reproduction – Brian A. Wandell and Louis D. Silverstein, Department of Psychology, Stanford University, Stanford CA. 94305-2130,USA, VCD Sciences, Inc. 9695 E.Yucca Street, Scottsdale, AZ 85260-6201, USA
[12]. ISO 3664:2000 - Viewing conditions – Graphic Technology and Photography
[13]. Color Management - Kelvin Tritton, Tech. Consultant, Pira International. UK
[14]. Handbook of Problem solving skills in Offset- Centre of Good Governance
[15]. Improve Efficiency and Reduce waste through Process Control in the Lithographic Printing Industry /Institute of Advanced Manufacturing Sciences Inc.- 1111 Edison Drive Cincinnati, Ohio 45216
[16]. Quality Control in Printing Industry- Srl – Via Zuccoli 18, 20125 MILANO

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