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[Dhirender * *et al.*, 6(7): July, 2017]
IC™ Value: 3.00

ISSN: 2277-9655
Impact Factor: 4.116
CODEN: IJESS7

IJESRT

INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY

IDENTIFICATION AND ANALYSIS OF INK SETTING AND DRYING IN SHEET-FED OFFSET AND DRY TONER BASED DIGITAL PRINTING PRESSES

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DOI: 10.5281/zenodo.834454

ABSTRACT

Sheet-fed offset has been one of the most popular printing methods to print cellulosic based substrates. Dry toner based digital printing methods have come to exist recently and captured a significant market share especially for short run print jobs. But if the ink doesn't dry on proper time, it may result into set-off and it may hamper press speed. Aim of this paper is to analyse and compare ink setting and drying capabilities of Sheet-fed offset and Dry Toner based Digital printing technologies. Uncoated, gloss coated and matte coated papers were taken to examine the inkdrying behaviour of both printing processes.

KEYWORDS: Ink Setting, Drying, Cellulosic substrate, Ink Set-off, Strike Through, Ink Density.

I. INTRODUCTION

Sheet-fed offset is the printing process in which the image and non-image areas are separated chemically and ink is transferred to the substrate using blanket cylinder. Sheet-fed offset is the most suitable technology to print on cellulosic substrates.Digital printing technology has come to arise in late 1990's and today it is replacing the traditional technologies of printing specially for short run print production. It also facilitates and attracts the customers with customized features. Sheet-fed offset uses very less amount of inks but ink needs to dry early to achieve faster speed. On the other hand dry toner based digital printing uses powder based inks which gets melted during ink fusing. The enhancement in digital printing methods in terms of advanced ink fusing mechanism has made its print quality comparable with sheet-fed offset. To examine the ink setting mechanism, ink drying capabilities and ink drying time in both printing process is the need of the hour.[1], [2].

II. RESEARCH OBJECTIVES

Maintaining ink consistency and obtaining ink drying capabilities of the printed colors are the major issues being faced by all the printers. But during the course of machine run the color values get changed due to inconsistency in ink drying, paper and machine limitations. Objective of this project is:

1. To identify and analyse various points related to ink drying mechanisms and ink setting while printing on different type paper substrates in sheet-fed offset and dry toner based digital printing presses.

III. RESEARCH METHODOLOGY

The work was carried out on multi-colour sheet fed offset printing press along with multi-colour toner based digital presses available in the local market. The experiment based methodology was used. Gloss coated, Matte coated and uncoated paper stocks were collected and printing wascarried out using sheet offset printing machine and digital printing machines form acting as a master. Finally coated and uncoated printed paper stocks are analysed to check ink setting and drying for the optimum ink setting and drying. The solid ink density was analyzed using X-Rite spectrdensitometer available in Department of Printing Technology, GJUST, Hisar. The ink drying factor and strike through factor were calculated using Standard Observer Method on the scale of 1-10 (0 for minimum and 10 for maximum) by Department of Printing Technology students.The whole data was analysed using graphs and various statistical tools to minimize the deviations.

ISSN: 2277-9655
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IV. DATA COLLECTION AND ANALYSIS

Table.1. Degree of Set-Off on Printed Sheets (0-10 Scale)

0 for minimum set-off
10 for maximum set-off

Observer	Sheet-Fed Offset Printing			Dry Toner Based Digital Printing		
	Gloss	Matte	Uncoated	Gloss	Matte	Uncoated
1	3	2	1	1	0	0
2	2	1	1	0	1	0
3	3	2	1	1	0	1
4	2	2	1	1	1	0
5	3	2	1	1	1	1
6	2	1	1	0	0	0
7	4	3	0	0	0	0
8	3	2	0	0	0	1
9	2	2	1	0	0	1
10	3	2	1	1	0	0
Avg.	2.7	1.9	0.8	0.5	0.3	0.4

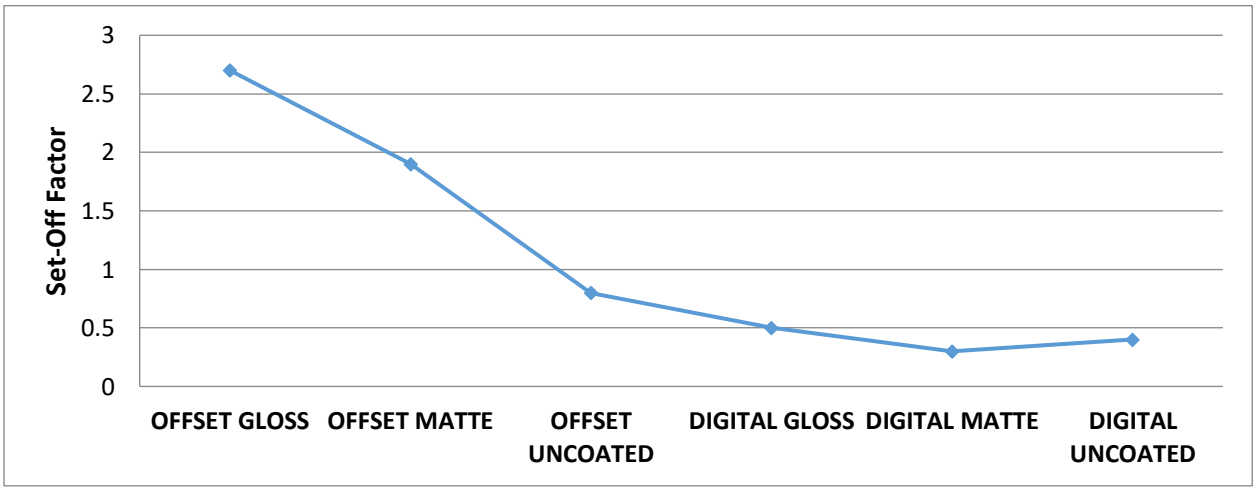

Fig.1. Set-Off Factor for Offset and Digital Printing on Different Paper Grades

Table.2. Degree of strike through on Printed sheets (0-10 Scale)

0 for minimum
10 for maximum

Observer	Sheet-Fed Offset Printing			Dry Toner Based Digital Printing		
	Gloss	Matte	Uncoated	Gloss	Matte	Uncoated
1	2	3	6	1	2	3
2	3	4	5	0	1	4
3	2	2	7	1	2	5
4	1	1	6	0	1	2
5	3	2	6	1	3	3
6	2	2	6	2	2	3
7	1	1	5	2	1	3
8	3	2	7	2	2	3
9	2	2	5	1	1	4
10	2	2	4	1	1	3
Avg.	2.1	2.1	5.7	1.1	1.6	3.3

ISSN: 2277-9655
Impact Factor: 4.116
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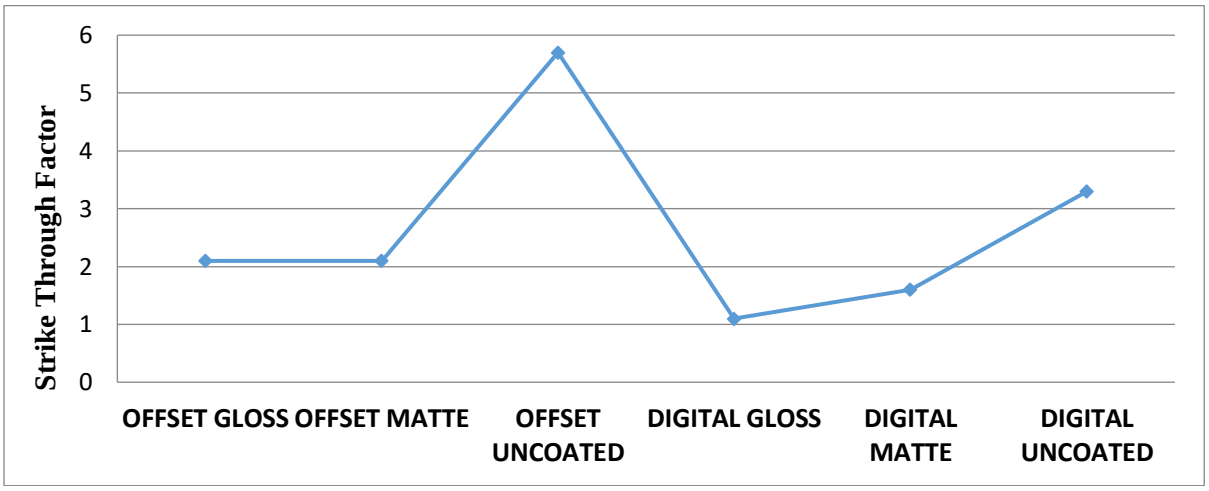

Fig.2. Strike through Factor in Offset and Digital Printing on Different Paper Grades

Table.3. Degree of ink drying after 1 hour of printing (0-10 Scale)

0 for minimum
10 for maximum

Observer	Sheet-Fed Offset Printing			Dry Toner Based Digital Printing		
	Gloss	Matte	Uncoated	Gloss	Matte	Uncoated
1	5	4	7	7	7	8
2	3	3	5	7	6	8
3	4	5	7	8	7	9
4	5	6	6	6	7	8
5	7	5	8	8	6	9
6	6	4	7	6	5	7
7	5	5	6	5	6	7
8	4	5	6	6	6	8
9	5	4	7	7	7	9
10	3	5	6	8	8	9
Avg.	4.7	4.6	6.5	6.8	6.5	8.2

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Impact Factor: 4.116
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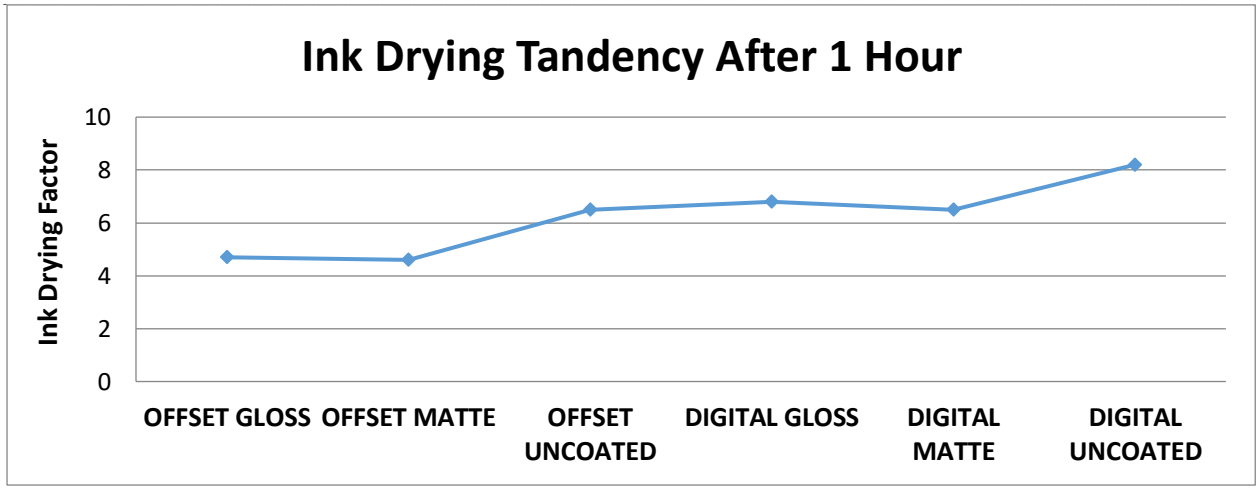

Fig.3. Degree of ink drying after 1 hour of printing

Table.4. Degree of ink drying after 5 hours(0-10 Scale)

0 for minimum
10 for maximum

Observer	Sheet-Fed Offset Printing			Dry Toner Based Digital Printing		
	Gloss	Matte	Uncoated	Gloss	Matte	Uncoated
1	7	6	8	8	8	9
2	8	7	9	9	8	9
3	7	7	8	9	8	8
4	7	7	7	7	8	9
5	7	6	8	7	8	9
6	7	6	9	8	9	8
7	6	6	8	8	7	9
8	6	6	8	8	8	9
9	6	7	8	8	8	9
10	7	7	8	8	8	9
Avg.	6.8	6.5	8.1	8	8	8.8

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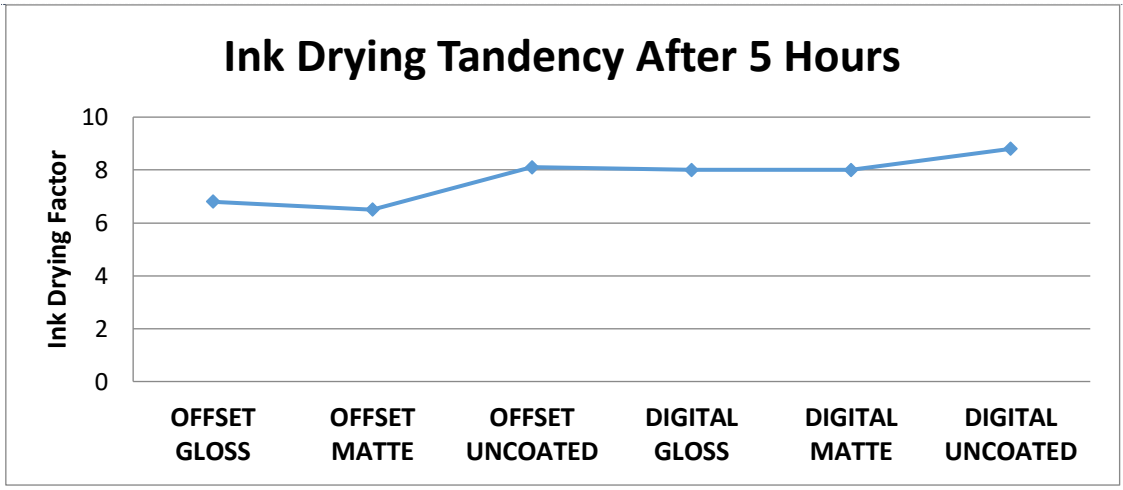

Fig.4. Degree of ink drying after 5 hours

Table.5. Degree of ink drying after 24 hours (0-10 Scale)

0 for minimum
10 for maximum

Observer	Sheet-Fed Offset Printing			Dry Toner Based Digital Printing		
	Gloss	Matte	Uncoated	Gloss	Matte	Uncoated
1	8	8	9	9	9	9
2	7	8	8	9	9	9
3	8	7	9	9	9	9
4	8	7	8	9	9	9
5	8	8	8	9	9	9
6	8	8	8	9	9	9
7	8	8	8	9	9	9
8	7	8	9	9	8	9
9	8	7	9	8	9	9
10	8	8	9	9	9	9
Avg.	7.8	7.7	8.5	8.9	8.9	9

ISSN: 2277-9655
Impact Factor: 4.116
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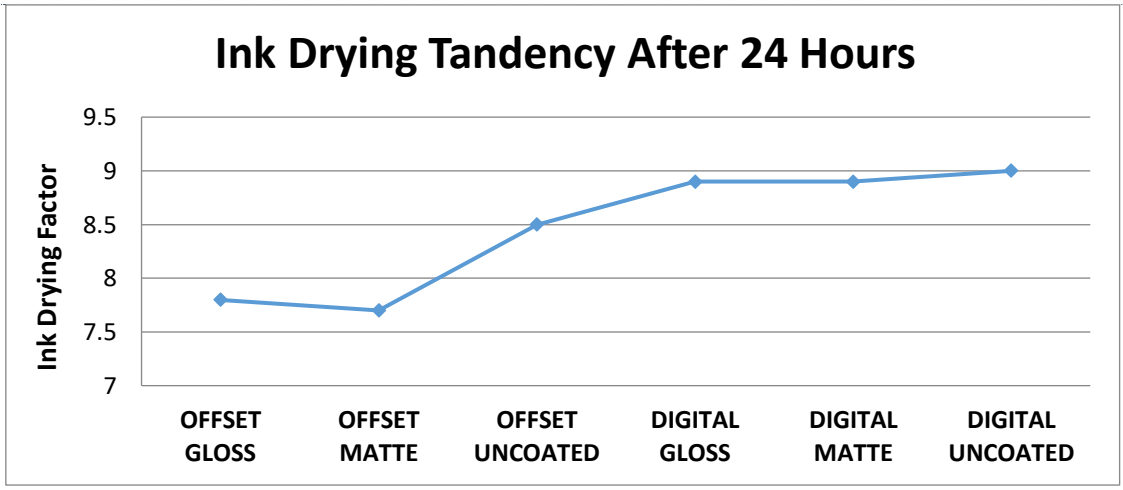

Fig.5. Degree of ink drying after 24 hours

Table.6. Degree of ink drying after 3 days (0-10 Scale)

0 for minimum
10 for maximum

Observer	Sheet-Fed Offset Printing			Dry Toner Based Digital Printing		
	Gloss	Matte	Uncoated	Gloss	Matte	Uncoated
1	9	9	9	9	9	9
2	9	9	9	9	9	9
3	9	9	9	9	9	9
4	9	9	9	9	9	9
5	8	8	9	9	9	9
6	9	9	9	9	9	9
7	9	9	9	9	9	9
8	9	9	9	9	9	9
9	9	9	9	9	9	9
10	8	8	9	9	9	9
Avg.	8.8	8.8	9	9	9	9

ISSN: 2277-9655
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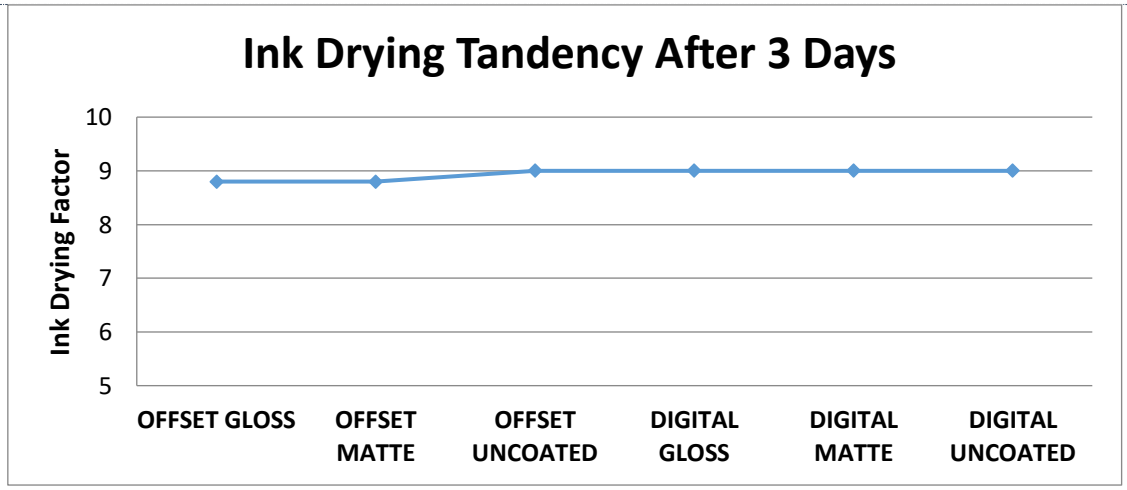

Fig.6. Degree of ink drying after 3 days

Table.7. Solid Ink Density Analysis of Sheet-Fed Offset and Digital Printing after 1 Hour of Printing

	OFFSET			DRY TONER BASED DIGITAL		
	GLOSS	MATTE	UNCOATED	GLOSS	MATTE	UNCOATED
C	1.75	1.55	1.10	1.38	1.34	1.39
M	1.85	1.65	1.06	1.53	1.46	1.45
Y	1.55	1.26	1.05	1.62	1.55	1.55
K	1.63	1.79	1.00	1.85	1.79	1.81

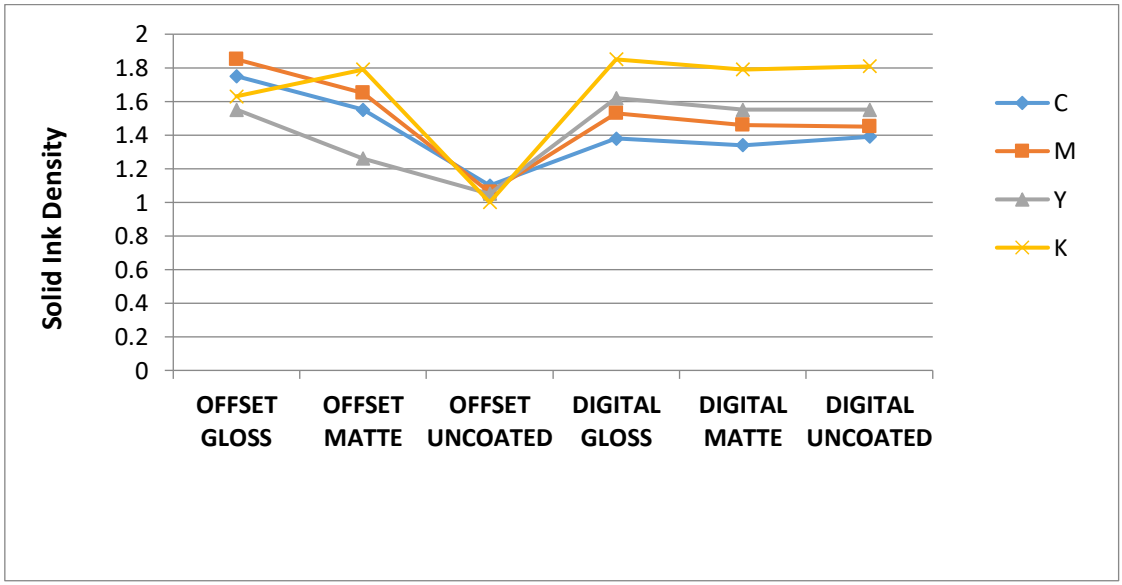

Fig.7. Solid Ink Density Analysis of Sheet-Fed Offset and Digital Printing After 1 Hour of Printing

ISSN: 2277-9655
Impact Factor: 4.116
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Table.8. Solid Ink Density Analysis of Sheet-Fed Offset and Digital Printing After 1 Day of Printing

	OFFSET			DRY TONER BASED DIGITAL		
	GLOSS	MATTE	UNCOATED	GLOSS	MATTE	UNCOATED
C	1.70	1.49	1.02	1.32	1.31	1.36
M	1.83	1.59	1.01	1.48	1.44	1.44
Y	1.48	1.20	0.98	1.60	1.53	1.53
K	1.57	1.72	0.94	1.83	1.77	1.79

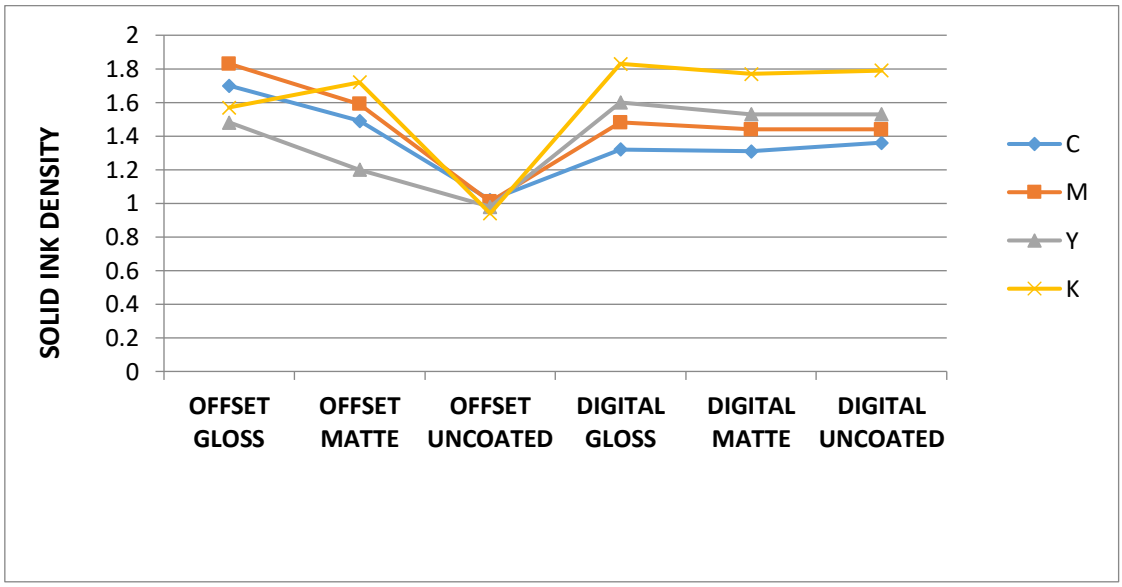

Fig.8. Solid Ink Density Analysis of Sheet-Fed Offset and Digital Printing After 1 Day of Printing

Table.9. Solid Ink Density Analysis of Sheet-Fed Offset and Digital Printing After 3 Days of Printing

	OFFSET			DRY TONER BASED DIGITAL		
	GLOSS	MATTE	UNCOATED	GLOSS	MATTE	UNCOATED
C	1.69	1.47	1.01	1.31	1.30	1.36
M	1.80	1.56	1.00	1.48	1.44	1.43
Y	1.46	1.18	0.96	159	1.54	1.53
K	1.54	1.70	0.93	1.83	1.76	1.78

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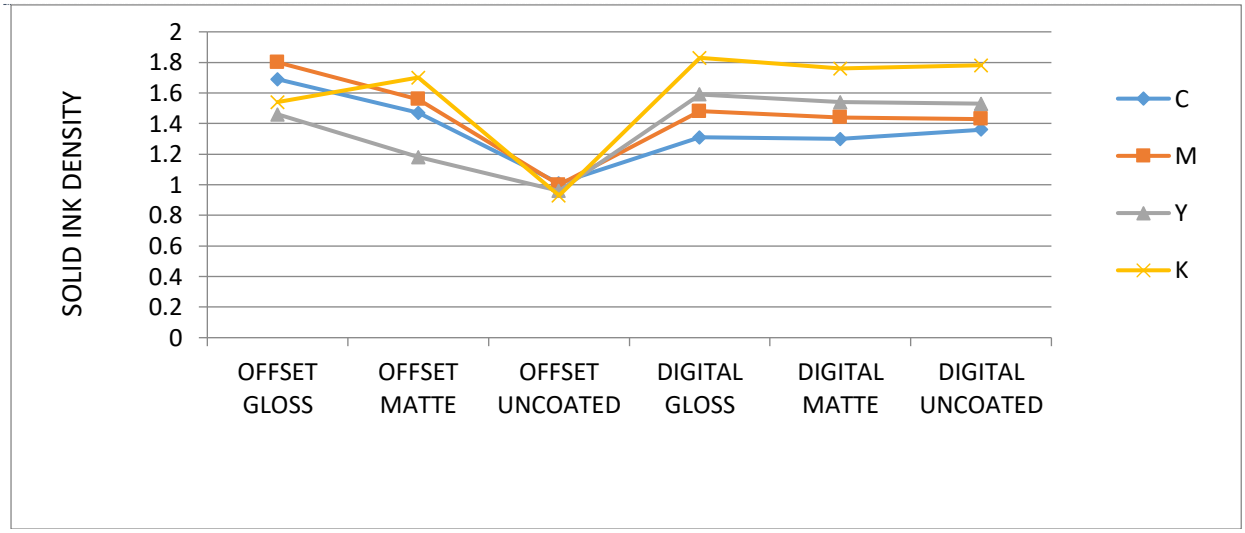

Fig.9. Solid Ink Density Analysis of Sheet-Fed Offset and Digital Printing After 3 Days of Printing

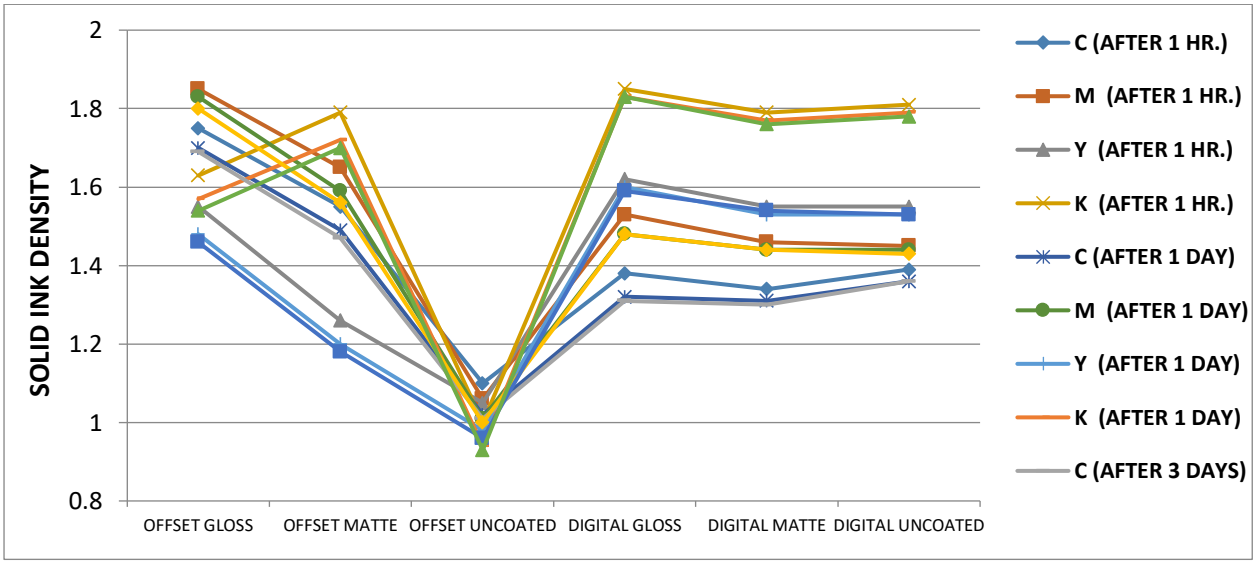

Fig.10. Comparative Solid Ink Density Analysis of Sheet-Fed Offset and Digital Printing After 1 Hr., 1 Day and 3 Days of Printing

V. RESULTS AND DISCUSSIONS

1. Ink Set-Off Analysis

From Table 1 and Fig 1 it is clear that Set-Off tendency was found maximum in Gloss paper while printed on sheet-fed offset printing. It can be due to the least porous nature of glossy paper and the paste nature of sheet-fed offset ink. While printing on sheet-fed offset, the set off factor was found least in uncoated paper. The reason might be the porous nature of uncoated paper which can absorb maximum ink resulting in the less ink on its surfacing causing least set-off. But in the case of dry toner based digital printing the set off was found least because of dry powder nature of digital ink. Further the strong fusing technique of dry toner based digital printing causes least set-set off.

2. Strike Through Analysis

Strike through factor was found maximum in uncoated paper in all the paper grades in both printing processes as shown in Table 2 and Figure 2. The reason is the porous nature of uncoated paper. But the trend was found maximum in the case of offset ink because of oily nature of ink which can penetrate the substrate more. In case of dry toner based digital printing, the strike though was found minimum because of powder nature of ink, which can't penetrate more.

ISSN: 2277-9655
Impact Factor: 4.116
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3. Ink Drying Time Analysis

After one hour of printing, the ink drying was found more in digital uncoated paper due to powdered ink being used in digital printing. But in case of glossy and matte paper, the ink drying was less due to non-porous nature of the substrate. In case of offset printing, the ink drying was less due to paste ink being used in the offset printing process.

After 5 hours of printing, ink drying was found more in sheet-fed offset printing, but in digital printing similar trend was found as in case of after 1 hour. After one day, the ink was settled more in offset printing but in digital printing ink was already settled as shown in Table 4 and Fig. 4. After 3 days the ink was nearly dried to maximum extent in both offset and digital printing Table 5,6 and Fig. 5 and 6.

4. Ink Density Analysis

In the present research work, the density of Cyan and magenta was found more in offset printing, but yellow and black density was found more in digital printing. But with the passage of time, the density started reducing in case of offset printing as shown in Table 7,8,9 and Graph 7,8,9,10. The reduction in density in case of digital printing was found very less. The reason behind reduction in density with the passage of time is the absorption drying of offset ink which takes a lot of time. But in case of digital printing this trend is less because of use of powdered base ink which quickly sets up.

VI. CONCLUSION

1. Dry toner based digital printing dries very rapidly compared to offset due to its powdered ink and strong fusing mechanism. Offset printing takes around 1 day to 3 days for drying stability.
2. Ink set-off tendency is more in offset printing compared to digital printing. In case of glossy paper set-off happens more as compared to matte paper. On uncoated papers set-off is found least.
3. Strike through happens more in sheet-fed offset compared to dry toner based digital printing. Strike through is found more in case of uncoated paper as compared to gloss coated and matte coated papers

VII. REFERENCES

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Dhirender, Mr, Rajeev Mr, and Bijender, Mr. "A COST EFFECTIVE FEA-BASED APPROACH FORDEVELOPING COMPLAINT AND SAFE AUTOMOBILE." *INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY* 6.7 (2017): 677-86. Web. 25 July 2017.