

Study of Colour Shift due to Aqueous Coating on various Coated Substrate in Offset Printing

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Offset printing is widely-used method in the printing industry for printing numerous jobs on wide varieties of substrates. Now a days, aqueous coatings are the popular post-printing process which is employed to improve the durability, appearance and tactile properties of printed materials. However, the interaction between these coatings and different paper substrates can result in varying degrees of colour shifts, impacting the final print quality. Colour shift expressed as ΔE value is the significant mismatch and crucial aspects while evaluating accuracy of colour while printing. This study investigates the colour shift outcomes of aqueous coatings on various paper media printed using offset printing technique. This analysis provides valuable insights for printers, guiding for the selection of appropriate paper and coating combinations to achieve desired print enhancements.

Keywords: Colour Shift, Offset Printing, Aqueous Coating, Coated (C1S) Media, Gloss Art, Matt Paper.

1. Introduction

“Ink and Water don’t mix with each other” is the principle on which Offset Printing underlies (Jangra, 2016). Offset Printing process is one amongst the most widely used printing process (Tutus, 2017) for numerous application which includes magazine, brochures and packaging applications where the application of coating is basic need for enhancing print quality (Olejnik-Krugly et al., 2013). In the realm of offset printing, achieving accurate colour reproduction (Jangra et al., 2023b) on coated paper is a critical endeavor. Coating on printed applications is used to serve multiple purposes in order to enhance appearance as well as durability (Wu et al., 2010). Coating process involves applying a thin layer (Varnish, UV, Aqueous coating) over the printed surface for achieving specific effects (Majnarić

et al., 2012). Aqueous coatings are water-based which are environment friendly with quick dry, offering good balance between protection and eco-friendliness. The choice of coating technique plays a pivotal role in determining the final appearance and colour stability of printed materials (Wu et al., 2010). Despite technological advancements, colour shifts (Gibert et al., 2005) remain a persistent challenge, affecting the fidelity and consistency (Jangra et al., 2023a) of final printed output. Therefore, this research endeavors to delve into the intricate relationship between various paper media, coating, and colour shifts in offset printing. The primary objective of this study is to comprehensively examine the impact of aqueous coating on various paper media and colour shifts observed on printed materials. Understanding colour shifts is paramount for ensuring the quality (Kipphan, 2001) and integrity of printed products, particularly in industries where visual appeal and accuracy are paramount, such as packaging and publication materials.

2. Objectives of Study

Various paper media are printed by offset printing which are commonly used for numerous applications. Numerous coatings on printed substrates are used for print enhancement purposes. The major objective of this study is to investigate the phenomenon of colour shift on different paper media due to Aqueous Coating on different paper media which include Coated Paper (C1S), Gloss Art Paper and Matt Paper.

3. Research Methodology

Colour shifting differences (ΔE Value) is common aspect to differentiate significant mismatch while evaluation colour difference. To find the colour shift using offset printing on various coated paper media (Coated Paper (C1S), Gloss Art Paper and Matt Paper) after aqueous coating techniques, first and foremost a master Test Chart was prepared by incorporating different technical elements. This master test chart was printed by using Offset printing process under standard press conditions. After printing on coated paper, aqueous coating was done. By using spectrophotometer, the complete data was captured and put on record for further analysis.

4. Data Analysis

For studying colour shift (ΔE Value) in offset printing due to Aqueous coating on coated paper media, various media were taken into consideration which included Coated Paper (C1S), Gloss Art Paper and Matt Paper. The analysis of data is represented as below using number of sample sheets measured on X-axis and their respective ΔE values on Y-axis:

1. Colour Shift Effect of Aqueous coating on Coated Paper (C1S) Media: The effect of Aqueous coating on Coated Paper (C1S) Media in terms of colour shift (ΔE Value) of process colour i.e. Cyan, Magenta, Yellow and Black during offset printing is presented in figure 1, 2, 3 and 4 respectively.

a. Colour Shift of Cyan Colour: The findings of colour shift (ΔE Value) of Cyan on coated paper (C1S) media during offset printing due to Aqueous coating are represented in figure 1. During observation it was found that the range of colour shift on coated paper (C1S) media without Aqueous coating was consistent at 3.01. After Aqueous coating on the printed Coated Paper (C1S) Media, the range of colour shift (ΔE Value) of Cyan were found in the range 1.97 - 2.80.

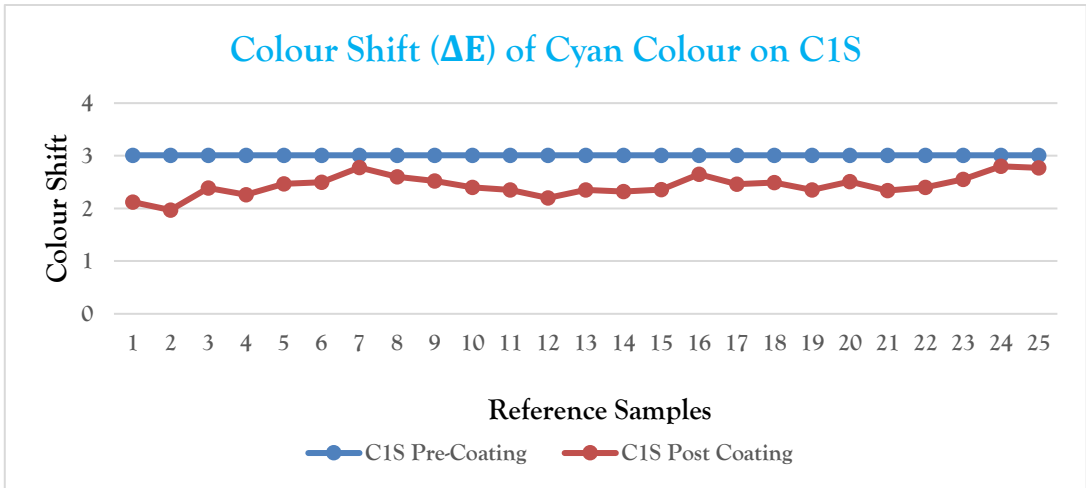


Fig. 1: Colour Shift (ΔE) of Cyan Colour on Coated Paper (C1S) Media

b. Colour Shift of Magenta Colour: The findings of colour shift (ΔE Value) of Magenta on coated paper (C1S) media during offset printing due to Aqueous coating are represented in figure 2. During observation it was found that the range of colour shift on coated paper (C1S) media without coating was consistent at 2.36. After Aqueous coating on the printed Coated Paper (C1S) Media, the range of colour shift (ΔE Value) of Magenta were found in the range 2.78 - 3.04.

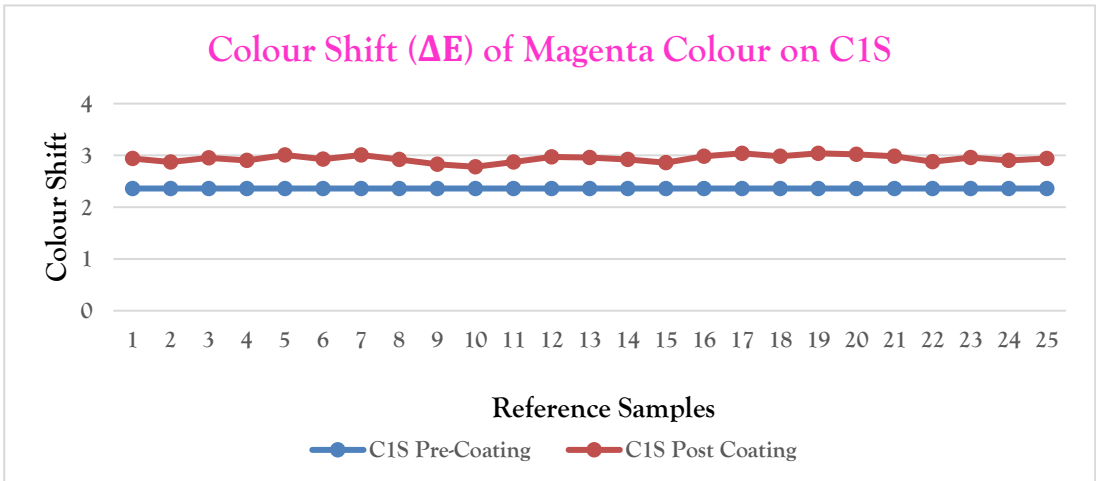


Fig. 2: Colour Shift (ΔE) of Magenta Colour on Coated Paper (C1S) Media

c. Colour Shift of Yellow Colour: The findings of colour shift (ΔE Value) of Yellow on coated paper (C1S) media during offset printing due to Aqueous coating are represented in figure 3. During observation it was found that the range of colour shift on coated paper (C1S) media without coating was consistent at 0.52. After Aqueous coating on the printed Coated Paper (C1S) Media, the range of colour shift (ΔE Value) of Yellow was found in the range 0.36 - 1.98.

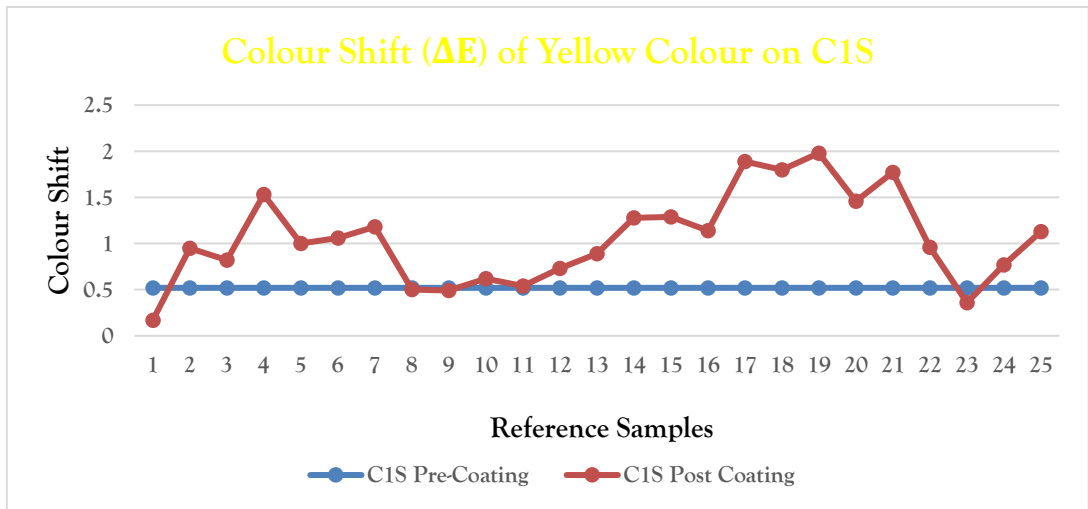


Fig. 3: Colour Shift (ΔE) of Yellow Colour on Coated Paper (C1S) Media

d. Colour Shift of Black Colour: The findings of colour shift (ΔE Value) of Black on coated paper (C1S) media during offset printing due to Aqueous coating are represented in figure 4. During observation it was found that the range of colour shift on coated paper (C1S) media without coating was consistent at 7.26. After Aqueous coating on the printed Coated Paper (C1S) Media, the range of colour shift (ΔE Value) of Black were found in the range 6.67 - 7.39.

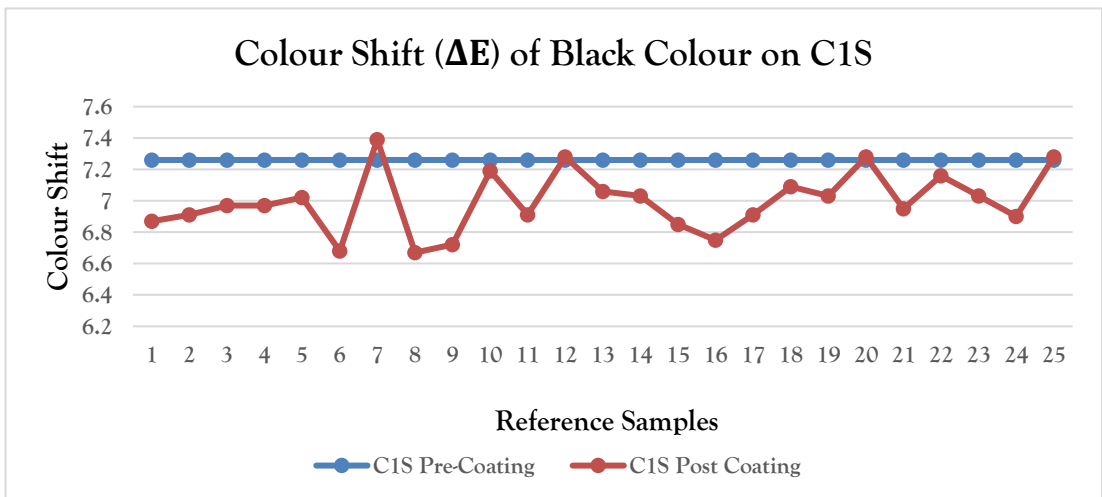


Fig. 4: Colour Shift (ΔE) of Black Colour on Coated Paper (C1S) Media

2. Colour Shift Effect of Aqueous coating on Gloss Art Paper Media: The variation of process colour i.e. Cyan, Magenta, Yellow and Black in terms of colour shift (ΔE Value) on Gloss Art Paper Media during Offset Printing due to Aqueous coating is presented in figure 5, 6, 7 and 8 respectively.

a. Colour Shift of Cyan Colour: The results of Colour Shift (ΔE value) of Cyan colour on Gloss Art paper media using offset printing are depicted in figure 5. The findings depicted that the range of colour shift on Gloss Art paper media without Aqueous coating was found 2.26 - 2.82. On the other

hand, the range of colour shift (ΔE Value) of Cyan was observed 1.94 - 2.55 on Gloss Art paper media after Aqueous coating.

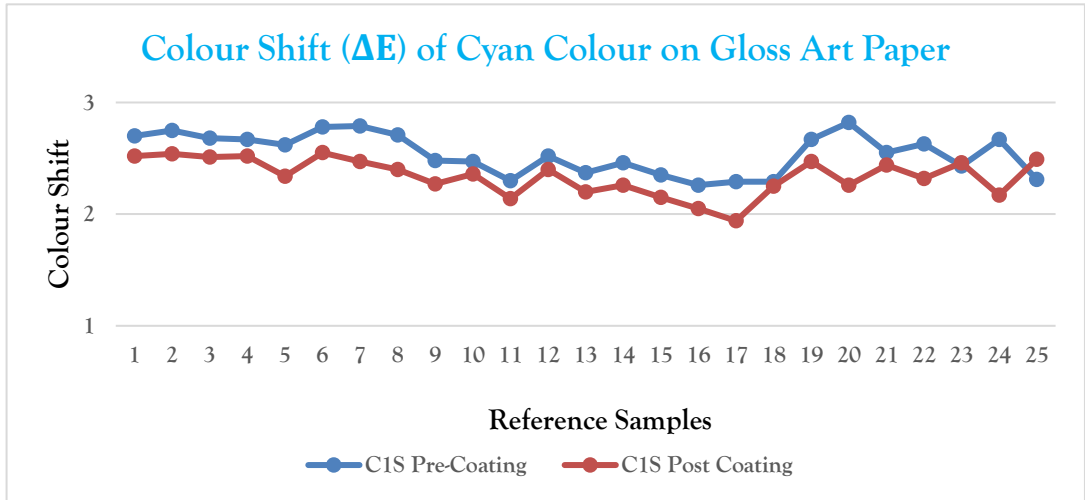


Fig. 5: Colour Shift (ΔE) of Cyan Colour on Gloss Art Paper Media

b. Colour Shift of Magenta Colour: The results of Colour Shift (ΔE value) of Magenta colour on Gloss Art paper media using offset printing are depicted in figure 6. The findings depicted that the range of colour shift on Gloss Art paper media without Aqueous coating was found 1.65 - 2.15. On the other hand, the range of colour shift (ΔE Value) of Magenta was observed 3.63 - 4.42 on Gloss Art paper media after Aqueous coating.

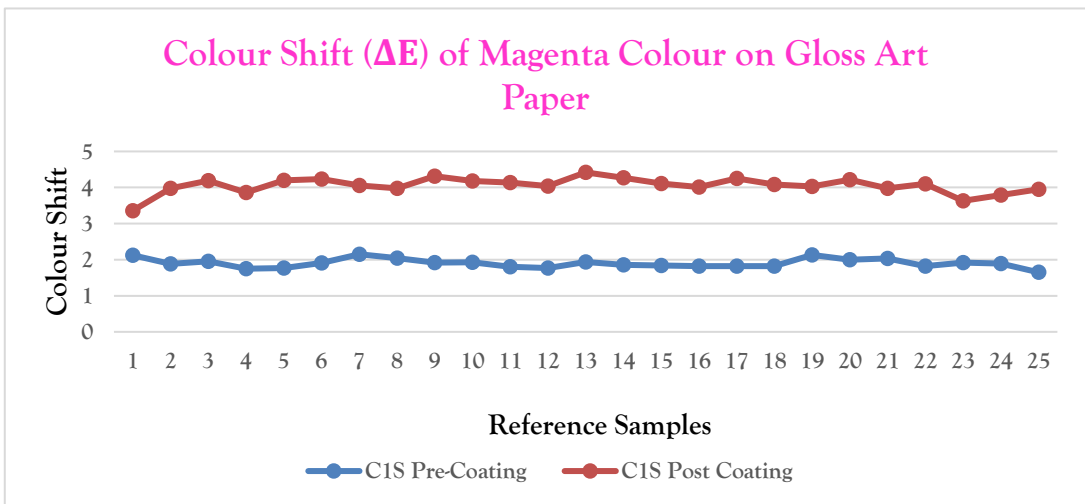


Fig. 6: Colour Shift (ΔE) of Magenta Colour on Gloss Art Paper Media

c. Colour Shift of Yellow Colour: The results of Colour Shift (ΔE value) of Yellow colour on Gloss Art paper media using offset printing are depicted in figure 7. The findings depicted that the range of colour shift on Gloss Art paper media without Aqueous coating was found 0.84 - 2.36. On the other hand, the range of colour shift (ΔE Value) of Yellow was observed 2.17 - 4.04 on Gloss Art paper media after Aqueous coating.

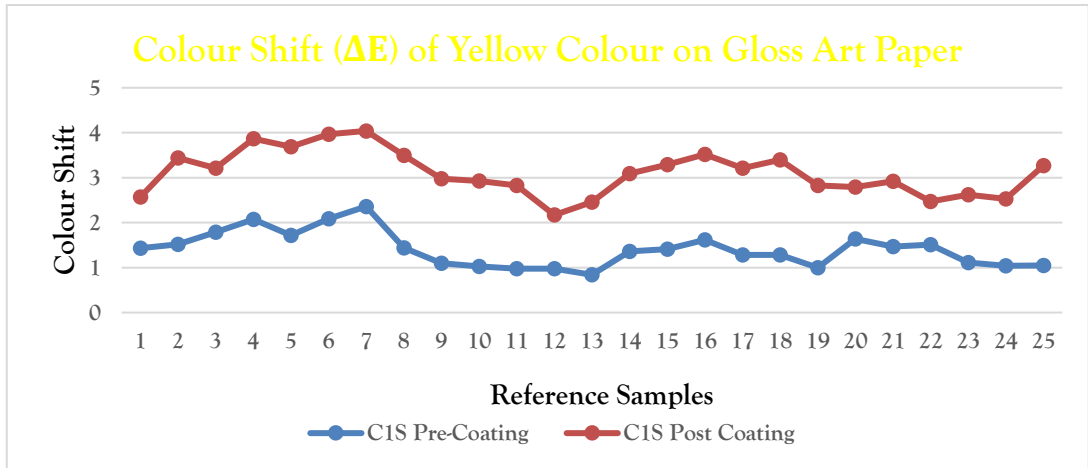


Fig. 7: Colour Shift (ΔE) of Yellow Colour on Gloss Art Paper Media

d. **Colour Shift of Black Colour:** The results of Colour Shift (ΔE value) of Black colour on Gloss Art paper media using offset printing are depicted in figure 8. The findings depicted that the range of colour shift on Gloss Art paper media without Aqueous coating was found 4.91 - 6.49. On the other hand, the range of colour shift (ΔE Value) of Black was observed 4.89 - 6.62 on Gloss Art paper media after Aqueous coating.

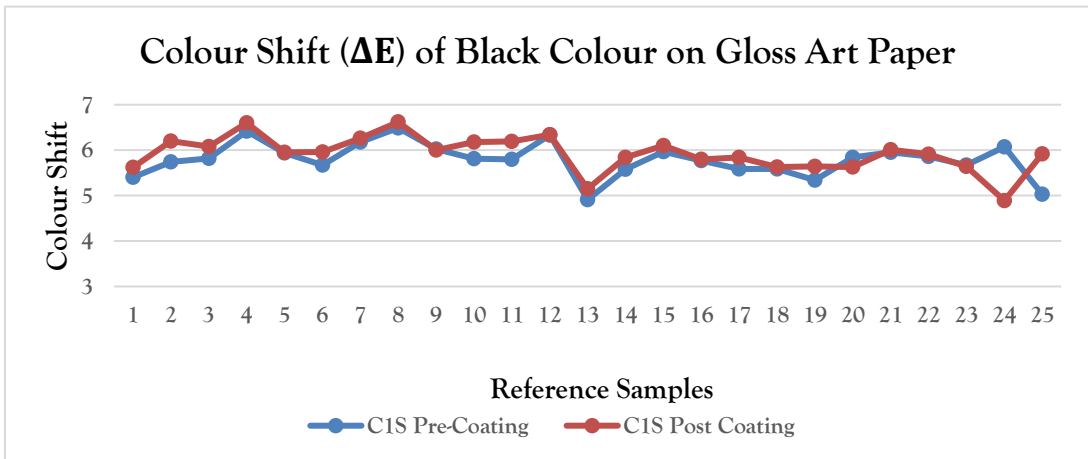


Fig. 8: Colour Shift (ΔE) of Black Colour on Gloss Art Paper Media

3. **Colour Shift Effect of Aqueous coating on Matt Paper Media:** The colour shift (ΔE Value) of process colour i.e. Cyan, Magenta, Yellow and Black during Offset Printing on Matt Paper Media due to Aqueous coating is presented in figure 9, 10, 11 and 12 respectively.

a. **Colour Shift of Cyan Colour:** The results of the findings for colour shift (ΔE Value) of Cyan colour on Matt Paper Media while offset printing are expressed in figure 9. During observation the range of colour shift (ΔE Value) of Cyan colour was consistent at 4.10 on Matt Paper Media without Aqueous coating. While the range of colour shift (ΔE Value) of Cyan after Aqueous coating was observed consistent at 3.06.

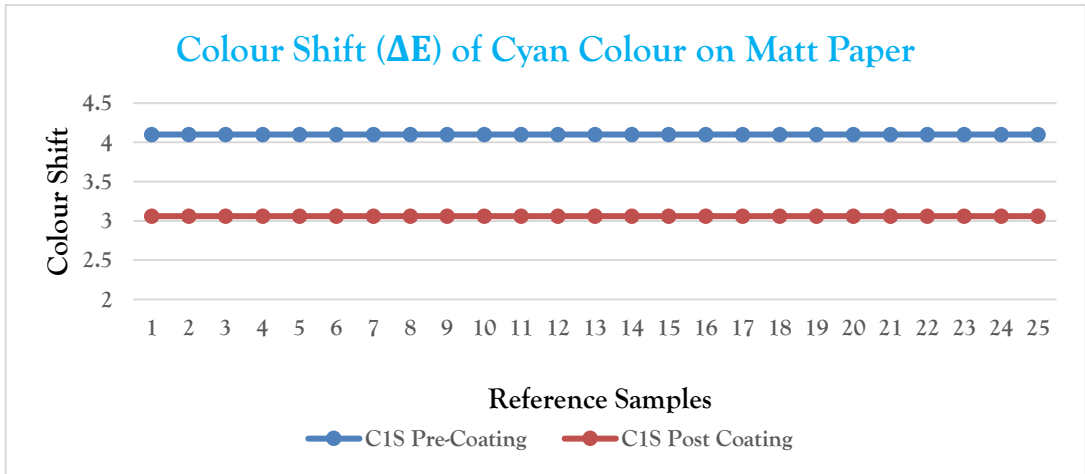


Fig. 9: Colour Shift (ΔE) of Cyan Colour on Matt Paper Media

b. Colour Shift of Magenta Colour: The results of the findings for colour shift (ΔE Value) of Magenta colour on Matt Paper Media while offset printing are expressed in figure 10. During observation the range of colour shift (ΔE Value) of Cyan colour was found consistent at 4.60 on Matt Paper Media without Aqueous coating. While the range of colour shift (ΔE Value) of Magenta after Aqueous coating was observed consistent at 4.49.

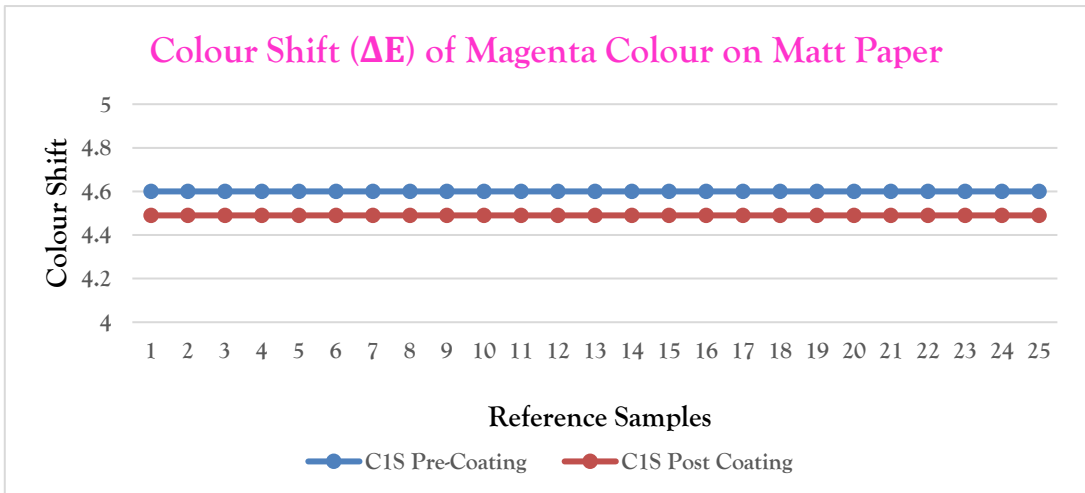


Fig. 10: Colour Shift (ΔE) of Magenta Colour on Matt Paper Media

c. Colour Shift of Yellow Colour: The results of the findings for colour shift (ΔE Value) of Yellow colour on Matt Paper Media while offset printing are expressed in figure 11. During observation the range of colour shift (ΔE Value) of Cyan colour was found consistent at 2.78 on Matt Paper Media without Aqueous coating. While the range of colour shift (ΔE Value) of Yellow after Aqueous coating was observed consistent at 1.06.

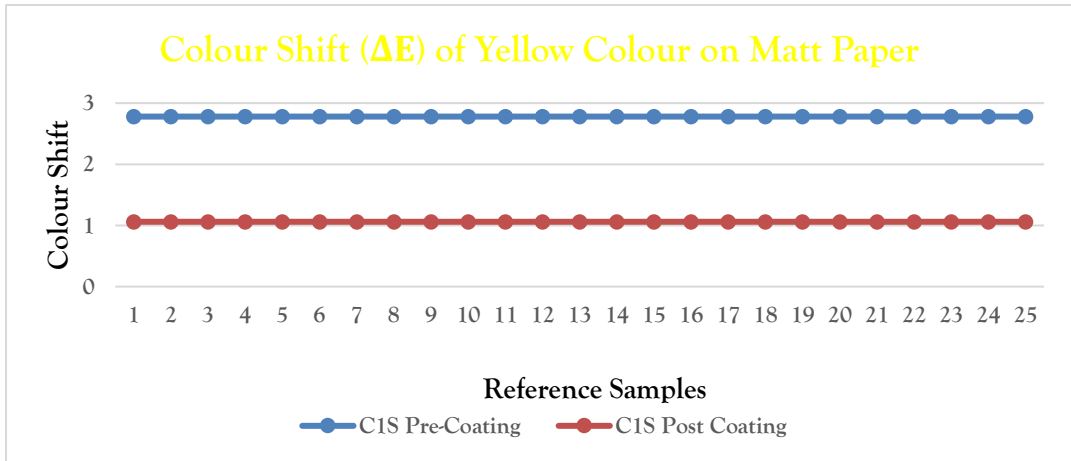


Fig. 11: Colour Shift (ΔE) of Yellow Colour on Matt Paper Media

d. Colour Shift of Black Colour: The results of the findings for colour shift (ΔE Value) of Black colour on Matt Paper Media while offset printing are expressed in figure 12. During observation the range of colour shift (ΔE Value) of Black colour was found consistent at 10.20 on Matt Paper Media without Aqueous coating. While the range of colour shift (ΔE Value) of Cyan after Aqueous coating was observed consistent at 6.57.

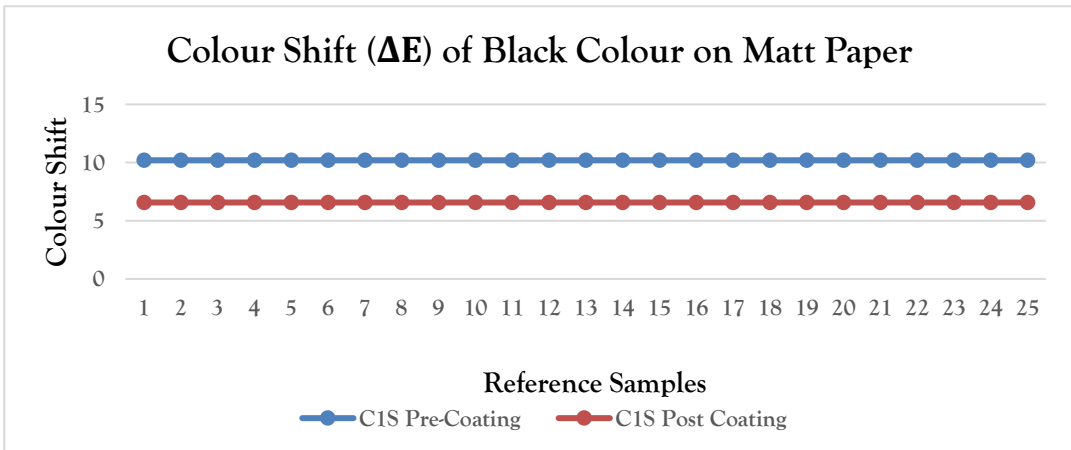


Fig. 12: Colour Shift (ΔE) of Black Colour on Matt Paper Media

5. Results and Discussion

Data was analyzed to interpret in form of information. The findings of colour shift i.e. ΔE Value using offset printing on Coated Paper (CIS), Gloss Art Paper and Matt Paper Media due to Aqueous coating due to Aqueous coating are summarized (Table 1) as below:

Table 1: Summary of Colour Shift (ΔE Value) on Coated Paper Media

Colour Shift (ΔE Value)		Coated Paper (C1S) Media		Gloss Art Paper		Matt Paper Media	
		Without Coating	Aqueous Coating	Without Coating	Aqueous Coating	Without Coating	Aqueous Coating
Cyan	Min.	3.01	1.97	2.26	1.94	4.1	3.06
	Max.	3.01	2.8	2.82	2.55	4.1	3.06
Magenta	Min.	2.36	2.78	1.65	3.63	4.6	4.49
	Max.	2.36	3.04	2.15	4.42	4.6	4.49
Yellow	Min.	0.52	0.36	0.84	2.17	2.78	1.06
	Max.	0.52	1.98	2.36	4.04	2.78	1.06
Black	Min.	7.26	6.67	4.91	4.89	10.2	6.57
	Max.	7.26	7.39	6.49	6.62	10.2	6.57

6. Conclusion

The findings indicate a discernible effect of aqueous coating on colour shift in offset-printed on various paper media which included Coated Paper (C1S), Gloss Art Paper and Matt Paper coated paper.

Coated Paper (C1S) Media: It was found that before coating on Coated Paper (C1S) Media, the value of colour shift (ΔE) of cyan colour was more and aqueous coating reduced colour shift. For magenta colour there was consistency before coating (aqueous) and post coating there was more colour shift i.e. colour deviation. Also there was consistency before coating (aqueous) for yellow colour, but post coating there was variation (both less and more) in colour shift. Black colour shift value was more as compared to other process colour (Cyan, Magenta and Yellow), but post aqueous coating helped in reducing colour shift up to a certain extent.

Gloss Art Paper Media: Colour shift was in acceptable range before and after aqueous coating on gloss art paper for Cyan colour. Also post coating effect where reduction of colour shift expect some points. For magenta and yellow colour, there was least colour shift (ΔE) prior to aqueous coating which was increased but within acceptable range. The colour shift value (ΔE) of Black colour was more as compared to other process colour (Cyan, Magenta and Yellow), but post aqueous coating the range of colour shift was almost similar.

Matt Paper Media: It was observed that the value of colour shift (ΔE) of cyan and yellow colour was consistent prior to aqueous coating. Post aqueous coating, reduction in colour shift (ΔE) value was observed for both cyan and yellow colour. For magenta colour, there was consistency in colour shift before and after aqueous coating. Also post aqueous coating helped in reducing colour shift (ΔE) value. There was more colour shift (ΔE) value for Black colour was high as compared to other process colour (Cyan, Magenta and Yellow), but post aqueous coating helped not only in reducing colour shift up to a certain extent, but also maintained consistency near acceptable range of colour shift (ΔE) value.

In nutshell, specifically for black colour, the colour shift (ΔE) value was reduced aqueous coating on all selected Coated Paper (C1S), Gloss Art Paper and Matt Paper media. There was reduction of colour shift (ΔE) value of cyan, magenta and yellow colour on all three selected media expected magenta and yellow on Gloss Art and Coated Paper (C1S) media while using offset printing.

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