2nd International Joint Conference on Environmental and Light Industry Technologies,
21 – 22 November 2011, Budapest, Hungary
Óbuda University

APPEARANCE OF PEARL LUSTER PIGMENTS AT DIFFERENT OBSERVATION ANGLES

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Abstract:

The aim of this study was to investigate the appearance of different pearl luster pigments which were measured at different observation angles. Three different pearl luster pigments by Merck were used (Iriodin 221® Rutile Fine Blue, Iriodin 223® Rutile Fine Lilac and Iriodin 231® Rutile Fine Green), which differ in end colour effects, which were applied on film synthetic paper (Yupo). The pigments were overprinted on the full tone black background in sheet fed offset technique. The investigation was focused on changes in lightness and chroma at observation angles of 15°, 25°, 45°, 75° and 110°. According to the results, the values of lightness of all three pigments were the highest at observation angles of 15°, while at observation angles of 110° were the lowest. The results also indicated that the values of chroma were the highest at observation angle of 15°.

Keywords: *pearl luster pigments, observation angles, lightness, chroma.*

1 INTRODUCTION

Effect pigments are colorants that give additional color effects, such as angular color dependence (iridescence, color travel, luster) or texture, when applied in an application medium [1]. Pearl luster pigments simulate the luster of natural perals. They are used to obtain pearl, iridescent (rainbow), or metallic effects, and in transparent color formulations to obtain brilliance or two-tone color, luster flops, and color travel effects (changing with viewing angle). Color effects depend on the viewing angle [2]. Pearlescent pigments consist of two ore more layers with high index of refraction difference; the values normally range from 1.5 to 2.9. The most used substrate is mica, but also metals or metal oxides are often applied [3]. Pearl luster pigment platelets split white light into two complementary colors that depend on the platelet thickness. The reflected (interference) color dominates under regular (maximum) reflection, i.e., when the object is observed at the angle of regular reflection. The transmitted part dominates at other viewing angles under diffuse viewing conditions, provided that there is a non-absorbing (white) or reflecting background. Variation of the viewing angle therefore produces a sharp gloss (reflectance) peak, and the color changes between two extreme complementary colors [2].

2 EXPERIMENTAL

In the research, three types of pearl luster pigments (Pigment 1: *Iriodin 221® Rutile Fine Blue*, Pigment 2: *Iriodin® 223 Rutile Fine Lilac* and Pigment 3: *Iriodin 231® Rutile Fine Green*) and a film synthetic paper (*Yupo*) as a printing substrate were used. Pigments were overprinted on 24 hours dried black offset prints by printing press KBA Performa74. In Table 1 properties of pearl luster pigments are presented.

Table 1: Properties of pearl luster pigments.

Properties	***Pigment 1***	***Pigment 2***	***Pigment 3***
Physical form	Dry, free-flowing powder	Dry, free-flowing powder	Dry, free-flowing powder
Chemical composition	Mica: 34-41 %, TiO_2: 59-65 %, SnO_2: 0-1 %	Mica: 35-44 %, TiO_2: 56-44 %, SnO_2: 0-1 %	Mica: 27-36 %, TiO_2: 64-72 %, SnO_2: 0-1 %
Interference color	Blue	Lilac	Green
Particle size	5-25 µm	5-25 µm	5-25 µm

Pearl luster pigments overprinted on black offset prints were measured by X-Rite MA68II multi-angle spectrophotometer. Measurements of lightness and chroma were made at observation angles of 15º, 25º, 45º, 17º and 110º.

3 RESULTS

3.1 Change of lightness of pigments at different observation angles

In Figures 1-3 the change of lightness of Pigment 1, Pigment 2 and Pigment 3, at different observation angles are presented.

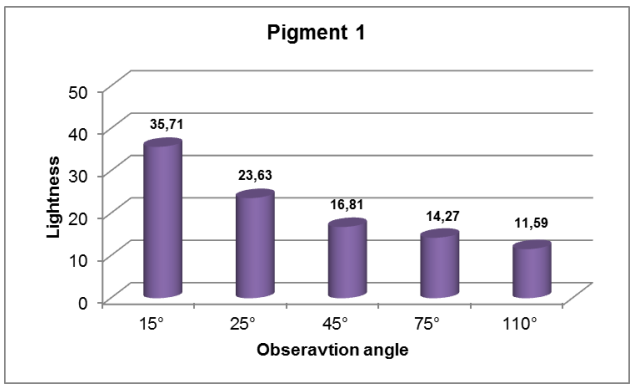

Figure 1: Change of lightness of Pigment 1.

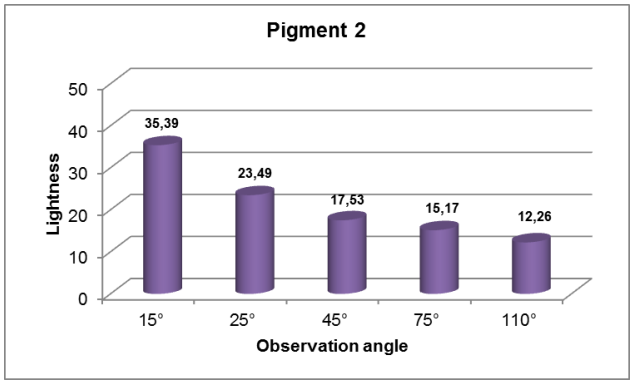

Figure 2: Change of lightness of Pigment 2.

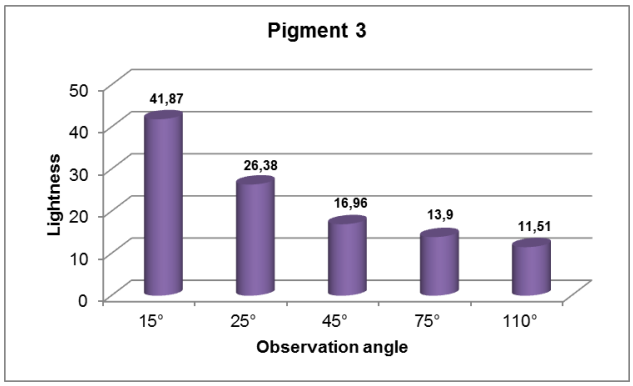

Figure 3: Change of lightness of Pigment 3.

3.2 Change of chroma of pigments at different observation angles

In Figures 4-6 the change of chroma of Pigment 1, Pigment 2 and Pigment 3, at different observation angles are presented.

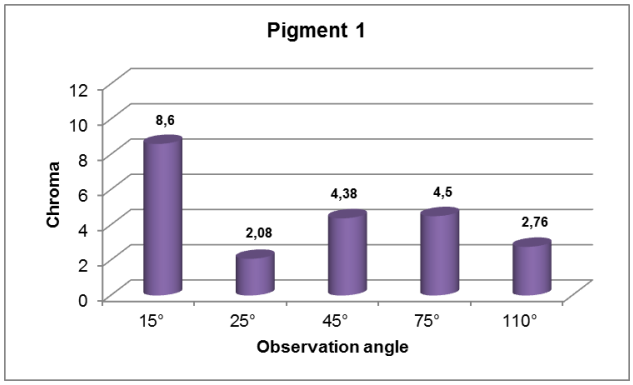

Figure 4: Change of chroma of Pigment 1.

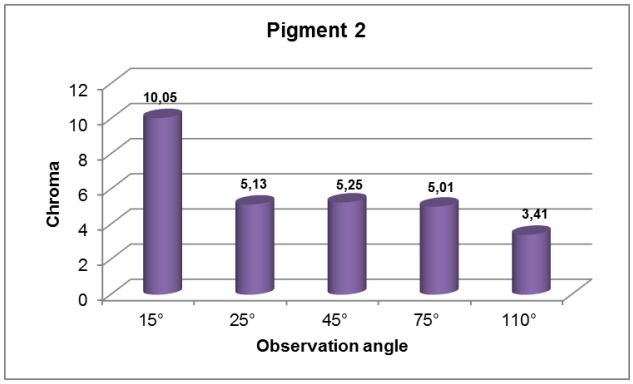

Figure 5: Change of chroma of Pigment 2.

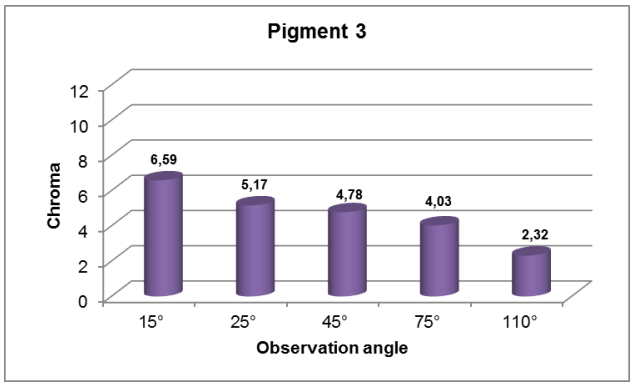

Figure 6: Change of chroma of Pigment 3.

4 DISCUSSION

As can be seen from Figures 1-3, the lightness of all three pearl luster pigments decreased from angle of 15º to angle of 110º. At observation angle of 15º the pigments are the lightest, while at angle of 110º are the darkest. It was also established that the pigment type has also influence on lightness. The change of lightness of Pigment 1 and Pigment 2 were similar, where Pigment 1 had decrease by 24.12 points and Pigment 2 by 23.13 points. The most obvious decrease of lightness was measured on Pigment 3, where the values from angle of 15º to angle of 110º dropped by 30.36 points. The observational angles are grouped into three categories: "Face" (Near Specular: 15º or 25º), "Mid Specular" (or diffuse: 45º), and "Flop" (Far Specular: 75º or 110º) and correlate to the instrumental viewing angles [4]. An angle of 25º [=L*(25º)] has become accepted to describe the visual effect on face. The angles of 110º [=L*(110º)], and 70º measure the darker appearance [5]. In contrast to conventional solid colors, effect pigments change their appearance with viewing angle and lightning conditions. With different observation angles, the lightness, chroma and also hue changed [4]. Figure 4 shows significant change of chroma of Pigment 1 measured at different angles. It was noticed that the chroma of Pigment 1 was the highest at observation angle of 15º (C*=8.6), meanwhile at observation angle of 25º the smallest (C*=2.08). From all three pigments, the Pigment 2 obtained the highest values of chroma, especially at observation angle of 15°. The results also indicate that Pigment 2 and

Pigment 3 obtained the smallest values of chroma at observation angle of 110° ($C^*_{Pigment\ 2}$: 3.41 and $C^*_{Pigment\ 3}$: 2.32).

5 CONCLUSIONS

In the present study was confirmed, that the values of lightness and chroma of pearl luster pigments printed on black offset prints, varied at different observation angles. The highest values of lightness of all three pearl luster pigments were noticed at observation angle of 15°, meanwhile with increasment of observation angles to 110°, the values of lightness gradually decreased. The most obvious change of chroma was noticed at Pigment 1. From all three pigments, the Pigment 2 obtained the highest values of chroma at all observation angles.

6 REFERENCES

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