PIGMENTS INFLUENCE ON COATED PAPER SURFACE AND PRINT QUALITY

Özden Ö. [1], Sönmez S.[2], Ertürk A.[1]
[1] Istanbul University-Cerrahpaşa
[2] Marmara University, School of Applied Sciences,

ABSTRACT
Coating the paper surface is an important process that improves the image and printability of the paper. The particle size, and type of pigments used for the coating cause changes in the mechanical and surface properties of paper. In this study, two different clay were used as pigment. Latex is used as a binder. Coating color prepared with a mixture of latex and pigment was applied to the paper surface with K-Control Coating type apparatus. Coatings are applied as 10 g / m^2 single face. For this study, the effect of coating in coating color with different pigments on paper surface resistance and paper resistances is aimed. Resistance properties of the papers were examined as a result of the coatings. In addition, water resistance and Dennison wax tests were determined for the printability effect. Printing was done on sample papers using Cyan ink in the IGT test device under laboratory conditions.
The results showed that the tensile strength, tearing, were improved as the type of pigment and the coating amount were increased. The printing properties of sample papers have improved.
Key words: *Ultra clay, macro clay, latex, mechanical properties, density, gloss*

Introduction

The pigment coating improves the paper surface by completely covering the fibers in the base paper. But if the base paper is not good, it cannot cover the defects [4]. Therefore, base paper plays an important role in the quality of the coating. If it has a good formation and surface smoothness, a stronger and smoother surface will be obtained with a less coating [5].

Surface coating or surface sizing are important processes for the quality and printability of the paper [6]. In addition to the appearance of the paper, mechanical resistance properties and surface resistance properties increase with surface treatments. The smoothness and mechanical properties of the

paper surface also affect the printing properties [6]. Used kind of pigment has an important effect on paper smoothness and mechanical properties [1]. Also, pigment particle sizes and shapes are important in determining surface smoothness of paper [2].

Many parameter results are required for the quality of paper and cardboard products. These:

Paper Parameters

1. Structure and composition

a) Basis weight

b) Bulk & Density

c) Caliper

d) Hardwood% or softwood%

e) Sizing

f) Porosity

g) Roughness

h) Young's modulus

2. Optical properties

a) Fluorescence

b) Brightness

c) Gloss

d) Micro gloss nonuniformity

e) Opacity

These features and effects are listed in Table 1.

Table 1. List of Paper Property & their Impact

Paper Property	Control Parameter	Impact (Affects)
Internal & Surface Sizing	- Sizing agents	Printability
Smoothness & Caliper Variation	- Filler distribution -Fiber type -Calendering	Print/Image Quality (mottle, density loss, & image transfer)
Strength & Dimensional Stability	- Filler content & distribution ---Fiber-fiber contact & bonding - Moisture Content	Runnability & Image Resolution
Moisture & Curl	- Filler concentration& distribution - Drying Process - Web formation	Runnability & Electrostatic Transfer Efficiency (mottle & toner density)

Paper Property	Control Parameter	Impact (Affects)
Brightness & Whiteness	- Moisture nonuniformity -Lignin content - Fiber -distribution & type	Print/Image Quality
Opacity	- Filler content - Fiber type - Heat & wet calendering - Additives & fillers	Print/Image Quality
Specular Gloss	- Calendering - Fiber orientation & distribution - Moisture nonuniformity - Toner transfer efficiency	Print/Image Quality
Electrical Resistivity & Static Properties	- Moisture content - Mass density - Paper composition	Runnability, Printability, &Print/Image Quality
Thermal Conductivity & Porosity	- Fiber distribution - Porosity - Pore size distribution	Print/Image Quality

Resource: Christoper J. Biermann, 1996 [3]

The aim of this study is determine the printability affect and strength properties which is one of the activities of coating pigments.

Materials and methods

In study, 80 g/m^2 commercial Kraft paper was used as the base substrate for coating. The Kraft paper properties are summarized in Table 1. The properties of the coating materials are given as reported by the supplier in Table 2 and 3. The (%) solids of the mineral pigments and binders used in the coating formulations are given in Table 4.

1. Preparation of Pigments

In this study, two different commercial kaolin clays with different morphologies, and particle size distributions (PSD) ranging and latex were used. The pigments were Capim DG, obtained from Imerys, UK, and Nurclay,

supplied by BASF (Table 2). The kaolins were received as dry powder and were dispersed in water prior to the coating preparation. Other pigments were received as slurries.

Table 2: Properties of pigments used

	ISO Brightness	wt% <2µm	wt% <0.25µm	D50 µm	Shape Factor	Concentration wt%
Capim Dg (Clay)	89	92	14	0.56	15	74
Nurclay (Clay)	86	80	n	n	n	70

(n:It2s not certain)

2. Preparing the Paper Coating Substances

For this study, five different coating formulation were prepared. All coating was prepared at 45% solid and at 8-8.5 pH. Distilled water used in all processes. The viscosities of the coatings were measured with a Brookfield viscometer (spindle No. 3; at 100 rpm). All paper surface single side coated with using # 3 bar by coating applicator (K Control - Coater Model Laboratory type rod coater). The applicator speed was 3 cm/s. The formulations of the coatings are given in Table 3.

Table 3: Coating Formulations (F)

	F1	F2	F3	F4	F5
Capim Dg (Clay)	100	-	50	60	40
Nurclay (Clay)	-	100	50	40	60
Acronal 360 (Latex)	12	12	12	12	12
pH	8.18	8.03	8.08	8.06	8.06
Viskosity (Brookfield) cP, 100RPM #3	10.4	2.06	7.03	1.78	4.59

3. Determination of Paper Strength Properties

Paper strength tests performed in İstanbul University-Cerrahpaşa, Faculty of Forestry, Department of The Chemistry and Technology of Forestry Products SEKKA Laboratory. Zwick Universal Test machine used for evaluate to bursting strength (ISO 2758) and tensile strength (ISO 1924-2). Tear strength (ISO 1974) evaluated in Elmendorf test machine. Cobb60 results

measure according to ISO 535. After kept 24 hours in the conditioning room, paper tests obtained. Standard method was ISO 287. The results of test are given in Table 4 and 5.

Table 4: Properties of uncalendered-coated Kraft paper.

Coating formulations	Coated paper weight (g/m^2)	Coating amount (g)	Cobb60 (gm^2)	Thickness (mm)	Dennison Wax number		
			WS1	FS2		WS1	FS2
F0	80	-	40.6	24.36	0.10	18	18
F1	107	27	30.45	34.51	0.11	5	5
F2	97	17	38.57	32.48	0,11	9	9
F3	99	19	36.54	32.48	0.11	6	6
F4	95	15	34.51	34.51	0.11	6	6
F5	102	22	38.57	40.60	0.11	6	6

1: Wire face, 2: Felt face

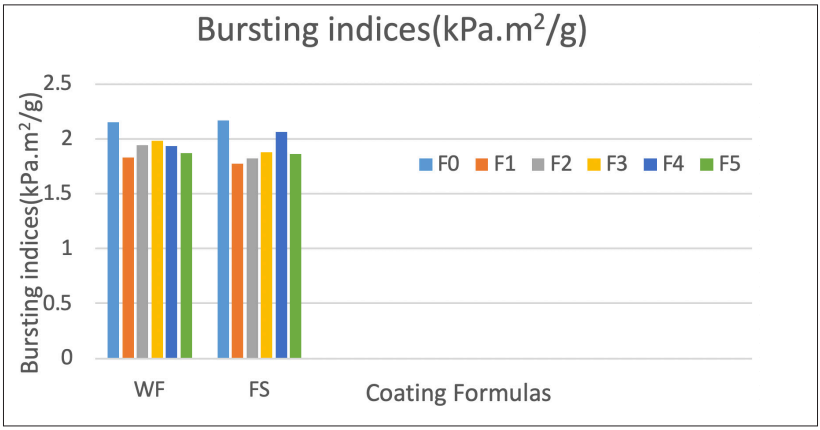
Base and coated papers were tested with Dennison waxes and acceptable values obtained for coated paper. Base paper, has higher values according to their coated ones. In this study, coated papers generally describe with 6A wax number, while base paper described with 18A (Table 4). Example F2 is described with 9A wax number.

Table 5: Physical properties of uncalendered-coated Kraft paper.

Coating formulations	Tensile strength indices (Nm/g)	Elongation (%)	Bursting indices (kPa. m^2/g)	Tearing indices (mN. m^2/g)				
	MD1	CD2	MD	CD	WF3	FS4	MD	CD
F0	57.18	36.85	1.73	4.56	2.15	2.17	6.13	6.98
F1	45.15	28.3	1.91	5.02	1.83	1.77	5.04	5.31
F2	49.35	31.15	2.03	5.56	1.94	1.82	6.52	6.97
F3	30.46	32.75	5.30	5.25	1.98	1.88	5.49	5.79
F4	53.90	32.74	2.06	4.99	1.93	2.06	5.42	5.73
F5	47.57	32.25	1.89	5.57	1.87	1.86	5.04	5.48

1: Machine direction, 2: Cross direction, 3: Wire face, 4: Felt face

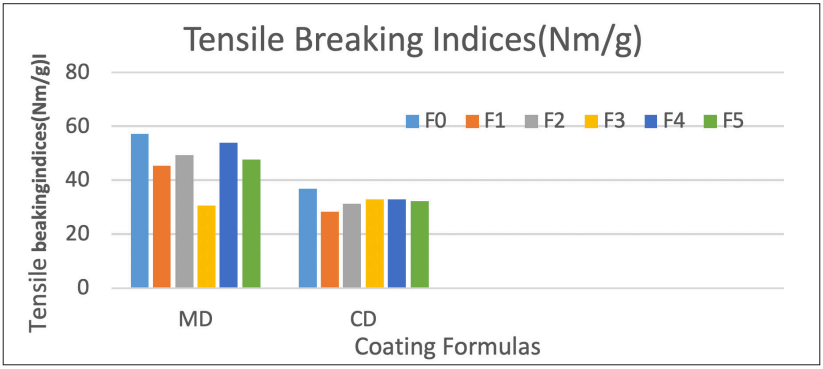
At the end of the coating process, the bursting indices values for the wire and felt direction decreased compared to the base paper. The highest bursting indices values out of base paper were obtained with F4. (Figures 1)



WF: Wire face, FS: Felt face

Figure 1: Bursting indices value

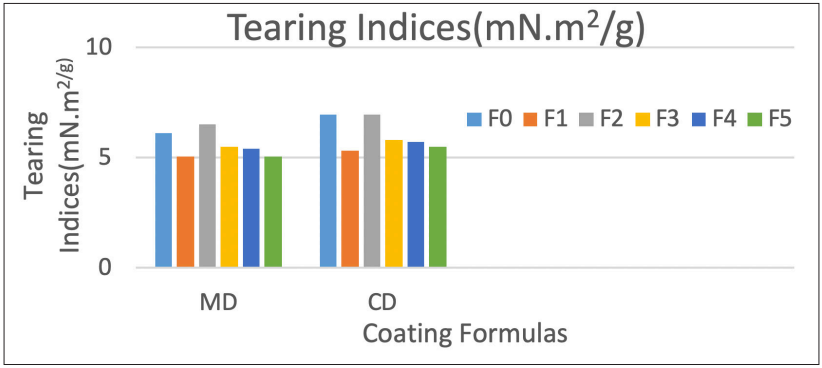
All coated papers' values of tensile strength indices in machine direction were increased. coating colors' tensile strength indices test results, respectively, are lower than that of base paper for machine directions and crosswise directions (Figures 2).



MD: Machine direction, CD: Cross direction

Figure 2: Tensile Strength breaking indices value

Tearing indices values of both clay pigment grades were decreased for both MD and CD because of coating colors. Compared with the base paper's tearing indices value; But only F2(100 part Nurclay) is increasing (Figures 3).



MD: Machine direction, CD: Cross direction

Figure 3: Tearing indices value

4. Print

The prints have made in laboratory conditions using IGT test apparatus. Cyan offset printing ink had used for printing. Density and gloss measurements were made after the prints were dried in room conditions. Then delta gloss values were measured.

Figure 4 shows that the highest density value was obtained in F5-WS, which is included two different clay. In F5-WS, there is an increase in the density values depending on using Nurclay (Clay) in coating formulations. The same result is also the same as F5-FS. The density values obtained on the face of WS are quiet higher due to FF.

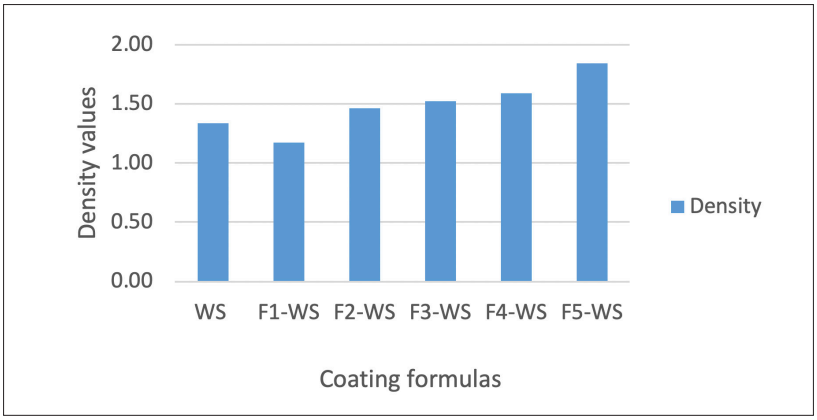


Figure 4: Density value for WS

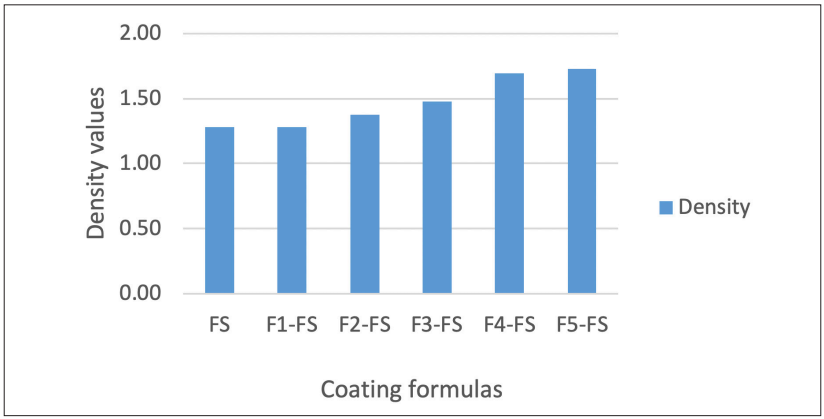


Figure 5: Density value for FS

Figure 6 and 7 show that the gloss values of paper before print is higher than the gloss after print. Both WS and FS have the same gloss values before print. Increasing Capim Dg (Clay) used in coating formulations increased gloss values. After Print, the gloss values of all formulations were affected negatively.

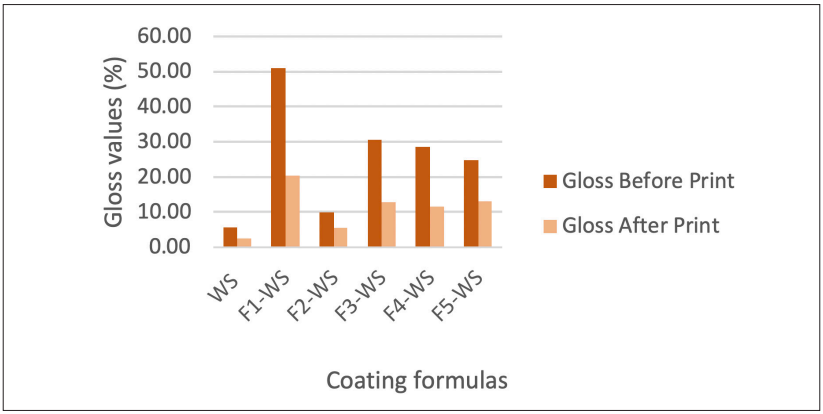


Figure 6: Gloss value for WS

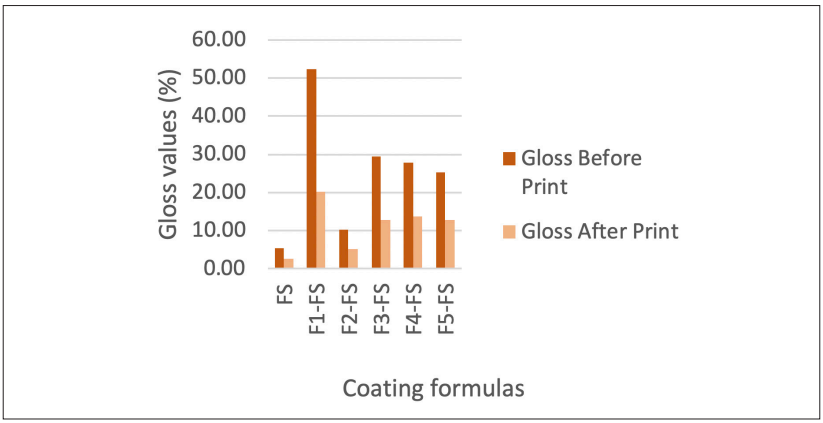


Figure 7: Gloss value for FS

Results and conclusions

In this study, grammage, coating amount, tearing, tensile breaking strength, bursting strength, gloss, density and wax pick of coated papers were determined.

In this study wood free base papers (bleached Kraft paper) was used and results of these base papers' physical tests were compared with each base papers which coated by different coating formulas. Our test results at the end of different coated applications have shown that ultra micro pigment has

improved its printability more. Because, although there is not much change in resistance values, gloss and print density increased.

Referances

1. Arnold, M. (1997). Ground calcium carbonate in coated papers and board, OMYA Plüss-Staufer AG, Oftringen, Switserland, p. 2-3.
2. Lehtinen, E. (2000). Introduction to pigment coating of paper", in: Pigment coating and surface sizing of paper, E. Lehtinen (ed.), Chapter 1, Book 11, Papermaking Science and Technology, Helsinki, Fapet Oy, 16.
3. Biermann, C. J., 1996, Paper and Its Properties, Handbook of Pulping and Papermaking(Second edition). ISBN. 978-0-12-097362-0, P.158-189
4. Özden, Ö. and Sönmez, S. (2018). Pigment used in the coating of paper and cardboards, in The most recents studies in science and art, Prof. Hasan Arapgirlioğlu, Assoc. Prof. Atilla Atik, Prof. Salim Hızıroğlu, Prof. Robert L. Elliott and Dr. Dilek Atik (eds.), Gece Publishing, Chapter 156, pp. 1979-1993, Ankara, Turkey.
5. Roberts, J. C. (1996). The chemistry of paper, in: The Surface Modification of Paper, Chapter 8, p.141-148, The Royal Society of Chemistry, UK.
6. Sönmez, S. and Özden Ö. (2019). The influence of pigment proportions and calendering of coated paperboards on dot gain, Bulgarian Chemical Communications, Vol.51, pp. 212-218.
7. Sonmez, S. (2011). Interactive effects of copolymers and nano-sized pigments on coated recycled paperboards in flexographic print applications, Asian Journal of Chemistry, Vol.23, pp. 2609-2613.
8. ISO:
   ISO 2758:2014 Paper – Determination of bursting strength.
   ISO 1924-2:2008 Paper and board – Determination of tensile properties
   ISO 1974:2012 Paper – Determination of tearing resistance – Elmendorf method
   ISO 535:2014 Paper and board – Determination of water absorptiveness – Cobb method
   ISO 287:2017 Paper and board – Determination of moisture content of a lot-Oven-drying method