

*A schematic representation
of color depth in dependence
on concentration for
reactive dyed cotton fabric*

Presented by

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ABSTRACT

- In this study dyeing of 100% cotton knit fabrics were performed by using reactive dye at different shade percentages (0.5%, 2.0%, 4.0% & 8.0%).
- Exhaust dyeing method was applied in the experiments for 100% cotton knitted fabrics.
- Two types of knitted fabric samples (single Jersey & Interlock) were taken for this experiment.
- Scouring & bleaching was carried out at 98°C for 45 minutes while dyeing was carried out at 60°C for 60 minutes.
- Reflectance (%) of the dyed fabric samples were measured after dyeing. The color strength of a dyed fabric is usually expressed by its K/S value.
- The color strength (K/S) of the dyed samples were also measured from the reflectance (%).



INTRODUCTION

- Reactive dyes are the most suitable dyestuff for the dyeing of cellulosic fibers considering its fastness properties since this dye makes a strong covalent bond with cellulose.
- Shade means the depth of color on the weight of the fabric. Shade (%) influences the reflectance (%) of the dyed fabrics. Reflectance of the surface of a material is its effectiveness in reflecting radiant energy.
- It is known to us that when reflectance is more, absorbance is less and when reflectance is less, absorbance is more.
- Color strength (K/S) is the most important parameter to test the quality measurement of a sample in terms of depth of the color dyed fabric.
- The aim of this research is to find out **the color depth in dependence on concentration of reactive dyes.**



MATERIALS AND METHODS

□ Materials

- This investigation has been carried out with single jersey of 100% cotton knitted fabric. The well scoured & bleached single jersey fabric was collected from sample dyeing machine of Orion Chem Laboratories.
- All the required dyes & chemicals were taken from the dyes & chemicals store.

METHODS:

Dyeing of RFD (Ready For Dyed) fabrics

A rapid sample dyeing machine of “Eco Dyer” was used for dyeing. Dyeing of single jersey & Interlock 100% cotton knitted fabric was done by using following recipe :

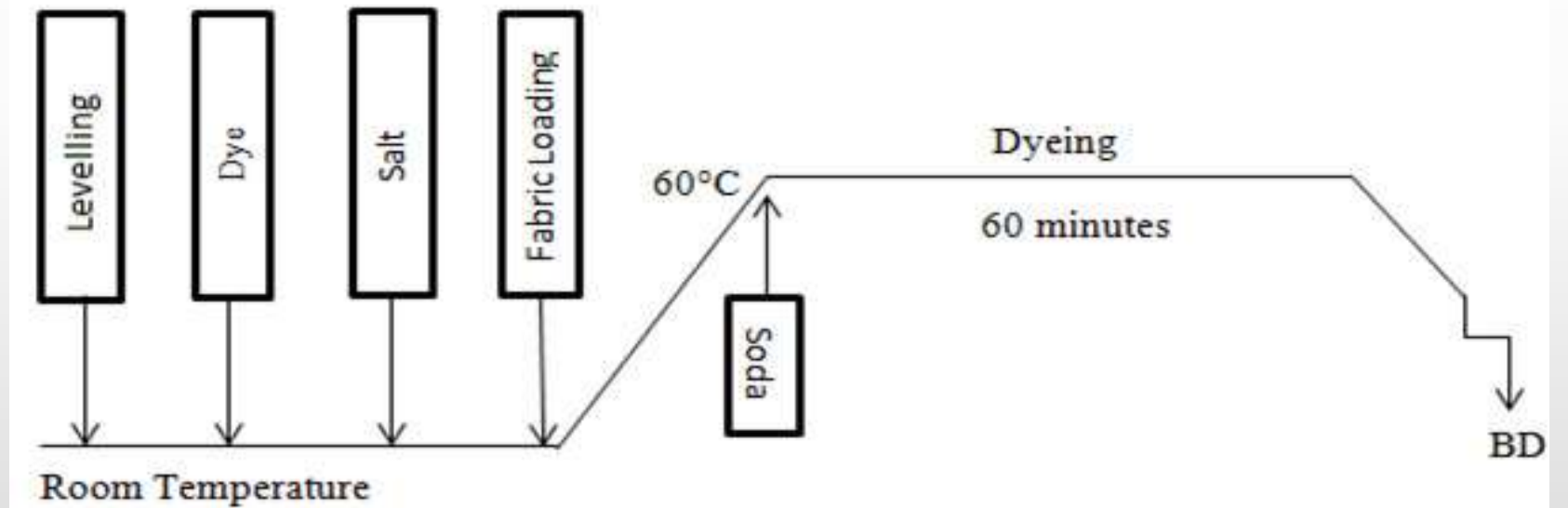
Reactobond Deep Red LW	= X%
Salt (Na_2SO_4)	= X%
Soda (Na_2CO_3)	= X%
Anticreasing agent (JingenLub ACN)	= 1.0 g/L
Levelling agent (Neucoblanc2013)	= 1.0 g/L
Sequestering Agent (Jintexyeco SQ-117)	= 0.6 g/L
Detergent (Jingen DT HLF-18)	= 0.80g/L
Sample weight	= 5gm
Time	= 60 min
Temperature	= 60°C
M:L	= 1:7
pH	= 10.5-11

USAGE OF SALT & SODA

Usage of Salt & Soda according to shade percentage

Shade (%)	Salt (g/L)	Soda (g/L)
0.5	15	8
2.0	40	12
4.0	60	20
8.0	80	20

DYEING CURVE





AFTER-TREATMENT

- After dyeing cold wash is performed for 2/3 times and normal hot wash is performed for 2/3 times followed by neutralization with acetic acid & rinsing.
- After hydro dyed samples were dried at “Rapid” hydro machine for 3 minute & the maximum temperature of the machine was 140°C.

MEASUREMENT OF REFLECTANCE (%) & COLOR STRENGTH (K/S)

➤ Reflectance (%) of the dyed fabric samples were measured by using Data color 650 TM spectrophotometer. Strength of any colorant (dyestuff / pigment) is related to absorption property. Kubelka–Munk theory gives us the following relation between reflectance and absorbance:

$$K/S = \left\{ \frac{(1-R)^2}{2R} \right\}$$

Where R is the reflectance, K is absorbance and S is the scattering. By using the above equation color strength of different samples were measured.



RESULTS AND DISCUSSION

□ Evaluation of reflectance (%) & color strength (K/S) of single jersey fabrics for Reactobond Deep Red LW :

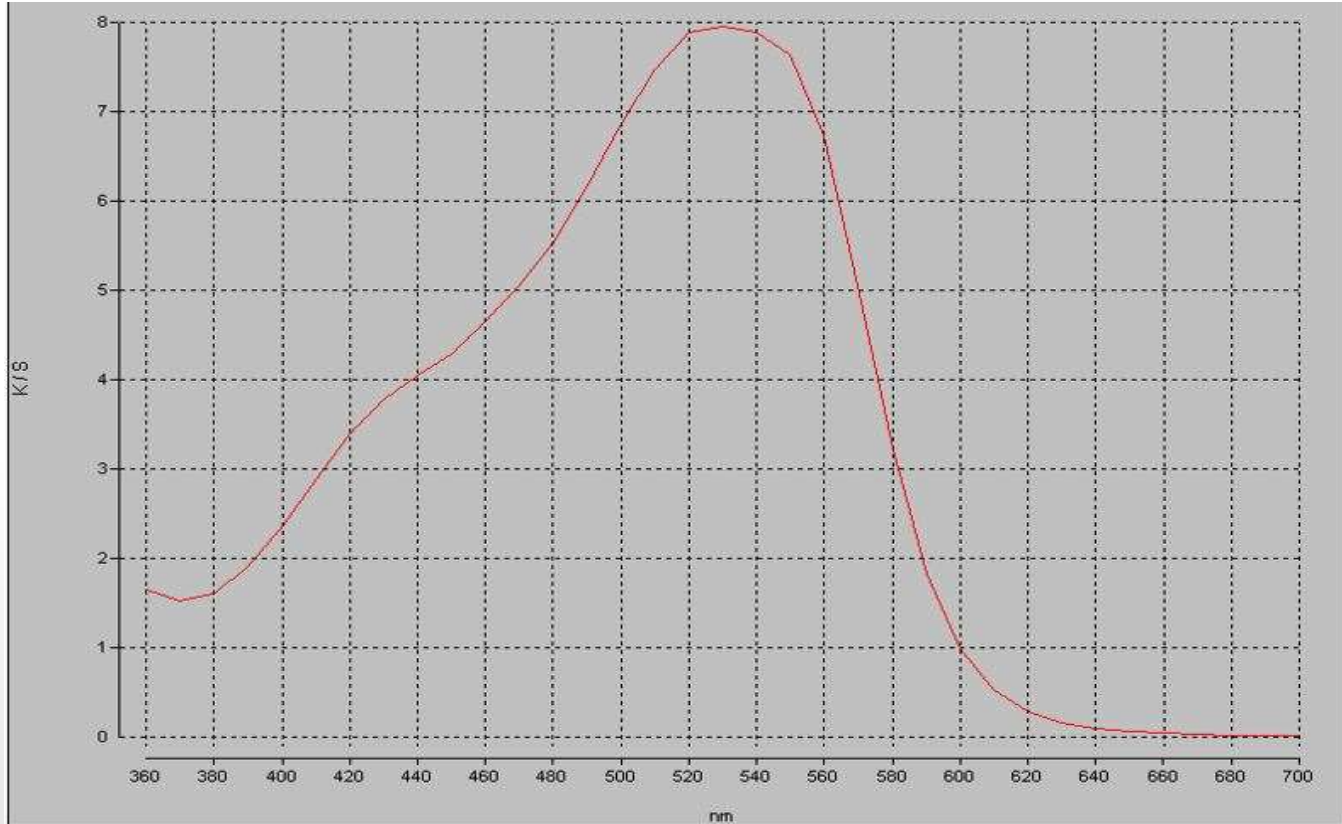
- The reflectance (%) of single jersey dyed fabric samples were evaluated.
- The following table shows the reflectance (%) and color strength (K/S) values of single jersey fabric samples for different shade (%).
- For 0.5% shade (%) the reflectance (%) was 5.60% and the color strength (K/S) value was 7.95. For higher shade (%) i.e. 4%, the reflectance (%) and color strength (K/S) was lower i.e. 2.08% and 23.10 respectively.

Analysis of reflectance (%) & color strength (K/S) For R. Deep Red LW

Fabric Type	Used Dyes	Shade (%)	Reflectance (%)	Color Strength (K/S)
Interlock	Reactobond Deep Red LW	0.5 %	5.60	7.95
		2.0 %	3.20	14.60
		4.0 %	2.08	23.10

The following table shows that the increasing of shade (%), the reflectance (%) is decreasing where the color strength (K/S) is increasing.

Reactobond Deep Red LW= 0.5%



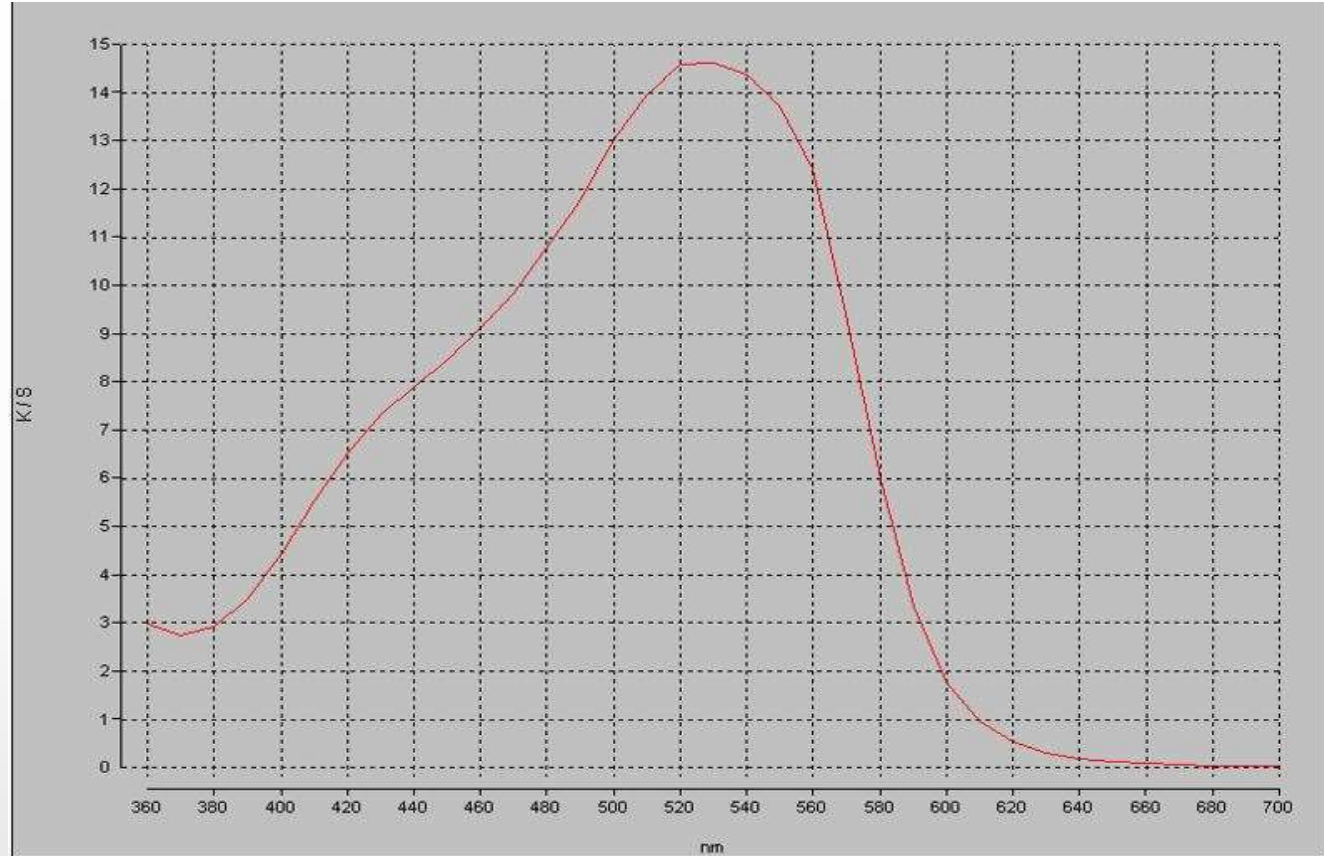
Standard: %R
Rb.Deep Red LW=0.50%

%R / %T Plot

K/S (Absorb.)

400-450 nm	15.16	13.07	11.53	10.59	10.01	9.53
460-510 nm	8.90	8.32	7.71	7.03	6.38	5.92
520-570 nm	5.64	5.60	5.65	5.81	6.49	8.33
580-630 nm	12.01	18.32	27.06	37.02	47.17	56.46
640-690 nm	64.22	70.27	74.50	77.52	79.74	81.16
700 nm	82.29					

Reactobond Deep Red LW= 2.0%



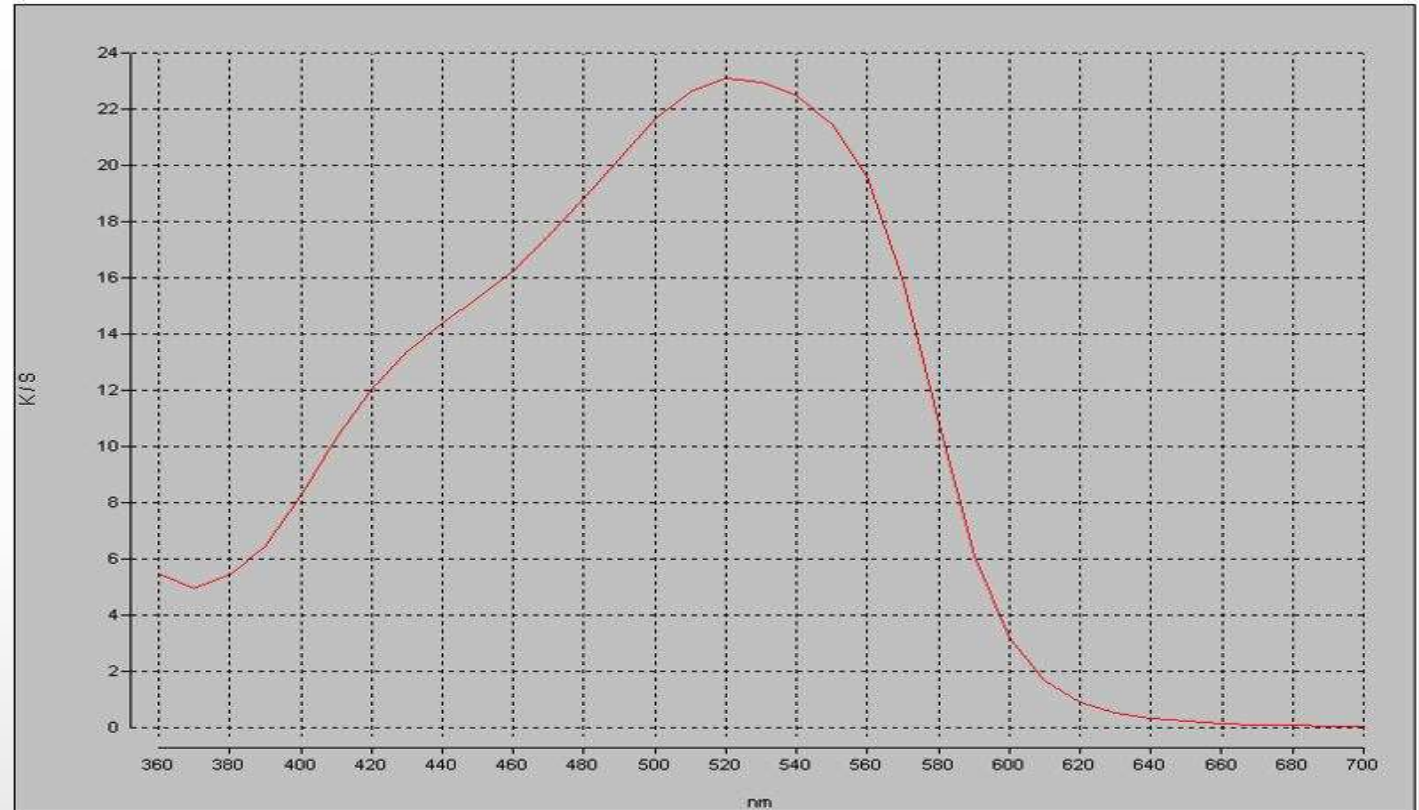
Standard: %R
Rb.Deep Red LW=2%

%R / %T Plot

K/S (Absorb.)

400-450 nm	9.27	7.69	6.68	6.03	5.65	5.30
460-510 nm	4.96	4.63	4.25	3.93	3.57	3.35
520-570 nm	3.21	3.20	3.26	3.40	3.73	4.81
580-630 nm	7.18	11.66	18.67	27.48	36.94	46.02
640-690 nm	54.05	60.84	66.18	70.37	73.72	75.87
700 nm	77.85					

Reactobond Deep Red LW= 4.0%



Standard: %R
Rb.Deep Red LW=4%

%R / %T Plot

K/S (Absorb.)

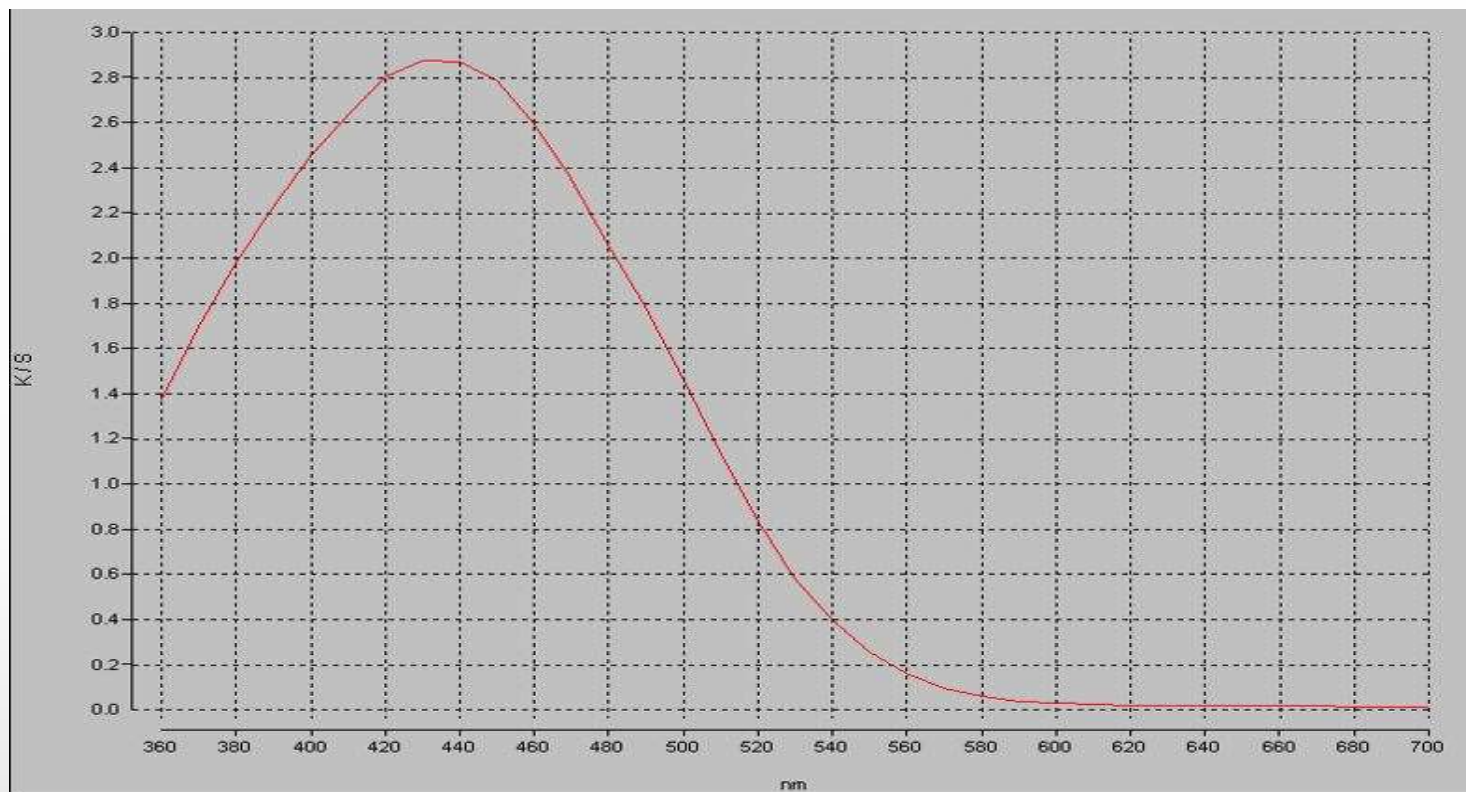
400-450 nm	5.40	4.42	3.84	3.47	3.26	3.07
460-510 nm	2.90	2.71	2.52	2.36	2.21	2.12
520-570 nm	2.08	2.09	2.13	2.23	2.43	2.94
580-630 nm	4.25	7.06	12.13	19.30	27.82	36.44
640-690 nm	44.38	51.37	57.21	62.12	66.22	68.93
700 nm	71.67					

Analysis of reflectance (%) & color strength (K/S) For R. Ultra Yellow RGB

Fabric Type	Used Dyes	Shade (%)	Reflectance (%)	Color Strength (K/S)
Single Jersey	Reactobond Ultra Yellow RGB	0.5 %	13.12	2.87
		2.0 %	4.18	11.00
		4.0 %	2.76	17.05

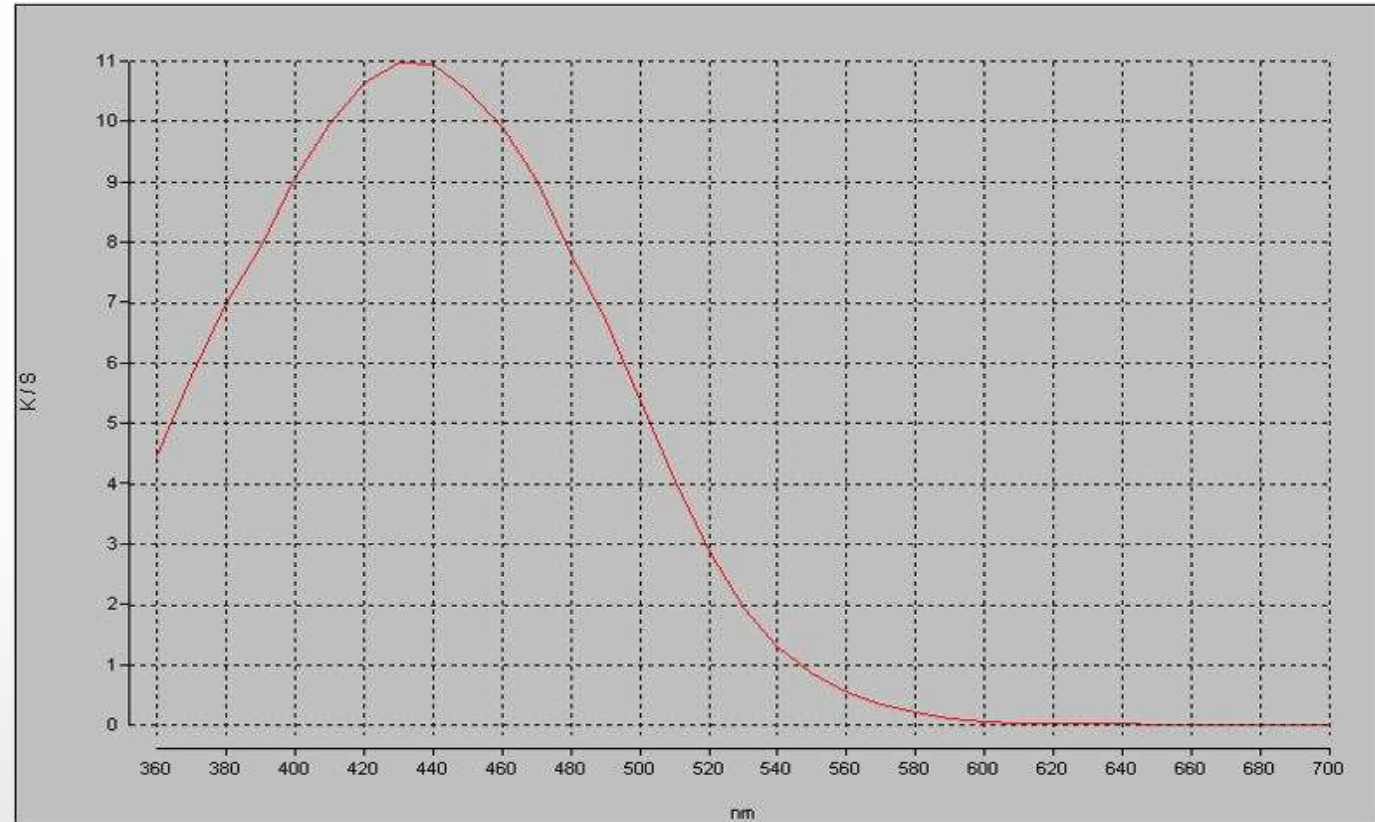
The following table shows that the increasing of shade (%), the reflectance (%) is decreasing where the color strength (K/S) is increasing.

Reactobond Ultra Yellow RGB= 0.5%



Standard: %R			%R / %T Plot		K/S (Absorb.)	
Rb.Ul.Yellow RGB=0.50%						
400-450 nm	14.77	14.02	13.39	13.12	13.15	13.45
460-510 nm	14.19	15.27	16.81	18.55	21.22	24.91
520-570 nm	29.69	35.66	42.07	49.44	57.26	64.49
580-630 nm	70.68	75.55	78.65	80.42	81.55	82.12
640-690 nm	82.57	83.07	83.24	83.48	83.64	83.68
700 nm	83.85					

Reactobond Ultra Yellow RGB= 2.0%



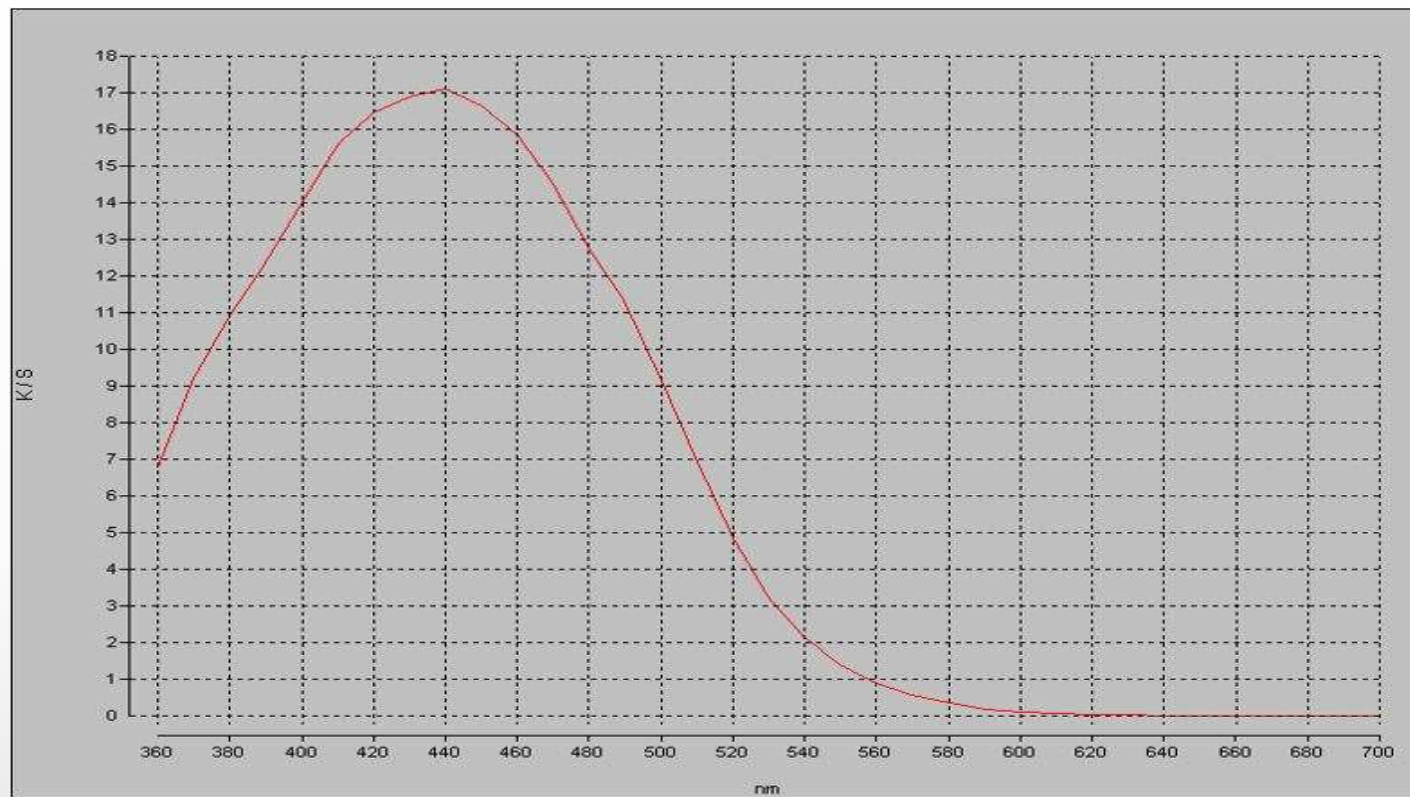
Standard: %R
Rb.UI.Yellow RGB=2%

%R / %T Plot

K/S (Absorb.)

400-450 nm	4.97	4.57	4.31	4.18	4.20	4.35
460-510 nm	4.60	5.00	5.70	6.53	7.90	10.03
520-570 nm	13.12	17.51	22.73	29.03	36.24	44.21
580-630 nm	52.82	61.63	69.17	74.62	78.14	80.13
640-690 nm	81.40	82.36	82.77	83.18	83.42	83.50
700 nm	83.66					

Reactobond Ultra Yellow RGB= 4.0%



Standard: %R
Rb.Ul.Yellow RGB=4%

%R / %T Plot

K/S (Absorb.)

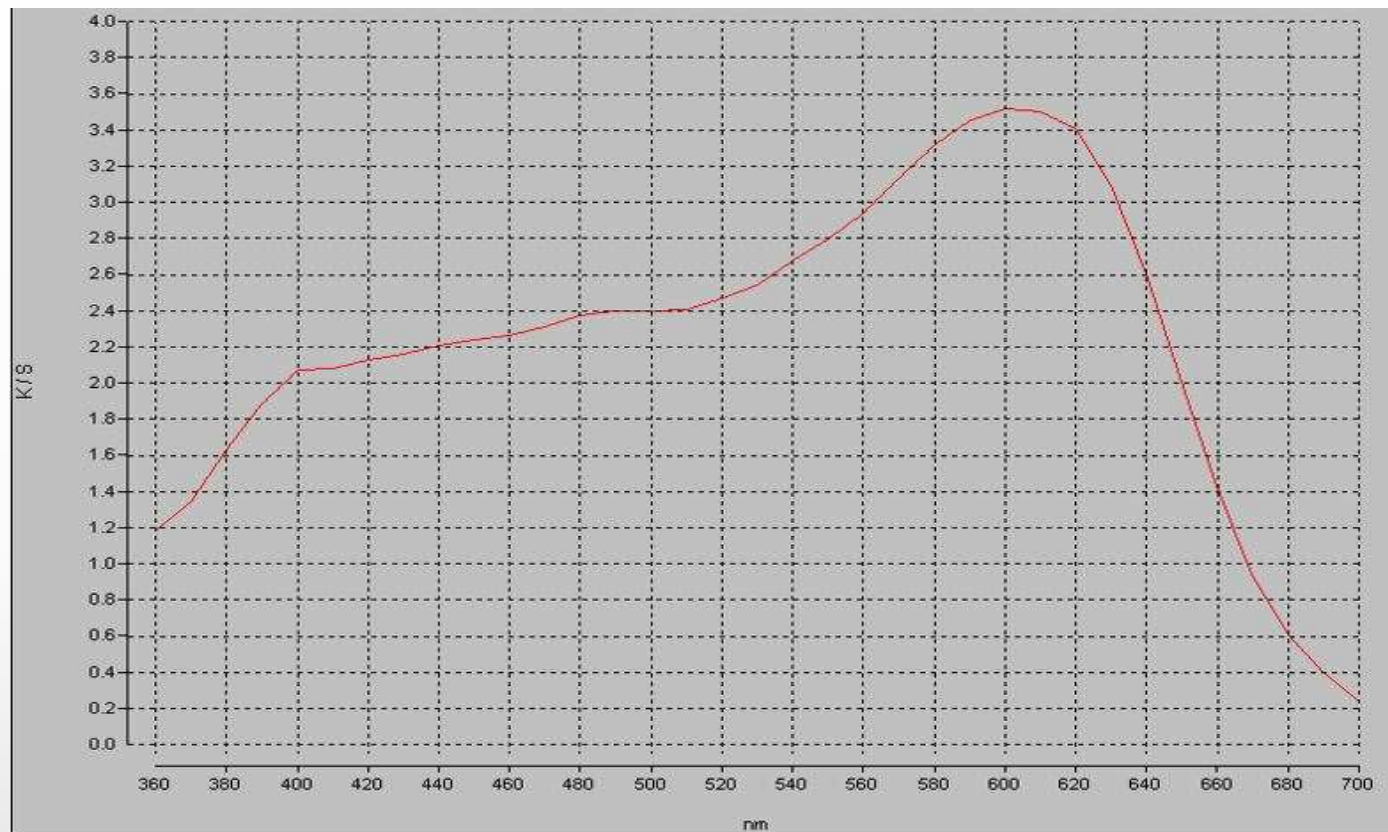
400-450 nm	3.32	3.01	2.87	2.80	2.76	2.84
460-510 nm	2.97	3.22	3.63	4.06	4.95	6.34
520-570 nm	8.59	11.97	16.37	21.98	28.65	36.11
580-630 nm	44.37	53.48	62.35	69.60	74.82	78.02
640-690 nm	80.06	81.50	82.24	82.80	83.18	83.37
700 nm	83.62					

Analysis of reflectance (%) & color strength (K/S) For Reactobond Black DN

Fabric Type	Used Dyes	Shade (%)	Reflectance (%)	Color Strength (K/S)
Interlock	Reactobond Black DN	0.5 %	11.22	3.50
		2.0 %	3.53	13.10
		4.0 %	2.28	20.90
		8.0 %	1.74	27.80

The following table shows that the increasing of shade (%), the reflectance (%) is decreasing where the color strength (K/S) is increasing.

Reactobond Black DN = 0.5%



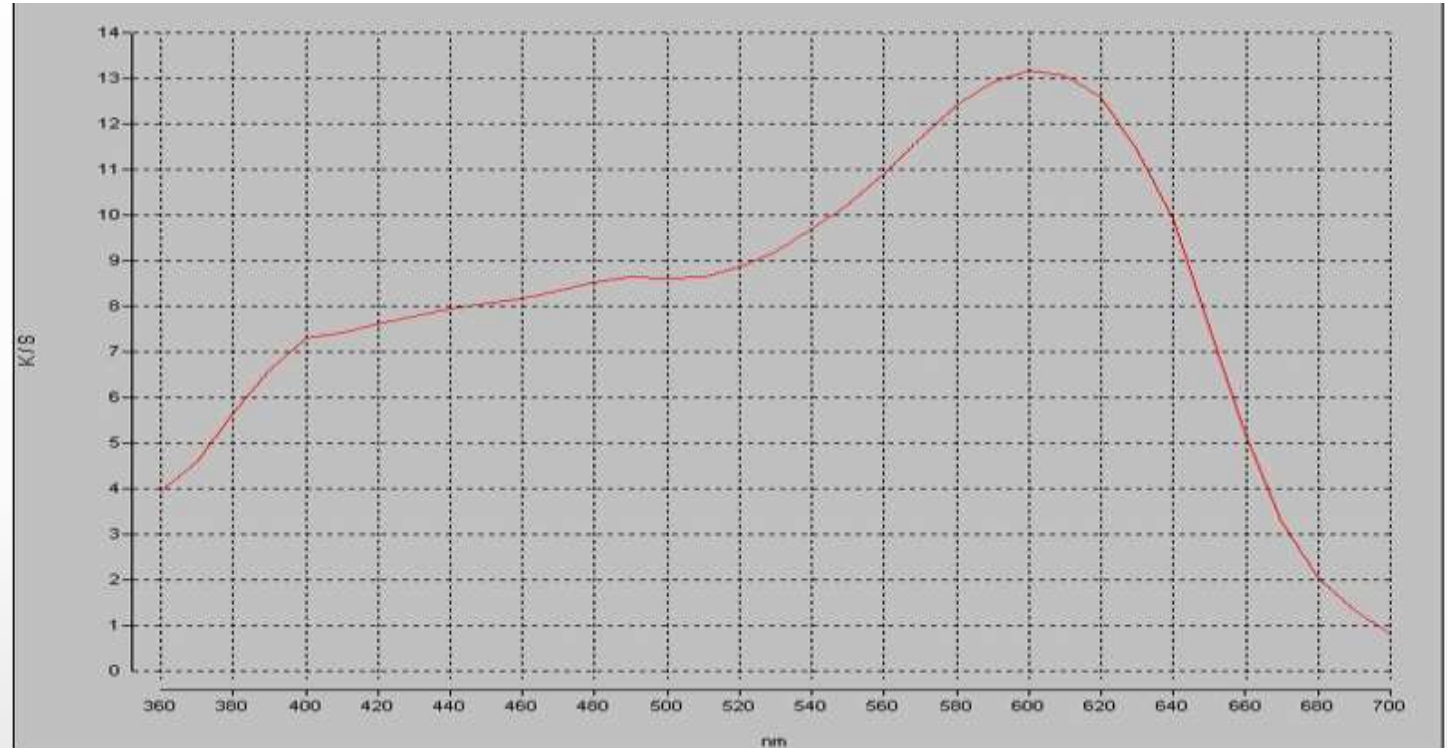
Standard: %R
Rb.Black DN=0.50%.

%R / %T Plot

K/S (Absorb.)

400-450 nm	16.74	16.67	16.42	16.23	15.98	15.81
460-510 nm	15.69	15.47	15.15	15.05	15.04	15.00
520-570 nm	14.73	14.43	13.87	13.42	12.91	12.29
580-630 nm	11.74	11.38	11.22	11.25	11.50	12.38
640-690 nm	14.14	17.12	21.56	27.66	35.07	41.92
700 nm	50.81					

Reactobond Black DN = 2.0%



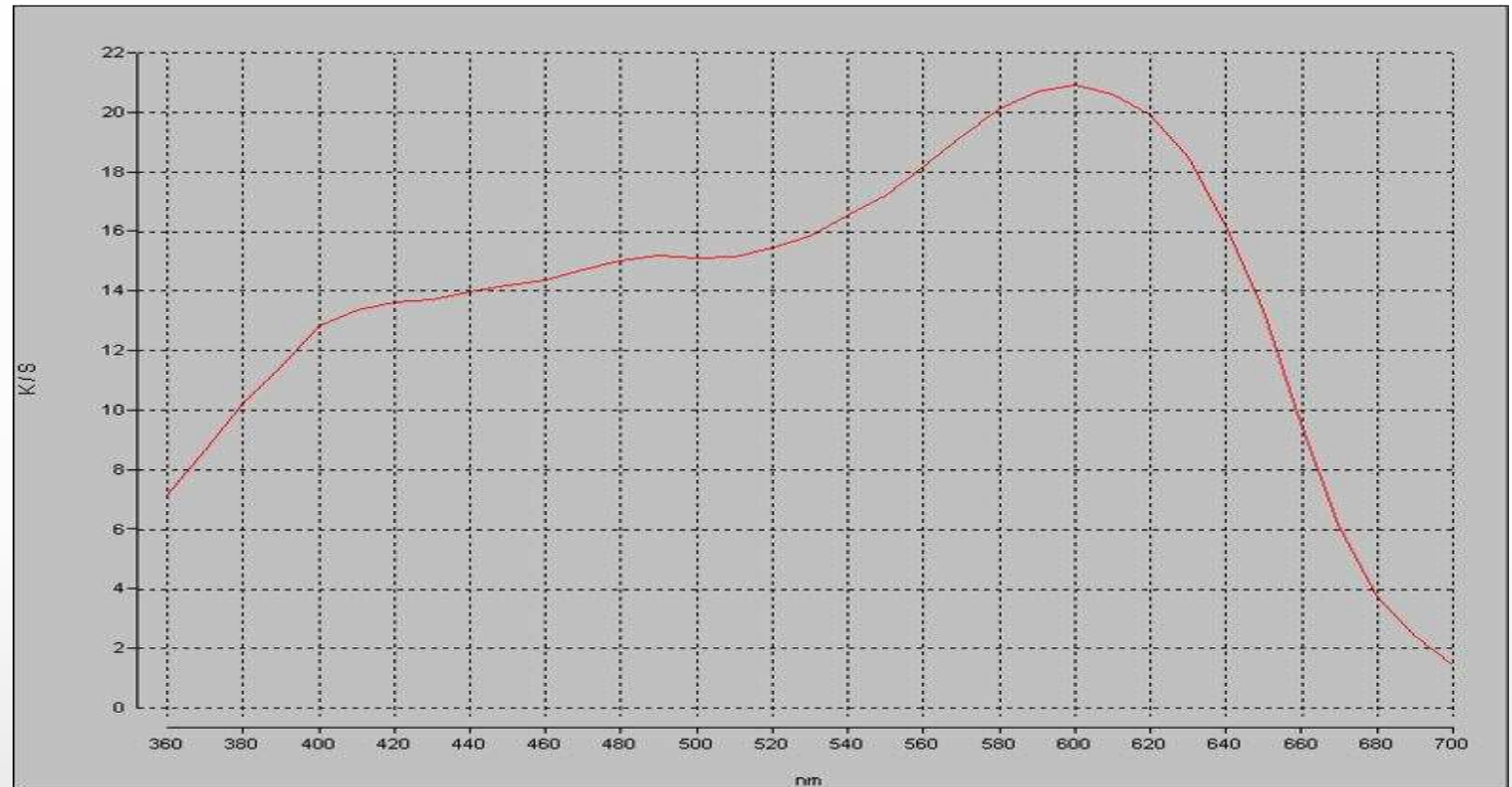
Standard: %R
Rb.Black DN=2%.

%R / %T Plot

K/S (Absorb.)

400-450 nm	6.03	5.95	5.82	5.72	5.61	5.53
460-510 nm	5.47	5.36	5.25	5.20	5.21	5.20
520-570 nm	5.08	4.92	4.68	4.47	4.22	3.95
580-630 nm	3.73	3.60	3.53	3.56	3.69	4.04
640-690 nm	4.59	5.85	8.10	11.73	16.95	22.43
700 nm	30.11					

Reactobond Black DN = 4.0%



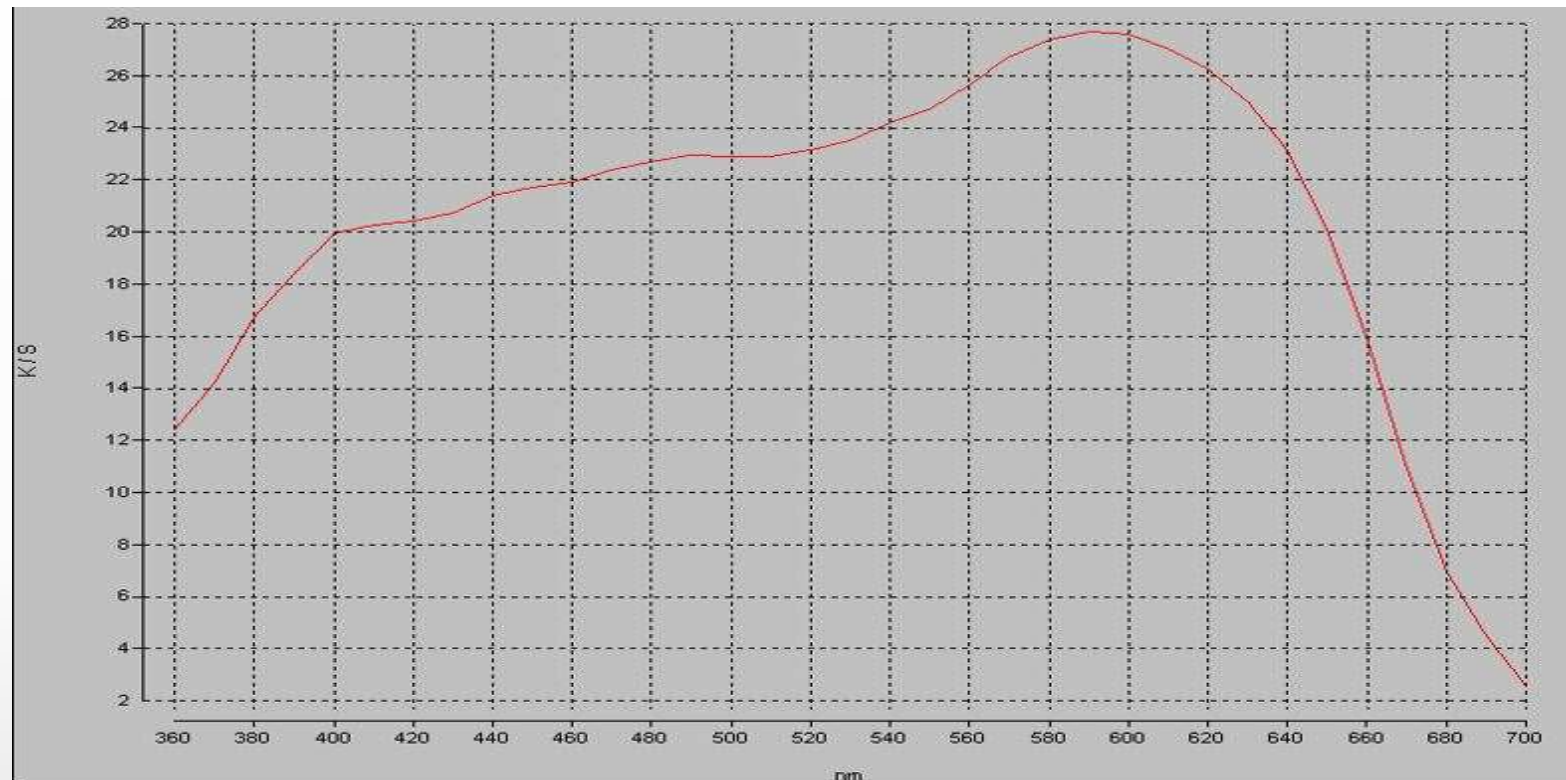
Standard: %R
Rb.Black DN=4%.

%R / %T Plot

K/S (Absorb.)

400-450 nm	3.62	3.48	3.42	3.41	3.35	3.29
460-510 nm	3.25	3.19	3.13	3.09	3.10	3.10
520-570 nm	3.04	2.97	2.85	2.75	2.61	2.48
580-630 nm	2.37	2.31	2.28	2.32	2.39	2.56
640-690 nm	2.91	3.49	4.75	7.02	10.69	14.95
700 nm	21.49					

Reactobond Black DN = 8.0%



Standard: %R
Rb.Black DN=8%.

%R / %T Plot

K/S (Absorb.)

400-450 nm	2.39	2.35	2.34	2.30	2.23	2.20
460-510 nm	2.18	2.14	2.11	2.09	2.09	2.09
520-570 nm	2.07	2.04	1.99	1.95	1.88	1.80
580-630 nm	1.76	1.74	1.75	1.79	1.84	1.92
640-690 nm	2.07	2.37	2.93	4.14	6.32	9.19
700 nm	14.26					

Analysis of Color Depth (%) & Color Strength (K/S)

Dyes	Shade%	Reflectance%	Color Strength
Reactobond Deep Red LW	0.5%	5.60	7.95
	2.0%	3.20	14.60
	4.0%	2.08	23.10
Reactobond Ultra Yellow RGB	0.5%	13.12	2.87
	2.0%	4.18	11.00
	4.0%	2.76	17.05
Reactobond Black DN	0.5%	11.22	3.50
	2.0%	3.53	13.10
	4.0%	2.28	20.90

Graphical representation of Color Depth (%) & Color Strength (K/S)





CONCLUSION:

- Reflectance (%) of a dyed fabric is greatly influenced by shade (%) of that dyed fabric.
- At the same time reflectance (%) also influenced by the absorption properties of a dyed fabric.
- When shade (%) is higher, the absorption of dye by the substrate is also higher which results in lower reflectance (%) value.
- At the same time when shade (%) is lower, the absorption of dye by the substrate is also lower which results in higher reflectance (%) value.
- Color strength (K/S) of the dyed fabric also influenced by the increase of reflectance (%) value.
- In this research a relation was found among shade (%) & reflectance (%) & Color Strength (K/S). When shade (%) increase, reflectance (%) is decreasing & color strength that means color depth (K/S) is increasing.

Thank You
All

