

SHADE VARIATION- A MAJOR OBSTACLE OF DOUBLE PLY COTTON YARN DYEING IN CONE FORM

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Abstract— The causes of package to package and within a package shade variation problem of double ply cotton yarn dyeing in cone form has been investigated during November 2006 to August 2009 in a well equipped modern yarn dyeing factory. It has been found that the main causes of unlevel dyeing in different position of a dyed cone and in the cones themselves are the package to package and within package density variation and disturbance of dyeing liquor flow at different stage of dyeing process. A method termed as 'reverse tension mechanism' has used to maintain even density within each single package and also at packages. Effective factors and techniques are suggested to maintain uniform flow of liquor. Beside these two main causes, improper loading, dyeing conditions (such as salt dissolving, soda dosing, color filtration), fixing and finishing process and final drying have been found as some other key factors for level dyeing. This paper is to discuss and give fruitful suggestions on these controlling features for ensuring level dyeing.

Key words: Unlevel dyeing, Portion density, Reverse tension mechanism, flow disturbance, Package to package & within package.

1. Introduction

Bangladesh is one of the developing countries in the world. Natural calamities are its common affair. Its natural resources are limited. Now a days, Apparel and Textiles are the most important and exportable industrial product in Bangladesh. After the phase out of multi fiber agreement the global markets are becoming very competitive day by day. Quality products are the key to survive & success. But the quality of a dyed yarn cheese greatly hamper by the shade

variation ie, unlevel dyeing problem. Package to Package and within package

shade variation problem is the major technical difficulty for all the yarn dyeing factories of Bangladesh. The problem causes lots of suffering for the industries deling with fabric manufacturing by the dyed yarn in solid color as it leads to different depth of shade (fig-1a,b) at different portion of the fabric. Rejecting the unlevel portion or re-correction of levelness of shade by washing or redyeing is definitely not an economically feasible step to minimize the problem as it causes a lot of time and money. The current research work tried to identify the possible causes of this type of problem and then suggestions have made to overcome them. The paper is narrating the possible causes of unlevel dyeing in different segment of a single cone and the cones themselves at each stage of yarn dyeing step by step along with the realistic ways to overcome them.

2. MATERIALS AND METHOD

“SSM PSC W/D DIGICONE Preciflex™ precision package winder” soft winding machine is used for preparing yarn packages. Winding tension has adjusted keeping Speed, Package diameter, Package weight as usual for all types of yarn. Yarn types used are 32/2 and 20/2 combed cotton yarn. Vertical “THIES” package dyeing machine is used associated with “ORGATEX” software for measuring flow pressure, controlling flow direction and monitoring the overall dye liquor flow velocity. STALAM RF dryer is used for the drying purpose. DATACOLOR spectrophotometer is used to measure the levelness of the dyed materials. Five different area of package

Manuscript received July 9, 2010. This work was financed by the Colormaster Ltd, Bangladesh.

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dyeing sequence have been selected for the investigation. This are-1. Soft winding parameters 2.Package density 3.Liquor flow 4.Dyeing technique 5. After dyeing process.

Samples had collected from soft winding section at regular basis. 'Portion density' i.e, density at different position of each single package and package to package density i.e, density of each individual package were checked. Variations are monitored. Around 200 trials were done with soft winding machine's settings of varying winding tension, keeping other parameters such as Diameter, weight, traverse length, winding speed, winding angle nearly same at every trial to achieve even density within a package and package to package. An effective method termed as reverse tension mechanism has been suggested. Suggestions have also made on the basis of trials for suitable packages holder and proper loading of packages on the dyeing carrier.

ORGATEX software had used to find out the possible causes that interrupt in continuous flow of liquor at constant velocity within packages by monitoring the liquor flow. Effective factors are discussed and techniques are suggested to minimize unlevel by controlling different dyeing parameter such as salt, soda and color addition.



Fig:-1(a): Unlevel yarn packages, which causes shade variation in different position of a knitted fabric.

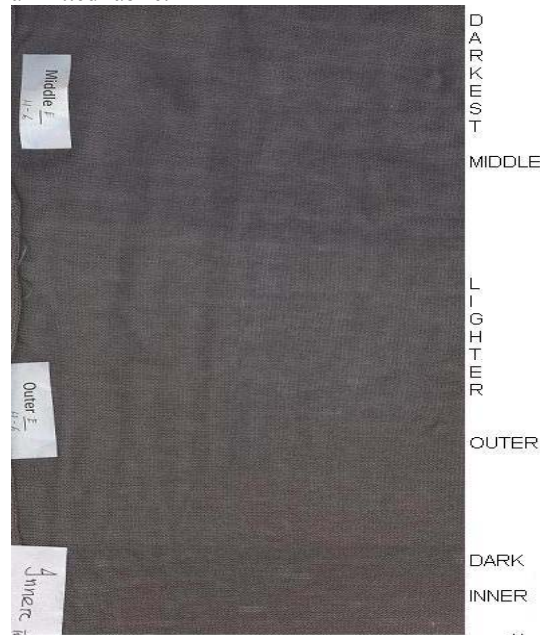


Fig 1(b):- Shade variation produced in the fabric due to the unlevelness of the dyed yarn package.

3. RESULTS AND DISCUSSION

3.1 Establishing evenly dense pre-dyeing package:

"Well wound is half dyed". It is required to wind the yarns evenly in order to bring the packages into even contact with dye liquor. Uneven tension causes uneven package density which in turn results unevenness in subsequent processes such as dyeing^[10]. Nevertheless it has not been possible to obviate unevenness in winding density, and

consequently, it has been extremely difficult to pursue even dyeing characteristics, since a dye liquor flows smoothly through soft portions of the cheeses, but is difficult to flow through high-density portions of the cheeses^[9]. So It needs to ensure uniform package density both at different portion of a package (density within the package) & among the packages themselves to avoid channeling^[6]. Package density are usually range of 0.25 to 0.5 kg/l for staple fiber^[3]. But it is necessary for all the packages of a

batch to be uniformly dense in packages themselves and within one package. All packages must be as identical as possible and the yarn tension throughout the package must be even^[8]. To check density within a package, density had checked at

A typical Soft winding machine setting can be as follows:

- 800 – 600 – 800;
 - 35% - 25% and 80% at 70s;
 - 145 mm – 19000 m – 180 mm;
 - 50 % overfeed;
 - 4.434 – 7.434 (Precision winding)
 - or 16⁰ – 12⁰ (DIGI winding)
- Here,
- 800 = The required production speed.
 - 600 = The required initial speed
 - 800 = The required full package speed or final speed.
 - 35% = Empty tube yarn tension factor
 - 25% = Full package yarn tension factor
 - 80% = Initial yarn tension factor
 - 70s = Initial yarn tension time.
 - 145 mm = The required starting traverse for determining the winding length
 - 19000 m = The required length of the yarn on the package
 - 180 mm = The required diameter results from the empty tube diameter & the wound yarn.

Overfeed = This parameter determine the difference between feeder speed and production speed. (eg: 50% means the feeder speed is 1.5 times as large as the production speed ie overfeed,

10 to 15 portion of a soft wounded package.

The experiment had run for both finer count ie, 32/2 and coarse count ie, 20/2 cotton yarn.

0% means the feeder speed and the production speed are identical and -100% means the feeder stands still).

4.434 = Winding ratio for precision winding

7.434 = Initial winding ratio for precision winding

16⁰ = Winding angle for DEGI cone winding

12⁰ = Initial winding angle for DIGI cone winding.

More than 200 trials have been run to find the actual machine setting as the package to package and within package density variation during soft winding can be reduced. A new technique termed as reverse tension mechanism^[11], where the initial winding tension is lower than the final tension, has used to produce soft winding package with even density where density variation is near 1%. The results are shown in the tables & charts below-

3.1.1 Data comperisn:

3.1.1.1 For finer count

Target package wt = 1170gm, Target package density = 0.370 gm/cc

The diameter of package holder is 6.8 cm and it is constant for all the trials.

Table: 1.- 32/2 combed yarn (Density in different portion in a package, i.e. portion density)

Reverse tension mechanism							Common or Normal mechanism						
M/C setting	Position	Package parameter				C V %	M/C setting	Position	Package parameter				C V %
		Pkg Dia (cm)	Pkg height (cm)	Pkg wt (gm)	density (gm/cc)				Pak Dia (cm)	Pkg height (cm)	pkg wt (gm)	density (gm/cc)	
1000-700-800	Outer	17.9	14.6	1180	0.376	1000-700-800	Outer	17.9	14.6	1172	0.373	2.2	
40%-48% & 80% at 70s		17.3	14.8	1100	0.374	52%-48% & 70% at 70s		17.3	14.8	1095	0.372		
		16.4	14.9	980	0.376			16.7	14.8	1015	0.376		
150mm-32500m-185mm	Middle	15.7	15.2	900	0.377	150mm-32400m-185mm	Middle	15.9	15	915	0.376		
		15.3	15.2	845	0.377			14.8	15	765	0.376		
		14.9	15.2	794	0.379			14	15	670	0.38		
16°-12°	Inner	13.9	15.3	670	0.38	16°-12°	Inner	12.9	15.2	545	0.38		
		13	15.3	562	0.381			12.2	15.2	465	0.38		
35% overfeed	Inner	10.8	15.4	323	0.38	30% overfeed	Inner	9.5	15.4	208	0.391		
		9.9	15.4	239	0.382			8.5	15.3	125	0.4		

Reverse tension mechanism							Common or Normal mechanism						
M/C setting	Position	Package parameter				CV %	M/C setting	Position	Package parameter				CV %
		Pkg Dia (cm)	Pkg height (cm)	Pkg wt (gm)	density (gm/cc)				Pak Dia (cm)	Pkg height (cm)	pkg wt (gm)	density (gm/cc)	
1000-700-800	O	17.7	14.4	1145	0.379	0.9	1000-700-800	O	17.4	14.8	1140	0.383	2.3
40%-48% & 80% at 70s		17.8	14.6	1175	0.379		52%-48% & 70% at 70s		17.9	14.6	1165	0.371	
		U	17.9	14.4	1160				0.374	U	17.9	14.4	
150mm-32500m-185mm	T	17.8	14.6	1165	0.376	150mm-32400m-185mm	T	17.8	14.6	1165	0.376		
	E	17.6	14.6	1155	0.382		E	17.5	14.5	1155	0.39		
	R	17.8	14.6	1156	0.373		R	17.8	14.6	1156	0.373		
16°-12°	R	17.8	14.5	1150	0.373	16°-12°	17.8	14.4	1150	0.376			
35% overfeed		17.7	14.5	1160	0.382		17.3	14.6	1160	0.4			
		17.8	14.5	1165	0.378		17.8	14.4	1165	0.381			
		17.6	14.6	1124	0.372			17.6	14.6	1124	0.372		

3.1.1.2 For coarser count

Target package wt = 1120gm, Target package density = 0.337 gm/cc

The diameter of package holder is 6.8 cm and it is constant for all the trials

Reverse tension mechanism							Common or Normal mechanism						
M/C setting	Position	Package parameter				CV %	M/C setting	Position	Package parameter				CV %
		Pkg Dia (cm)	Pkg height (cm)	Pkg wt (gm)	density (gm/cc)				Pak Dia (cm)	Pkg height (cm)	pkg wt (gm)	density (gm/cc)	
1000-700-800	Outer	17.9	14.6	1123	0.357	2.1	1000-700-800	Outer	17.9	14.5	1120	0.359	4.9
48%-56% & 80% at 70s		17.4	14.6	1070	0.364		56%-52% & 70% at 70s		17.2	14.6	1027	0.359	
		16.8	15	985	0.354				16.7	14.7	960	0.358	
145mm-18100m-181mm	Middle	15.7	15.2	850	0.356	150mm-18100m-185mm	Middle	15.6	14.8	818	0.357		
	14.8	15	715	0.351	14.5		15	698	0.361				
	13.6	15.2	582	0.352	14		15	620	0.352				
16°-12°	Inner	11.5	15.3	371	0.359	16°-12°	12	15.4	402	0.34			
		10.4	15.4	269	0.359		10.8	15.4	301	0.354			
		9.4	15.4	187	0.367		9.7	15.4	227	0.392			
35% overfeed		8.1	15.4	88	0.376	30% overfeed		8.6	15.3	134	0.402		

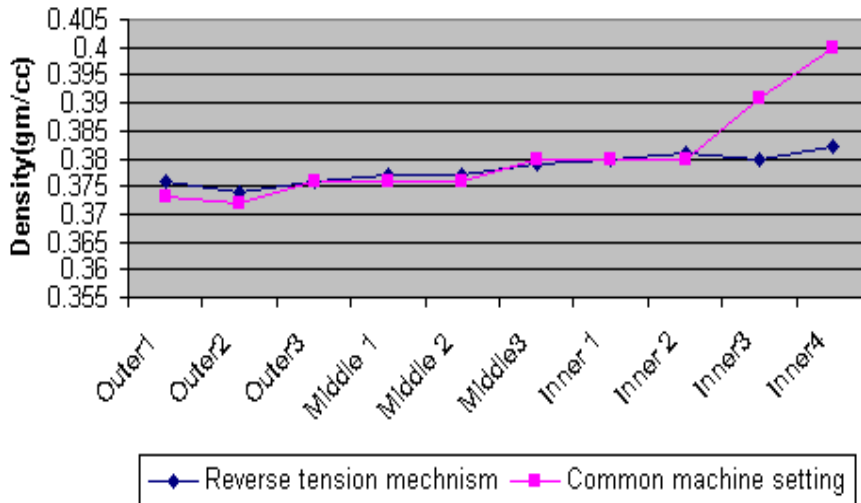
Table- 4 :- 20/2 combed yarn (Density of ten different package)

Reverse tension mechanism							Common or Normal mechanism						
M/C setting	Position	Package parameter				CV %	M/C setting	Position	Package parameter				CV %
		Pkg Dia (cm)	Pkg height (cm)	Pkg wt (gm)	density (gm/cc)				Pak Dia (cm)	Pkg height (cm)	pkg wt (gm)	density (gm/cc)	
1000-700-800	O	17.8	14.6	1125	0.363	1000-700-800	O	17.9	14.5	1142	0.366	2.2	
48%-56% & 80% at 70s		17.8	14.5	1122	0.364	56%-52% & 70% at 70s		17.6	14.6	1125	0.372		
	U	17.7	14.5	1133	0.373		U	17.8	14.6	1122	0.362		
		17.9	14.6	1129	0.359			17.6	14.5	1133	0.378		
145mm-18100m-181mm	T	17.8	14.4	1124	0.367	150mm-18100m-185mm	T	17.5	14.6	1129	0.379		
		17.9	14.6	1141	0.363			17.7	14.4	1133	0.375		
	E	17.6	14.5	1132	0.377		E	17.4	14.6	1141	0.388		
16°-12°		17.7	14.5	1124	0.37	16°-12°		17.4	14.5	1135	0.389		
35% overfeed	R	17.5	14.6	1126	0.378	30% overfeed	R	17.6	14.5	1124	0.375		
		17.6	14.6	1144	0.379			17.6	14.5	1144	0.381		

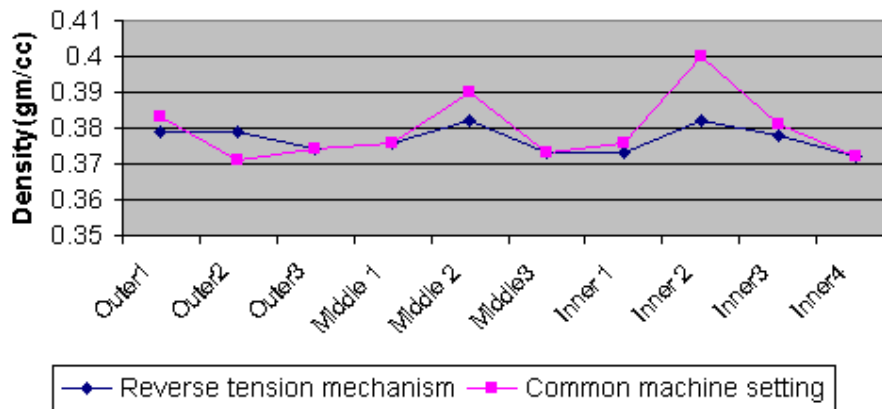
3.1.2 Graphical comparison

The variation of package density can be easily understand by the following graphs prepared on different density at different position of a soft wounded package and dessity of different soft wounded yarn packages themselves. The packages wound by the reverse tension mechanism performed lower density variation by presenting less scattered graphs.

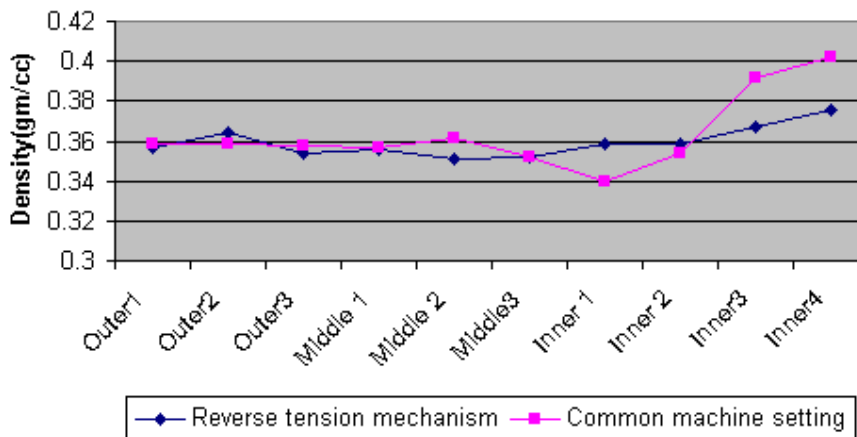
Density variation within a package(32/2)



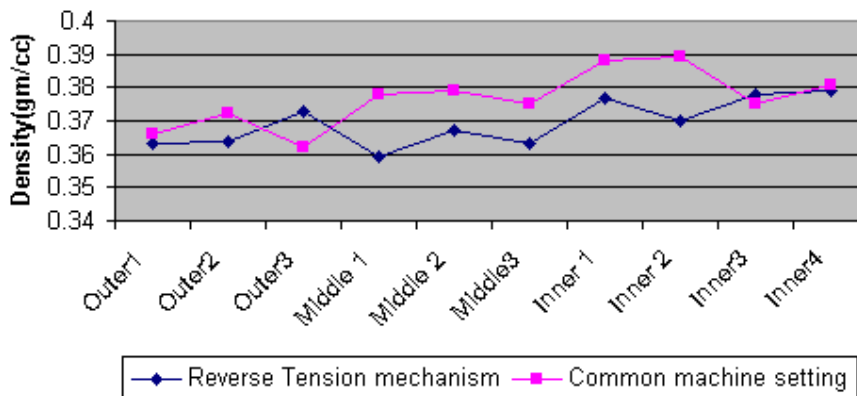
**Package to Package density variation
(32/2)**

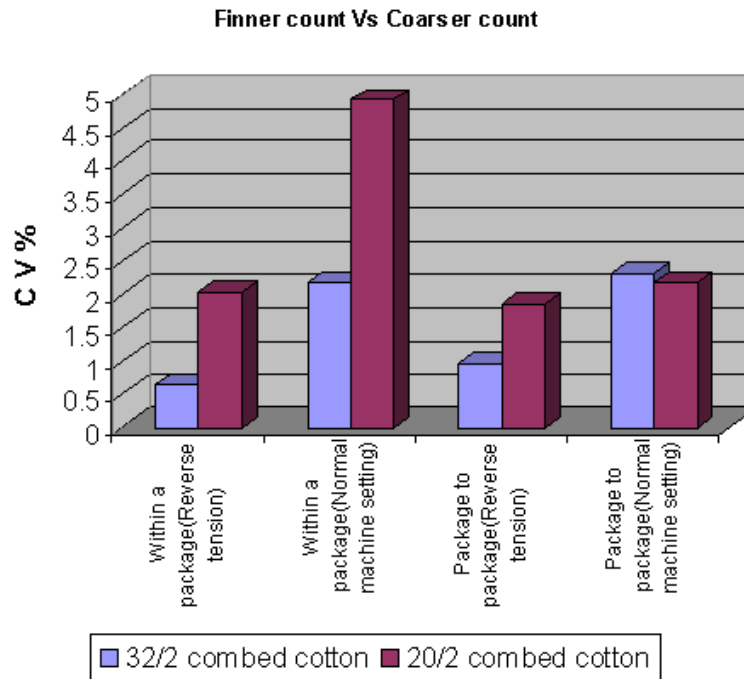


Density variation within a package(20/2)



**Package to package density variation
(20/2)**





3.1.3 Discussion on tables and graphs

The tables above shows that the conventional machine setting causes more density variation (cv is more than 2%) than the controlled machine setting i.e., in reverse tension machine settings (cv is less than 1%). The density vary from 0.373 to 0.400 gm/cc within package and 0.371 to 0.400 gm/cc package to package for finer count whether it vary from 0.374 to 0.382 gm/cc within package and 0.372 to 0.382 gm/cc package to package for finer count with newly established 'reverse tension mechanism' machine settings. Again within package density vary from 0.352 to 0.402 gm/cc package to package density vary from 0.362 to 0.389 gm/cc for coarser count with conventional machine setting whether in case 'reverse tension mechanism' machine settings, it varies from 0.351 to 0.376 gm/cc within package and 0.359 to 0.379 gm/cc package to package. Thus the main density problem of soft winding can be controlled.

The key findings from the chart can summarized as follow-

- ✓ Within a single package, the density variation is high at inside and out side portion of a package than the middle of the package.
- ✓ Density variation is more in the packages themselves than the different portion of a single package.
- ✓ In both cases, it is possible to maintain the density variation within acceptable limit by controlling and improving the machine setting as like reverse tension mechanism.
- ✓ Coarser count yarn provides more density variation (higher CV %) than the finer count with equal machine setting.

3.1.4 Other considering factors

Following factors are also founded important considering factors to build perfect soft winding package-

- I) Separating nearly same diameter packages in different stake and loaded same diameter packages in the same spindle.
- II) Removing package with faulty shape or unbalanced package shape.

- III) Proper handling of soft winding package during unloading from soft winder, storage and at loading in dyeing carrier.
- IV) To make rounded outer-line (molded outer line) of soft package instead of edged outer-line in case of DIGI cone winding

3.2 Discussion on Package holder

Working and finding out suitable package holder's shape and its specification and category is a influencing factor for level dyeing. Commonly two types of packages holders are available – metallic spring type and rigid plastic tube type (fig 2a, b). A spring type package holder has advantage of minimizing within

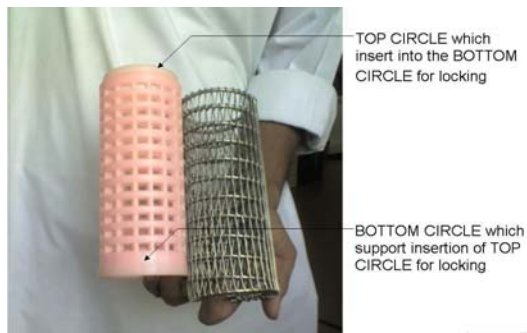


Fig: 2: (a) plastic tube type and metallic spring type soft winding package holder

package density variation. During pressing (fig-2c) the soft, low density portion of the package compressed more than the comparatively hard high density portion and equalization of density occurs. But this type of package holder have the disadvantages of implying weight of upper packages on the lower packages and thus the bottom most packages gain highest load pressure than the top most one (fig-3), and this definitely causes the package to package density variation

and thus the packages to package shade variation. On the other hand, the rigid type plastic package holder don't need pressing, and they have interlocking facilities and thus the joint column of package holders carry the load of the packages and don't imply the load on the yarn packages. Thus no package gain extra load from the upper one. So chance of density variation within the packages on a spindle of the carrier due to pressing is zero but the within package density equalization facility is also absence in case of rigid type plastic package holder. better result have achieved for plastic packages than metallic spring, but it needs close observation and trial to determine perfect package holder type for a factory as many factory also having good results with metallic type.



Fig: 2: (b) soft winding packages from grey package on spring and plastic tube.

Fig: 2: (c) pressing of soft winding package in case of spring tube that can hamper even density



Fig-3: Dyeing carrier loaded with soft winding packages on plastic type holder where TOP CIRCLE of lower package inset into the BOTTOM CIRCLE of upper package & thus support the weight of upper package and so the lower packages gain no extra pressure from the weight of upper packages.

3.3 Controlling and ensuring properly loading of packages on dyeing carrier

At this stage, accurate loading of packages on dyeing carrier is maintained by-

- i) Proper and accurate loading of soft winding package in each

- ii) Placing relatively larger diameter package in the bottom of a spindle

single spindle of carrier by maintaining 'same diameter package in same spindle' method.

Best result has been found at the following pressing setting:

Table 5:- Recommendation for Pressing

Winding type	No of packages per spindle	Pressing Height (cm)
Precision winding & DIGI cone winding	8	107
	7	98
	6	84
	5	70
	4	59

N.B:- Before pressing package height of each package was nearly 16.5 cm.

3.4 Evaluation and working on flow control during dyeing:

Dyeing liquor flow disturbance is a major cause of unlevel dyeing at different position of a yarn package. The following reasons are found main factors for flow disturbance:-

3.4.1 Flow disturbance due to faulty pump setting:

Uniform and adequate flow of liquor through the wound packages of material is a necessary prerequisite for level dyeing^[5]. Besides this, complete air removal has to be ensured prior to pressure build up for uniform results Dyeing of yarn packages in cone form provide difficulties in level dyeing as the whole part of the package can not be come to the contact of dye liquor at same extent. Incase of liquor flow from inside-out, the concentrated dye liquor emerging from the central perforated tube comes into contact with a smaller amount of the fibres than when it leaves the carrier when a weaker dye solution comes into a larger amount of fibres, leading to outer surface variation (lighter of the shade)^[1]. A previous research shows that Loss of air pad pressure in one way low liquor dyeing can cause reduced liquor flow^[4]. That means when pump setting is "10/0; 90/90; 1.5/1.5", it will causes unlevel as liquor

flow is single direction. Now the question is, why it hasn't found unlevel for cotton-acrylic blend yarn dyeing where it always used unidirectional pump setting? It is certain that flow differences can be reduced to a minimum by altering the pumping power and thus level dyeing can be facilitated. The abnormal liquor flow indicates the flow disturbance which leads to unlevelness. To be ascertain one can check the in-out and out-in pressure gauges and compare the readings with past. Previous works shows that modest pumps should register a pressure differential of around 0.5 kg per sq.cm . If the differential is significantly lower than this value, liquor may be freewheeling or channeling through a badly seated carrier, a sprung cap or a loosely loaded column of cheeses^[4]. To minimize the problem, in most cases the dyer run the machine in bi-directional flow, i.e, IN→OUT and then OUT→IN. Many dyer remark that this alteration is very important to ensure level dyeing as penetration is obviously better is if the flow can be reversed periodically^[7] But the problem is how many times a dyer should give for each direction? Trials are done on various pump setting as below. Changes in the pump setting are made to one trial to another after evaluation of the result of previous setting. Better result has been found for 4/6, 90/90, 1.5/1.5 setting for this research factory, but this setting differs from factory to factory. So, it has been sum up that the

pump setting should set locally by trial bases for each factory as faulty pump setting causes not only unlevel but also waste valuable time and money.

Table 6:- Different Pump Settings for Trial

Flow direction time IN→OUT/OUT→IN (min)	Pump's efficiency IN→OUT/OUT→IN (%)	Max ^m Differential pressure (IN→OUT/OUT→IN) (Bar)	Result
10/0	90/90,90/80,90/75,100/0	2.5/2.5;1.5/1.5 & 1/1	Gradually lighter to darker from in to out or out to in position
0/10	90/90,90/80,90/75,100/0	2.5/2.5;1.5/1.5 & 1/1	Same result
6/4	90/90,90/80,90/75,100/0	2.5/2.5;1.5/1.5 & 1/1	Same result
4/6	90/90,90/80,90/75,100/0	2.5/2.5;1.5/1.5 & 1/1	Same result
2/8	90/90,90/80,90/75,100/0	2.5/2.5;1.5/1.5 & 1/1	Same result
8/2	90/90,90/80,90/75,100/0	2.5/2.5;1.5/1.5 & 1/1	Same result

Again, the rate of flow of liquor per unit are depends of several points. Any variation to these points may lead to the unlevel. In the ideal system, it can be shown ^[2] that,

$$F = (KPN\pi D)/(VT)$$

Where, F = rate of flow of liquor per unit area

K = Constant

P = Pressure difference between inside & outside of the package

N = No. of Channels per unit cross-section,

D = Diameter of Channels per unit cross-section

V = Viscosity of liquor

T = Wall thickness of the package.

It is assume that the package is stable.

However, at high pumping pressure, the yarns are flattened, thereby reducing the diameter of the channels & consequently the rate of flow is reduced. But a decrease

in Viscosity of liquor on heating increases the rate of flow. In current research it has been found that the above mentioned points can be affected by the liquor lick out during dyeing. Two main causes of liquor lick out are illustrated at the following sections.

3.4.2 Liquor lick out

3.4.2.1 Liquor lick out at the junction point of two adjacent package due to faulty loading of carrier. Chance of faulty carrier loading is zero for plastic tube package holder as two plastic tube insert into one another at the end (fig:- 2 a,b).

3.4.2.2 Liquor lick through the tinny hole of cup plate locking point in case of 'separate type cup-plate'(fig-4a).This type of liquor lick out is zero for the 'combined type cup-plate'(fig-4b).



Fig:4(a):- Separate type cup-plate



Fig:4(b):- Combined type cup-plate

3.5 Working on dyeing techniques

Several trials are done to work on bleaching, salt, soda, color dosing and dyeing technique and after treatment. The findings are as follows-

3.5.1 At bleaching stage

Packages should be properly pre-treated. Absorbency and whiteness required must be controlled carefully. The packages with insufficient absorbency lead to the chance of unlevel dyeing due to its varying absorption at different portion of the package. Fabric from In-Middle-Out of a package can be made to check the levelness of the packages after bleaching and this checking is very effective to control unlevelness that arise from faulty bleaching.

3.5.2 Salt

Addition of salt at the beginning of dyeing is a vital issue for level dyeing. Following factors should be taken in mind during salt adding-

- i) Salt should be contamination free. Salt with huge contaminations should be properly stirred and filtered before injecting to the main vessel.
- ii) Proper dissolving of salt should be ensured. For this, salt can be added time to time through a long period or 'salt dissolving function' of several dyeing machines (such as this dyeing machine) can be utilized. 'Salt dissolving' has been found to be a very effective technique where the salts are added gradually to the side tank and continuous liquor circulation is maintained from the main dyeing vessel to side tank. Only the implementation of this technique, relief has been found to be the best solution from the

unlevel problem that was doubted to be arising from improper dissolving of salt.

3.5.3 Color

- i) Color should be dosed rather than injected.
- ii) Proper color dissolving is a very important factor to ensure level dyeing. Trials have found that it can be achieved by dissolving color at 50^o or 70^o c before start dosing.
- iii) Stirring of color before pouring into the dosing tank is also a favorable idea. Proper filtration of color ensures that there is no color sludge or undissolved color, which causes streak problem in the packages.

3.5.4 Soda

- i) Soda must be dosed.
- ii) 'Progressive dosing' of alkali proved better result. Trials have found best result in 70% progression in soda dosing.
- iii) Soda should be dissolved well before dosing and possibly contamination free.

3.5.5 Time, Temperature and Ph

Optimum values of time, temperature and Ph should be maintained for level dyeing.

3.5.6 Washing:

All unfixed dyes must be removed before start finishing of a batch. Again washing time and temperature should be selected carefully.

3.5.7 Fixing & Finishing

Fixing agents are not a friendly item for level dyeing. Most often it has been found that batches are level after dyeing but the finished goods show unlevel. The following table shows some of this type of unlevel problem that the project faced during its investigation-

Table 7:- Finishing chemicals can be a cause of unlevel

Weight of the batch (kg)	No of package per spindle	Color combination	After dyeing	After finishing.
213	7	Cibacron Yellow FN2R = 1.397% Cibacron Red FNR = 0.41200% Cibacron Blue FNR = 0.01133% (color name = Harvest pumpkin)	Slightly darker at inner position	Gradually lighter from 'in' to 'out'. Acceptable
562	7	Cibacron Yellow S-3R = 0.918% Cibacron Deep Red SB = 1.176% Cibacron Navy SG = 4.5% (color name = Navy)	Slightly darker at inner	Gradually lighter towards outer. Not acceptable.
567	7	Novacron Yellow S-3R = 2.678% Novacron Red S-2B = 1.28972% Novacron navy SG = 1.38844% (color name = Coffee)	Gradually lighter towards outer but acceptable	Gradually lighter towards outer. Not acceptable
840	7	Remazol G. Yellow RGB=1.38304% Remazol Red RR=0.39660% Remazol Blue RR = 0.767582% (color name = Khaki)	Slightly unlevel, 'middle' lighter. But acceptable	In-Middle-out shade variation. Streak problem. Unacceptably unlevel.

Finally it has summed up that-

- i) Cationic softener causes problem in white shade.
- ii) Non-ionic softener is not so problematic but packages are not enough soft.
- iii) Fatty acid based cationic softener performed best.

3.6 Drying Conditions

It has been found that a batch is found levelly dyed after checking cones before drying the whole batch but the same batch is found to be unlevel when checked after drying of the whole batch in a RF dryer. More over it has been observed that the packages which are placed at the sides of the conveyer belt, shows not evenly dried and causes more unlevel. Again packages can internally burn when spring type metallic package holder is used and the drying conditions are not properly handled. So belt speed, drying temperature and time, placement of packages and package-to-package distance on conveyor belt should monitor carefully.

4. CONCLUSION

Level dyeing is the key to success for a dye house. Some important physical factors are investigated here for achieving the goal. But it should be noted that the chemical factors related to dyeing and the influences of used chemical in dyeing procedure in different stage are not discussed in this paper. If any one can control the above mentioned factors with care, it can be hope that he will able to finish his product with good quality levelness. Definitely there is many scope for further research for the improving the discussed factors and there are many considerable factors which have not discussed here. But this is a guideline and general information for the investigation of the levelness problem of yarn dyeing in cone form

ACKNOWLEDGEMENT

This research project was wholly launched by the "COLORMASTER LTD", a sister concern of SQ group. Financial helps for technical supports from few German and British experts are also sponsored by the group. The

authors paid their deepest gratitude to those German and British advisors who provided their valuable suggestions and comments at different stages of the project. The authors also thank to many local technical helping hands from “Dhaka University of Engineering & Technology” for their cooperation.

References:

- [1] Shenai V.A., “*Technology of Textile Processing*” vol-VI, 2000.
- [2] Duckworth C. (Ed.) *Engineering in Textile Coloration* (Bradford, UK, SDC), 1983
- [3] Choudhury, A. K. Roy, “*Textile Preparation and Dyeing*, (New Delhi), 2006
- [4] *Textile Yarn Dyeing -Tips & Techniques: Package Dyeing (HT HP)-Cheese Yarn Dyeing-I*
<http://yarn dyeing.blogspot.com/2008/04/package-dyeing-ht-hp-cheese-yarn-dyeing.html>
- [5] Von Der, Eltz Hans-ulrich (Frankfurt am Main,DE) and Glander, Siegfried (Bad Soden am Taunus, DE), “*Process for the uniform dyeing of textile wound packages or packaged material*”, United States Patent 4135268.
<http://www.freepatentsonline.com/4135268.html>
- [6] Pavan S. Chinta and Sapna Dhar , DKTE’s Textile and Engineering institute, Ichalkaranji.
<http://www.fibre2fashion.com/industry-article/pdfdownload.asp?filename=1678&article=1678>
- [7] Trotman, E.R. “*Dyeing & Chemical Technology of Textile fibre*”, 1975.
- [8] Broadbent. Arthur D. “*Basic Principles of Textile Coloration*”, 1995,
- [9] “*Methods of dyeing yarn cheeses*”, United states patent 5351351.
<http://www.freepatentsonline.com/6921421.html>.
- [10] Babaarslan, Osman , “*Tension Variations During Cone Winding on an Open-End Spinning System*”. *Textile Research Journal*, Vol. 68, No. 9, 649-654. 1998
- [11] Shaid, Abu, “*Reverse tension mechanism: a key to success of Cheese dyeing, provides uniform within a package density and also minimizing package to package density variation*”, DIUJST, (accepted for publication in July,2010).