



# Scope of Knit Denim Products Using Reactive Dye and Convenient Washing Effects

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**Abstract**—In this work, the use of reactive dye has been successfully introduced on knit denim. Various washing effects were developed both in mechanical and chemical process. Also the current paper introduces some types of knitted denim products on single cylinder circular knitting machine with different yarns and stitches, and the style and strength of these types of knitted denim met almost all the requirements of denim fabric after dyeing and finishing, they were tested by fabric strength tester for testing physical and mechanical properties.

**Keywords**—Knit denim, structure of knit denim, washing types, knit denim samples.

## I. INTRODUCTION

At present, a lot of derivatives of denim are available. Also new types of denim are being developed. The diversification of denim has gone so far that now knit denim is being produced to focus both appearance and effect like woven denim [5]. Knit denim is the perfect combination of centennial culture of denim and the excellence features of knitting fabrics. It has not only the style of woven denim, but also the unique characteristics of knitted fabrics. Its texture is exquisite and fresh, soft and comfortable by touching, elastic, and air permeable with a wide variety, it can be transferred into different style easily which can be washed in several way, the surface of the knitted denim will present a delicate pattern, which keep a great similarity with traditional(woven) denim [6].

Denim related works have performed on knit denim & still on producing. Denim effects have been developed by using 100% cotton yarn, cotton-polyester blend yarn, slub yarn etc. which have been dyed by indigo dye. Reactive dye has also been used now-a-days. The effect of denim effect as like woven denim can be produced by using indigo dyed yarn [1]. But indigo dyes have some problem such as: i) Insoluble in water, ii)The dye molecule of vat dye is attached physically, iii) Before dyeing vatting process has to be done, iv) Dyeing time also more. [15]

To overcome the limitations reactive dye has been proposed. Washing effect on reactive dyed knit denim fabric will be glorious introduction in knit denim. So to make this type of denim 100% cotton yarn is used in this research. Reactive dye (Remazol group) is widely used for dyeing the fabric. In this case the extra yarn dyeing process can be skipped. When reactive dye is used, washing effect is also possible to produce after dyeing the fabric. Enzyme wash, bleach wash, hydrose wash, potassium permanganet wash, formic acid wash, caustic wash, laser wash, and ozone wash etc. are proposed for imparting washing effect. Variation in electrolyte, soda ash in several bath are also proposed to produce washing effect on knit denim. Distinguished washing effects have successfully been developed by using bleach wash & hydrose wash.

## Objectives

- ❖ To search out the present knit denim products in details.
- ❖ To develop the washing effect on Reactive dyed knit denim in a convenient way.
- ❖ To establish useful and prospective washing effect on knit denim.
- ❖ To promote the derivatives on knit denim by using different raw materials such as 100% cotton yarn, polyester yarn, cotton- polyester blended yarn etc.

Communication problem with factories is due to political unrest.

## II. LITERATURE REVIEW

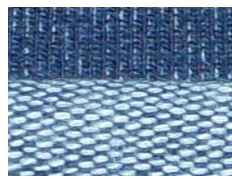
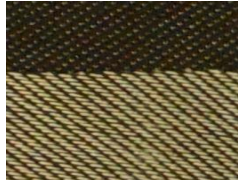

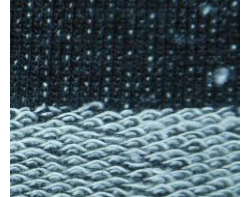
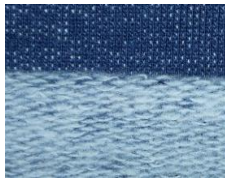



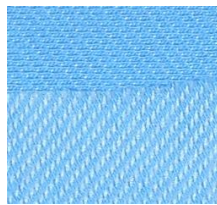

Knit denim is special type of knitted fabric of which structure is knitted but outlook is like woven denim. Generally denim is comparatively heavy fabric composed of higher linear density (Direct Count) yarn both in warp & weft. The fabric is not very soft in handle. For removing this bad appearance knit denim could be the most suitable alternate. Generally cotton is used in knit denim. But for variation cotton, cotton-polyester blended yarns are most widely used as raw material in knit denim [4].

The demand of knit denim is increasing day by day. Some finishing properties such as resin finish, water repellent finish etc. are the desired demand of different

buyer's such as LIDL, OVS, COLIN'S, of different countries such as Italy, Usa, Sweden, Spain, French, Germany, Uk [2].

*A. Specification of Knit Denim Samples*

**Table I**  
**Product Details (Collected From Alim Knit BD Ltd): [2, 3, 4, 5, And 6].**

			
<b>95%Coton+5%Lycra</b>	<b>70%Coton+30%Polyester</b>	<b>100%Cotton</b>	<b>100% Cotton</b>
			
<b>100%Coton</b>	<b>65%Coton+30%Polyester+5%Lycra</b>	<b>95%Coton+5%Lycra</b>	<b>95%Coton+5%Lycra</b>
			
	<b>95%Coton+5%Lycra</b>	<b>95%Cotton+5%Lycra</b>	

*B. Methods*

*1) Knit Denim Production Methods:*

Generally three processes are invented for producing the knit denim till dates. Those are:

- ❖ Float plated technology (Terry fleece).Which includes:  
Tuck- knit denim, knit - knit denim.
- ❖ Thread fleece.
- ❖ Interlock plated jacquard.

Generally single jersey circular knitting m/c is used for float plated technology.

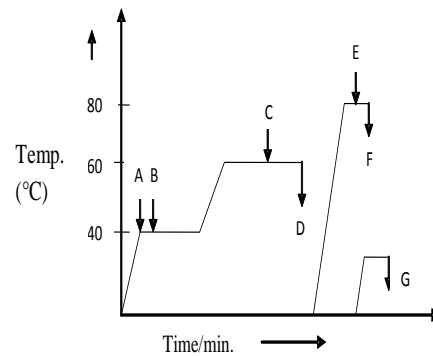
- ❖ Fleece knitting m/c is used to produce fleec knit denim.
- ❖ Interlock plated jacquard does not get success [1].

*2) Dyeing Method [7]:*

To prefer the effective dyeing process by which desired washing effects can be obtained, several dyeing methods are used. Those are

*For Example:*

*Method D1:* Common salt (60 gm/l) + reactive blue (4%) + soda (12 gm/l) dozing



**Figure 1: Dyeing Scheme of Method D1**

**Table II**  
**Description of the Symbol of Method D1**

Symbol	Description
A	Dye
B	Electrolyte
C	Dying (60°C x 20')
D	Drain.
E	Hot wash (for 10').
F	Drain.
G	Cold wash & Drain.

**Table III**  
**Condition and Recipe of Other Methods**

Method D2	Common salt (60 gm/l) + reactive blue (2%) + soda (8 gm/l) dozing.
Method D3	Glauber salt (40 gm/l) + reactive blue (4%) + soda (12 gm/l) dozing
Method D4	Glauber salt (40 gm/l) + reactive blue (2%) + soda (8 gm/l) dozing.
Method D5	Gray fabric + Glauber salt (40 gm/l) + reactive blue (4%) + soda (12 gm/l) dozing
Method D6	Gray fabric + Common salt (60 gm/l) + reactive blue (4%) + soda (8 gm/l) dozing.
Method D7	Only dye (4%) + soda (16gm/l) dozing
Method D8	Only dye (4%) + soda (16 gm/l) inject.
Method D9	Glauber salt (40 gm/l) + reactive blue (4%) + soda (12 gm/l) inject.
Method D10	Glauber salt (40 gm/l) + reactive blue (4%) + soda (12 gm/l) inject (run time 5 min).
Method D11	Glauber salt (40 gm/l) + reactive blue (4%) + soda (12 gm/l) inject (run time 10 min).
Method D12	Glauber salt (40 gm/l) + reactive blue (4%) + soda (12 gm/l) inject (run time 15 min).

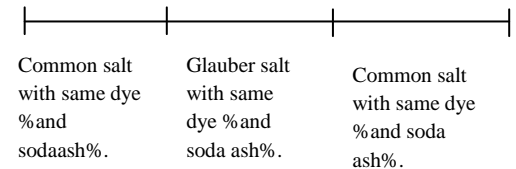
*Note: In general*

- ❖ 16gm/l soda is used for 4% shade of reactive dye. But here, 12 gm/l soda is used.
- ❖ 12gm/l soda is used for 2% shade of reactive dye. But here, 8 gm/l soda is used.
- ❖ After soda dozing the dyeing process is run about 30 min, but in the above methods run time 15 -20 min is used.

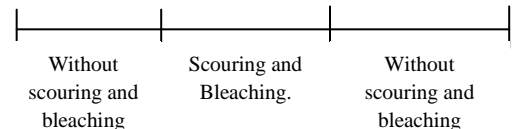
*C. Methods are used for obtaining the Various Washing Effects on Reactive Dyed Sample*

*Method W1: Tie dyeing method. This includes,*

- I. Tie dyeing with same shade %, same amount of soda, but glauber salt & common salt are in different parts.  
In figure



II.



*1) Washing Effect by Chemical Treatment on Reactive Dyed Sample:*

*Method W2: By Bleaching effect*

*Potassium permanganate (KMnO<sub>4</sub>) treatment*

*Recipe*

KMnO <sub>4</sub>	:	2%
Temperature	:	100 c
Time	:	15 to 20 min (depends upon fading).
M: L	:	1:20

*Sodium hypochlorite treatment*

*Recipe*

Sodium hypochlorite	:	1 to 3 g/l
Anticreasing agent	:	0.5 to 1 g/l
p <sup>H</sup>	:	9.5 to 10
M:L	:	1:20
Temperature	:	100 <sup>0</sup> c
Time	:	20 to 30 min (depends upon fading).

*Calcium hypochlorite treatment*

*Recipe*

Calcium hypochlorite [Ca(ocl) <sub>2</sub> ]	:	1 to 3 g/l
Anticreasing agent	:	0.5 to 1 g/l
p <sup>H</sup>	:	9.5 to 10
M: L	:	1:20
Temperature	:	100 <sup>0</sup> c
Time	:	20 to 30 min (depends upon fading)

*Hydrosulphite treatment*

*Recipe*

Sodium Hydrosulphite [Na <sub>2</sub> S <sub>2</sub> O <sub>4</sub> ]	:	1 to 3 g/l
Anticreasing agent	:	0.5 to 1 g/l
p <sup>H</sup>	:	9.5 to 10
M: L	:	1:20
Temperature	:	100 <sup>0</sup> c
Time	:	20 to 30 min (depends upon fading )

*Method W3: By using enzyme*

*Recipe*

Laccase enzyme:	3 to 4g/l
Anticreasing agent:	0.5 to 1 g/l
p <sup>H</sup> :	6.5 to 7
M: L:	1:20
Temperature:	55 <sup>0</sup> c
Time:	30 to 40 min (depends upon fading).

*2) Washing Effect by Mechanical Treatment on Reactive Dyed Sample:*

*Method W4: By Leaser treatment*

The intensity of leaser depends upon the fading according to buyer requirements.

*Method W5: By Whiskering.*

*3) Washing Effect with Chemical and Mechanical Treatment on Reactive Dyed Sample:*

*Method W6: Spray and rubbing method*

- By using acid (Formic acid 5%).
  - By using bleaching agent.
- In this method, above chemicals are sprayed and then rubbed manually.

*D. Color Fastness to Rubbing Test Method: ISO 105x12*

*Principle:*

This test is designed to determine the degree of color which may be transferred from the surface of a colored fabric to a specify test cloth for rubbing (which could be dry and Wet).

*Equipments:*

1. Crock meter
2. Grey scale
3. Stop watch
4. Color matching cabinet

*Size of Fabric:*

Fabric sample size 14 Cm × 5 Cm (one warp direction/wale direction and other weft/course direction).

*Evaluation:*

In this stage compare the contrast between the treated and untreated white rubbing cloth with grey scale and rated 1 to 5 [8].



*E. Color Fastness to Wash Test Method: ISO 105C03*

The ability of a dyed fabric to retain its original shade against fade during washing is known as wash fastness.

*F. Color Fastness to Light Test Method: ISO B02*

*Principle:*

1. A test specimen together with blue wool standards is exposed to the light from a mercury ballast tungsten fluorescent lamp (MBTFL) fading lamp.
2. The color fastness of specimen is assessed by comparing its fastness with that of 1-8 Blue Wool standards.

After dyeing the k/s values of those samples were determined. The k/s values of those samples are mentioned in the table (4.1). The comparison between k/s values of standard sample and reactive dyed samples according to different dyeing methods are mentioned in the figure (4.1). The light fastness, wash fastness, rubbing fastness of different dyeing methods and their comparison with standard samples are also mentioned in the following table (4.2, 4.3, 4.4) with graphical representation.

*B. Information about Standard (Indigo Dyed) Sample*

K/S value: 25

Light fastness rating: 5

Wash fastness rating:

**III. RESULTS AND DISCUSSIONS**

*A. Results (Dyeing related)*

At the first step different dyeing methods were selected for developing different shade% on the samples with reactive dye.

**Table IV**  
**Wash Fastness Rating**

Standard Sample	Rating Of Staining						Rating Of Color Change
	Acetate	Cotton	Nylon	Polyester	Acrylic	Wool	
	4/5	4	4	4/5	4/5	4/5	4

*Rubbing fastness rating:*

**Table V**  
**Rubbing Fastness Rating**

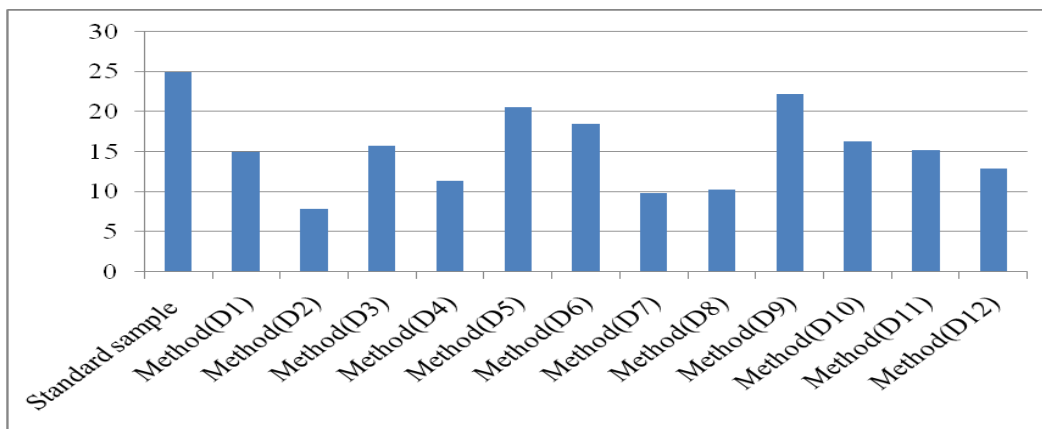
Sample	Rating	
	Dry	Wet
Standard Sample	3	2

**Table VI**  
**K/S Values of Different Dyed Samples after Enzyme (Laccase) Wash**

Sample Name	K/S Value	Weave Length
Sample Dyed Of 5 Min.	4.01	600 Nm.
Sample Dyed Of 10 Min.	6.1	''
Sample Dyed Of 15 Min.	7.9	''
Sample Dyed Of 30min.	8.3	''

**Table VII**  
**K/S Value of Differently Dyed Samples**

Method	K/S Value	Wave Length	Method	K/S Value	Wave Length
D1	15	600 Nm.	D7	9.8	”
D2	7.9	”	D8	10.3	”
D3	15.8	”	D9	22.2	”
D4	11.4	”	D10	16.3	”
D5	20.6	”	D11	15.2	”
D6	18.5	”	D12	12.9	”



**Figure 2: Graphical Representation K/S Values of Standard Sample and Reactive Dyed Samples According to Different Dyeing Methods.**

**Table VIII**  
**Result of Color Fastness to Wash**

Sample According To Method	Rating Of Staining						Rating Of Color Change
	Acetate	Cotton	Nylon	Polyester	Acrylic	Wool	
Standard Sample	4.5	4	4	4.5	4.5	4.5	4
D1	4.5	4	4	4.5	4.5	4.5	4
D2	4.5	4.5	4.5	4.5	4.5	4.5	4
D3	4.5	4	4.5	4.5	4.5	4.5	4.5
D4	4.5	4.5	4.5	4.5	4.5	4.5	4.5
D5	4.5	4	3.5	4	4	4.5	4
D6	4.5	4	4	4.5	4.5	4.5	4.5
D7	4.5	4.5	4.5	4.5	4.5	4.5	4.5
D8	4.5	4.5	4	4.5	4.5	4.5	4.5
D9	4.5	4.5	4.5	4.5	4.5	4.5	4.5
D10	4.5	4.5	4.5	4.5	4.5	4.5	4.5
D11	4.5	4.5	4.5	4.5	4.5	4.5	4.5
D12	4.5	4.5	4.5	4.5	4.5	4.5	4

**Table IX**  
**Result of Color Fastness to Light**

Sample According To Method	Rating Of Light Fastness	Sample According To Method	Rating Of Light Fastness
Standard Sample	5	D7	3
D1	3	D8	3
D2	3	D9	4
D3	3	D10	3
D4	3	D11	3
D5	3	D12	3
D6	3		

**Table X**  
**Result of Color Fastness to Rubbing**

Sample According To Method	Rating		Sample According To Method	Rating	
	Dry	Wet		Dry	Wet
Standard Sample	3	2	D7	4.5	3.5
D1	4.5	3	D8	4.5	3.5
D2	4.5	4	D9	4.5	3.5
D3	4.5	3.5	D10	4.5	3.5
D4	4.5	4	D11	4.5	4
D5	4.5	3.5	D12	4.5	4
D6	4.5	3.5			

**C. Results (Washing effects related)**

After obtaining the successful result of dyed samples in case of different tests (i.e. color fastness to washing, rubbing and light), different washing effects were developed on those samples. The developed washing effects are shown in the following figure.

1) *Methods are used for obtaining the various washing effects on reactive dyed sample:*

*Method W1: Tie method.*



**Figure 3: Washing Effect by Tie Die Method**

*Method W2: By bleaching effect by*

1) *Potassium permanganate (KMnO<sub>4</sub>) treatment*



**Figure 4: Washing Effect by Potassium Permanganate**

2) *Calcium chlorohypochlorite treatment*



**Figure 5: Washing Effect by Calcium Chlorohypochlorite**

3) *Hydrose treatment*



**Figure 6: Washing Effect by Hydrose**

*Method W3: By using laccase enzyme treatment*



**Figure 7: Washing Effect by Laccase Enzyme**

2) *Washing effect by mechanical treatment on reactive dyed sample:*

*Method W4: By Laser treatment*

The intensity of laser depends upon the fading according to buyer requirements.



**Figure 8: Washing Effect by Laser**

*Method W5: By whiskering.*



**Figure 9: Washing Effect by Whiskering**

3) *Washing effect with chemical and mechanical treatment on reactive dyed sample:*

*Method W6: Spray and rubbing method*



**Figure 10: Washing Effect by Spray and Rubbing**

4) *Washing effect on a knit denim apparel:*



**Figure 11: Washing Effect on a Knit Denim Apparel**

IV. DISCUSSIONS

From dyeing related information it was seen that, the k/s value of different dyeing method was commendable. It has been seen that the k/s value of reactive dye was increased with increasing dyeing time also. The sample dyed for 5 minute posed the less k/s value. Electrolyte also affects the k/s value. Compared with standard sample and grey scale, the good color fastness to wash has been found of different dyed samples. The color fastness to light is also significant. The color fastness to rubbing was better when compared with indigo dyed sample. Because reactive dye makes co-valent bonds with fibers.

After obtaining the successful result of dyed samples in case of different tests (i.e. color fastness to washing, rubbing and light), different washing effects were developed on those samples. The comparative characteristics which are obtained from this thesis are mentioned below:

- ❖ **Appearance:** Fig.4.13 shows the outlook of woven denim by using vat dye. On the other hand the samples (knit denim) simply dyed with reactive dye seen to be very close to that of appearance created by vat dye.
- ❖ **Comfortability:** From the force elongation curve elongation at break of woven and knit denim is quite different. As knit denim provides higher value in this property, definitely body comfort will be ensured.





- ❖ **Strength:** The strength of knit denim is lower than woven denim. This matter should be considered while preparing knit denim fabrics.
- ❖ **Washing effect:** The washing effects of knit denim is hopeful, although vigorous effect can't be applied.
- Enzyme wash: Not so much better as woven. Still it works.
- Leaser effect: Almost similar as shown in figure...
- Bleaching effect: The result of bleaching effect is satisfied as woven denim.
- Hydroze wash: It creates a good washing effect. Shown in the figure..
- ❖ Multiple washing techniques were exercised for knit denim fabrics and exhibited prospective and smart appearance like woven denim. In some cases the combination effect of knit denim could be considered for better effect and appearance as shown in figfig.4.13.
- ❖ The comfortabilty of blended knit denim is lower than 100% cotton woven denim. It was assessed by water absorbability test.

#### V. CONCLUSION

Knit denim with reactive dye save the time, cost and extra arrangement of processes. The different fastness properties are also demandable. The washing effects with chemical treatment are the best for reactive dyed knit denim. Knit denim could be produced by setting grey yarn in one feeder and bleached yarn in other feeder and then dyeing with solid reactive dyeing.

The grey yarn and bleached yarn exhibit different shade% of dye which will create a new washing effect. To develop denim effect as equal to woven denim by using coarser count yarns lower gauge knitting machine can be produced. For the above possibilities in future knit denim with reactive dye will cover the most of the denim demand.

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