

# **Appendix 5**

## **Chemical Audit Findings for Misr Mahalla**

## Chemical Audit Findings for Misr Mahalla

### 1 Product Line

During the orientation program with the senior staff members of the company it was decided that the scope of work will be confined to one of the major articles produced for export.

After detailed discussions pyjama suit (night wear) was selected. This article is made using Giza 75 and 85 Egyptian cotton in counts ranging from 16 s to 40 s. Major identification numbers of the fabrics are 27/57, 3032, and 2786.

These varieties are produced in plain (27/57) or twill weave (3032 and 2786) and processed as (a) bleached, (b) dyed, (c) printed (on white or dyed ground) and (d) colour woven (plain weave article No. 3121 and 3276), to make the pyjama suit garment. Hence, chemical audit was carried in sizing, wet preparatory processes (desizing, scouring, bleaching and mercerizing) dyeing (including yarn dyeing), printing, finishing and garment making departments.

#### 1.1 Sizing

Annex 1 gives the list of sizing materials, etc. used for sizing warps for grey fabric production for pyjama.

Sizing is conducted in two different units; (a) housed in the mill compound and (b) Sammanoud Factory.

#### 1.2 Preparatory Process

A list of chemical items used in several preparatory processes (desizing, scouring, bleaching and mercerizing) is given in Annex 2.

After grey mercerizing, the fabric of a, b, and c categories is subjected to enzymatic desizing, then processed into one of the rope form bleaching ranges.

The company has three bleaching ranges, namely Storke, Brugman and Gaston County. Cloth for pyjamas is being processed in one of the first two ranges, where the process sequence is as follows:

- Washing
- Double scouring with intermediate and subsequent washing
- Hypochlorite bleaching followed by washing
- H<sub>2</sub>O<sub>2</sub> bleaching followed by final washing

After bleaching the fabric is scutched and dried. The third range, that is Gaston County range, does not have hypochlorite bleaching, at present fabric processed for pyjama does not go on this range.

White pipes (pyjama accessories) are also bleached by route which includes hypochlorite.

#### 1.3 Dyeing (Including Yarn Dyeing)

A list of chemicals and dyestuffs used for fabric and for yarns for colour woven fabrics is given in Annex 3.

Fabric is dyed in jiggers using reactive and vat colours. For colour woven fabric (d category) yarn is dyed in vat colour and for white bleached yarns are after weaving

without sizing, the fabrics go directly for soft finishing as accessory in garment making are dyed using some reactive and vat dyestuffs.

#### **1.4 Printing**

Printing is done on white or dyed ground using rotary or roller printing machines

Fabrics for pyjama are printed by use of pigment colours. Pigments and auxiliaries, such as binders, thickeners, solvents, catalysts, emulsifiers, etc., is given in Annex 4.

Pigment colours are fixed using curing treatment.

#### **1.5 Finishing**

Fabric meant for raising is given a softener treatment prior to raising and subsequent printing.

Chemical finishing is conducted using several softeners prior to final pre shrinking (sanforizing) operation.

A list of chemicals used for finishing of pyjama fabric is given in Annex 5.

White pipes used as accessory for pyjama is finished using optical whitener and softener.

#### **1.6 Garment Making**

Out of several accessories used, the colour and chemicals used for pipes are included in the lists given in the Appendices.

## **2 Chemicals and Auxiliaries**

Examination of the lists of chemicals and auxiliaries used for the pyjama fabric reveals the following objectionable chemicals, which needs to be omitted or restricted:

- NaOCl
- Kerosene
- High Formaldehyde containing binders (e.g. Imperon Binder MTB)
- Stilbene based optical brighteners
- Cationic softeners for dyed yarns

## **3 Dyestuffs and Pigments**

Colour Index Numbers of some of the dyes and pigment used were not available. The mill has agreed to supply them as soon as getting them from the suppliers.

As per the banned list available to date none of the reactive and vat colours used for pyjama fabric fall in the banned category.

As per the information available, pigment colours have not yet been covered in the banned category. However, some pigment colours which contain banned azo amines may be banned at a future date. They are:

- Ismament Yellow 2 G
- Pigmatex Yellow TCGG
- Imperon Yellow K-R
- Pigmatex Golden Yellow TGRM
- Imperon Orange K-G

- Imperon Red KG3R
- Imperon Violet K-B
- Imperon Dark Brown K-BRC

#### **4 Recommendations and Action Plans**

1. It is recommended to conduct a qualitative test for absence of PCP in sizing agents. The procedure is given in Annex 6.
2. Hypochlorite bleach needs to be totally avoided, hence it is advised to conduct trials by eliminating this process from the bleaching sequence. After obtaining satisfactory results, the modified process without NaOCl bleaching should be implemented for regular production of pyjama cloth and consequently other articles.
3. Optical brightener (used in bleaching and finishing) should be checked to ascertain that they are not based on stilbene or other harmful chemicals.
4. It was observed that a large number of dyestuffs and pigments are in use, it is advisable to reduce the number for reducing inventory, improving the reproducibility and fastness characteristics as well as minimizing corrections.
5. For improving the fastness of dark shades, the dyeing conditions must be optimized and the fastness tests must be conducted prior to over printing. Use of bifunctional reactive dyes of high fixation properties can be attempted to achieve the goal.
6. It is advisable to replace cationic softener (Belfazin) used for after treatment of dyed yarns with a non ionic softener.
7. Kerosene based thickener in printing should be restricted by its replacement with proper synthetic thickeners. Replacement must be implemented after necessary trials.
8. To reduce the formaldehyde content and to improve the rubbing fastness of the printed articles, formaldehyde based binders must be replaced with others containing less formaldehyde and after careful study of available alternate binders.
9. It is advisable that the factory team should explore the possibility of reducing the cost without affecting the product quality and the environment. For example Roberto (high squeeze rollers) can be used on cylinder dryers in bleaching department to minimize the residual water before drying and hence drying cost.

## **Annex 1 - Sizing Materials**

1. Native rice starch
2. Polyvinyl alcohol
3. Carboxymethyl cellulose
4. Sulphonated tallow
5. Glycerin
6. Treflix PWET
7. Oinor 4007

### **Notes**

- 1: is the main sizing ingredient
- 2 and 3: are mainly used for warps in case of high speed air jet looms
- 4: is the softener
- 5: is the hygroscopic agent
- 6 and 7: are after waxing agents

**Annex 2 - Chemical Items Used in Preparatory Processes**

1. NaOH
2. NaOCl
3. H<sub>2</sub>O<sub>2</sub>
4. Na<sub>2</sub>SiO<sub>3</sub>
5. CH<sub>3</sub>COOH
6. Reductol KB (antioxidant for scouring)
7. Espycon 1030 (wetting agent)
8. Egyptol PLM (wetting agent)
9. Peroxide stabilizer HOET
10. Kamilaze (starch enzyme)

**Annex 3 - Chemicals and Dyestuffs Used for Fabric and Yarn Dyeing****A Chemicals**

- NaOH
- Na<sub>2</sub>S<sub>2</sub>O<sub>4</sub>
- H<sub>2</sub>O<sub>2</sub>
- NaCl
- Na<sub>2</sub>CO<sub>3</sub>
- CH<sub>3</sub>COOH
- Organic stabilizer
- Aspekone 1030
- Welfazin (cationic softener)
- Sequestal B
- Leveling agent (solidigal GLET)

**B Dyestuffs****B.1 Reactive**

- Levafix Yellow EGA (reactive yellow 25)
- Appolofix Golden Yellow SF3R
- Rotmazol Red F3B
- Triactive Blue R Special
- Ismative Black B
- Procion Turquoise MXG
- Triactive Violet 5 R
- Reactafix Yellow H4G (and H4GL)
- Reactafix Yellow HRML
- Chlorazol Yellow BRS

**B.2 Vat**

- Ismanthrene Yellow GCN
- Ismanthrene Yellow RK
- Ismanthrene Green FB
- Ismanthrene Brown BR
- Ismanthrene Olive R (Vat Black 27)
- Ismanthrene Olive Green B
- Ismanthrene Black BBN
- Ismanthrene Blue CLF
- Ismanthrene Blue RS (Vat Blue 4)
- Indanthrene Violet 3B (Vat Violet 9)
- Indanthrene Green FB
- Indanthrene Green 6705
- Indanthrene Red FBB
- Nivaron Navy TRR
- Hydron Blue 3RC

## Annex 4 - Pigments and Auxiliaries Used in the Printing Department

### A Pigment Dyestuffs

1. Helizarin Orange R (Pigment Orange 5)
2. Minedaico Red GRL (Pigment Red 2)
3. Imperon Red K-B (Pigment Red 146)
4. Minedaico Red BB (Pigment Red 146)
5. Minedaico Violet 2BTL (Mix Violet 23, Red 146)
6. Ismament Blue M2G (Pigment Blue 15)
7. Imperon Blue K-B (Pigment Blue 15)
8. Imperon Blue K-RR
9. Imperon Turq. Blue K-3G
10. Imperon Green K-G (Pigment Green 7)
11. Imperon D. Brown K-BR
12. Ismament Black C
13. Imperon Black KGF (Pigment Black 7)
14. Imperon White BF (Pigment White 6)
15. Daico White 51
16. EBCA Discharge S (Ready to print pastes)
17. EBCA White H-S (Ready to print pastes)

### B Auxiliaries of Pigment Colours

1. Imperon Binder M/ET
2. Minerdaico Binder SME
3. Helizarin Binder ET
4. Solegal WW-ET
5. Daico Emulsifier P/L
6. NSD EMVL
7. Lutexal HVW
8. Imperon Thickener N-2282
9. Urea
10. Diamm Phosphate
11. Ammonia
12. Kerosene or other solvent

## **Annex 5 - Chemicals Used for Finishing**

1. Leomin NI (non ionic fatty acid softener)
2. Adaline (Polyethylene softener)
3. Finish PE (Polyethylene softener)
4. Siligen MM (Silicon softener)
5. Lebeurosoft NNSL (Silicon softener)
6. Polysoft (polyethylene emulsion softener)
7. Belsoft (Fatty acid softener)
8. Ismawhite 2BL (Optical Brightener)
9. Hostalux (Optical Brightener)
10. Acetic Acid
11. Aspekone (Wetting Agent)

**Annex 6 - Test of PCP**

1. Take 5 - 10 g of sizing material
2. Dissolve in water
3. Acidify with conc. 5 - 10 ml HCl, if PCP present in Na form it will precipitate.
4. Add 3 - 15 ml of conc. HNO<sub>3</sub>, and allow to stand for 10 - 15 min at room temperature
5. The reddish or orange pigmented colour indicates the presence of PCP
6. For comparison of colour, you can test known samples of PCP for the colour

# **Appendix 6**

## **Chemical Audit Findings for Giza Spinning and Weaving**

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## Chemical Audit Findings for Giza Spinning and Weaving

### 1 Chemical Audit

#### 1.1 Product Line

After detailed discussions with the chairman (Dr. Maged Marzouk) and the general production manager (chem. Magdy Hassan), it was decided to select T-Shirts designated for export and made from 100 % cotton knitted fabric fully bleached or dyed in different colours.

Yarn counts ranging from 20 S to 30 S, using 100 % Egyptian cotton (Giza 70 and Giza 85) and 100 % Indian cotton is used to produce knitted fabric which is further subjected to preparatory processes (scouring and bleaching), dyeing, soft finishing and garment making.

Accordingly chemical audit was carried out on the preparatory, dyeing, finishing and garment making departments.

List of chemicals and dyestuffs used for preparatory treatments, dyeing and finishing of knitted fabric (used for T-Shirt making) as well as polyester threads, (for stitching) is given in Annex 1

It is to be noticed that all wet processes are carried out in batches using either winch or jet dyeing machines.

##### 1.1.1 Preparatory processes

The fabric is scoured (using two commercial agents), followed by two hot wash and a cold wash.

After scouring the fabric can be dark shade dyed or bleached.

There are two kinds of bleaching:

1. Full bleaching: which begins with hypochlorite bleaching:-followed by cold washing, antichlorination (using sodium bisulphite), cold washing and hydrogen peroxide bleaching followed by hot wash and cold wash. After full bleaching the fabric is soft finished. An optical brightener can be added during  $H_2O_2$  bleaching or prior to soft finishing.
2. Half bleaching: which is intended for light shade dyeing process, where no hypochlorite bleaching is performed and the fabric is subjected to  $H_2O_2$  bleaching, followed by hot and cold washing, then acetic acid treatment ( $H_2O_2$  killer) before light shade dyeing.

##### 1.1.2 Dyeing (Including Thread Dyeing ) and Soft Finishing

Knitted fabric is reactive dyed, mostly using vinyl sulphon or by functional reactive dyestuffs. Black colour is achieved using Direct Black 22, followed by after treatment either with copper sulphate or a commercially available non formaldehyde containing fixing agent (namely Dalton Fix N 62 of DAICO Co.).

Dyed fabric (reactive or direct dyed) is then soft finished using a cationic softener.

Polyester Stitching threads are disperse dyed at 130 °C in a small pressurized vessels

### **1.1.3 Garment Making**

Most accessories used are supplied by the European customers. However, polyester stitching threads are dyed in the company using disperse dyestuffs that are listed in Annex 1.

## **1.2 Investigation of Chemicals and Dyestuffs Used**

### **1.2.1 Chemicals and Auxiliaries**

Investigation of Annex 1 reveals the following objectionable chemicals, which need to be omitted or restricted:

1. NaOCl
2. CuSO<sub>4</sub>

### **1.2.2 Dyestuffs**

Colour Index No. of all dyes used, except Disperse Black EX 300 %, were supplied by the company.

The company has agreed to supply it as soon as getting it from the supplier.

As per the banned list available till date, none of the dyestuff (of known C.I. No.) falls in the banned category.

## **1.3 Recommendations and Action Plan**

1. Hypochlorite bleach needs to be totally avoided. It is advised to conduct trials by eliminating this process from bleaching sequence.
2. For improving the fastness of dark shades, the dyeing conditions must be optimized
3. It is recommended to avoid the use of CuSO<sub>4</sub> or copper containing compounds in the after treatment of the dyed fabrics (direct). Use of safe resinous compounds is advisable.
4. It is advisable that the factory team should explore the possibility of reducing the cost without affecting the product quality and the environment.
5. The quality control department should prepare a manual of test methods for testing raw materials, in process checks and for finished products to meet the Oeko-Tex requirements. Heavy metal content, (specially for dark shades) must be tested at a reputable laboratory.

## Annex 1 - Chemicals, Auxiliaries and Dyestuffs used for Fabric (and Threads) Processing

### A Chemicals and Auxiliaries

1. Soda ash
2. Sodium hydroxide
3. Hydrochloric acid
4. Acetic acid
5. Common salt
6. Sodium hydrosulphite
7. Sodium meta bisulphite
8. Sodium hypochlorite
9. Copper sulphate
10. Hydrogen peroxide
11. Nonil N (detergent for scouring)
12. Invandin NF (scouring agent)
13. Invatex CRA (wetting agent)
14. Humactol C30 (wetting detergent after dyeing)
15. Antifoam (silicon based)
16. Stabilizer 2000 SK (organic stabilizer)
17. NSD sequest (EDTA)
18. Tricolene PES (dispersing agent, thread dyeing)
19. Persoftal UK (Cationic softener)
20. Kint softener WA (softener for whites)
21. Tricot silicon LEA( softner for threads)
22. Dalton Fix N62 (cationic fixing agent after direct dyeing)
23. Uvilex 2 B optical (optical brightener, stilbene based)
24. Hostalux polyester (optical brightener for polyester)
25. Lubrisoft CULS/G

### B Dyestuffs

1. Reactive Yellow MERL (India, Reactive Yellow 145 )
2. Reactive Yellow KE3G (China, Reactive Yellow 81)
3. Reactive Yellow HE4R (India, Reactive Yellow 84)
4. Reactive Yellow GR (India, Reactive Yellow 15)
5. Reactive Orange M2R (India, Reactive Orange 14)
6. Reactive Orange ME24L (India, Reactive Orange 122)
7. Reactive Orange 3R (India, Reactive Orange 16)
8. Reactive Red M5B (India, Reactive Red 2)
9. Reactive Red ME4BL (India, Reactive Red 195)
10. Reactive Blue 19 (England, Reactive Blue 19)

11. Reactive Blue 3R (India, Reactive Blue 28)
12. Reactive Blue XBR (China, Reactive Blue 18)
13. Reactive Turq. Blue G (India, Reactive Blue 21)
14. Reactive Navy Blue HE2R (India, Reactive Blue 172)
15. Reactive Black B ((India, Reactive Black 5)
16. Disperse Yellow G (England, Disperse Yellow 134)
17. Disperse Orange 2RFS (England, Disperse Orange 30)
18. Disperse Red 2B (England, Disperse Red 60)
19. Disperse Ruben FL (England, Disperse Red 73)
20. Disperse Blue R (England, Disperse Blue 56)
21. Disperse Turq. BGL (local, Disperse Blue 65)
22. Disperse Black EX 300 % (England)
23. Disperse Scarlet 2GH (England, Disperse Red 54)
24. Direct Black 22 (India, Direct Black 22)

## **Appendix 7**

# **Phase-Out of Harmful Chemicals and Processes Modifications at Misr Mahalla**

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## Phase-out of Harmful Chemicals and Processes Modifications at Misr Mahalla

### 1 Phasing out of Harmful Chemicals

Based on the chemical audit, the working group consisting of the consultancy team and the company team decided to phase out the following harmful chemicals within pyjama line:

1. Hypochlorite
2. Pigment colours which contain banned azo amines, namely:
  - Ismament Yellow 2G
  - Pigmatex Yellow TCGG
  - Imperon Yellow K.R
  - Pigmatex Golden Yellow TGRM
  - Imperon Orange K.G
  - Imperon Red KG 3R
  - Imperon Violet K-B
  - Imperon Dark Brown K-BRC
3. Kerosene, totally or partially

### 2 Replacement of Hypochlorite by H<sub>2</sub>O<sub>2</sub> in Bleaching of Pyjama Fabric

Four semi-production trials were carried out in order to replace hypochlorite by H<sub>2</sub>O<sub>2</sub> in bleaching of pyjama cloth. The conventional hypochlorite bleaching method includes the following steps:

1. Grey mercerization
2. Kamilaze desizing (16 - 18 h storing)
3. Hot wash (90 °C)
4. Double scouring with intermediate and subsequent washing, each scouring recipe is as follows:

NaOH	25 g/L
Reductol KB	2 g/L
Espycon 1030	2 g/L

5. Hypochlorite bleaching: (using 1.5-2 g/L active chlorine)
6. H<sub>2</sub>O<sub>2</sub> bleaching using the recipe:

H <sub>2</sub> O <sub>2</sub> (35%)	15 g/L
NaOH	1.5 g/L
Na <sub>2</sub> SiO <sub>3</sub>	6 g/L
Organic stabilizer	2 g/L
Espycon 1030	2 g/L

followed by hot and cold washing

These processes are conducted on either Stork or Brugman bleaching range.

## 2.1 First trial

### 2.1.1 Preparation

The grey mercerized fabric (57/27) was treated with Kamilaze enzyme and entered into the Gaston County Range, where it was subjected to the following preparatory steps:

1. Hot washing (90 °C)
2. Scouring using the following recipe:

NaOH	25 g/L
Reductol KB	2 g/L
Espycon 1030	2 g/L

(storing in the J-box for 2.5 h at 90 ° -95 °C)
3. Hot (90 °C) and cold washes
4. Half bleaching, using the recipe:

H <sub>2</sub> O <sub>2</sub> (35%)	5 g/L
NaOH	5 g/L
Na <sub>2</sub> SiO <sub>3</sub>	3 g/L
Organic stabilizer	1 g/L
Espycon 1030	1 g/L

(storing in the J-box for 2 h at 95 ° -100 °C)
5. Hot wash (90 °C) and cold wash.
6. At this end, the fabric can be taken either for dyeing and/or printing or full bleaching, using the following recipe:

H <sub>2</sub> O <sub>2</sub> (35%)	10 g/L
NaOH	5 g/L
Na <sub>2</sub> SiO <sub>3</sub>	5 g/L
Organic stabilizer	2 g/L
Espycon 1030	2 g/L

The fabric is then hot and cold washed.

The result of this trial showed that:

- The half bleached fabric has a satisfactory degree of whiteness as well as wettability, that copes with those needed for dyeing and/or printing.
- The full bleached fabric has an unsatisfactory degree of whiteness.

Accordingly, the half bleached fabric was sent to the dyehouse for dyeing and to the printing house for printing.

### 2.1.2 Dyeing

In the dyehouse, the fabric was dyed with special dark shades as follows:

**Sample 1** - colour number 885 (Dark Blue) using the following mixture of reactive dyes:

- Ismative Black T
- Triactive violet 5 R
- Apolofix Yellow 5F 3R

the shade was 6.25 %

**Sample 2** - colour number 883 (Blue) using the following vat dyes mixture:

- Indanthrene Blue CLF
- Ismanthrene Black BBN
- Ismanthrene Olive Green B
- Indanthrene Red FBB

the shade was 6%

**Sample 3** - colour number 882 (Dark Green) using the following vat dyes mixture

- Indanthrene Green FB
- Ismanthrene Black BBN
- Ismanthrene Olive Green B

The depth of colour coped with the standard samples within the allowed tolerance.

The fastness properties of these samples are given in Table 1, where it can be noticed that all the fastness properties comply with the Oko-Tex Standard 100, except that of wet rubbing fastness.

This problem disappears upon further washing the samples in the washing department. Accordingly the process manager decided that all dyed fabric should be given further washing operation in the washing department before printing and/or finishing.

**Table 1: Fastness Properties of Samples 1, 2 and 3**

Sample	Wash	Rubbing		Alkaline	Water
		Wet	Dry	Perspiration	
1	3-4	2	4	4	4
2	3-4	2-3	4-5	4	4
3	3	2	4-5	4	4

## 2.2 The Second Trial

The second trial was conducted using fabric 27/57 on Brugman bleaching range. Gaston County bleaching range was not available during the time of the second trial, and the production people of the company desired to check if Brugman range can be an alternative of Gaston County range (in case of shut down or repair).

However, the design of Brugman range necessitates that the fabric is subjected to double scouring followed by half bleaching to produce half bleached fabric.

Accordingly, the grey mercerized - kamilaze treated fabric was processed on Brugman range as follows:

1. Hot wash (90 °C)
2. Double scouring using the following recipe:
  - NaOH            25 g/L
  - Reductol KB   2 g/L
  - Espycon 1030 2 g/L

(storing in the J-box for 1.5 h at 95 ° -100 °C) with intermediate and subsequent hot (90°C) washing.

3. Cold washing
4. Half bleaching, using the following recipe:

H <sub>2</sub> O <sub>2</sub> (35%)	16-18 g/L
Na <sub>2</sub> SiO <sub>3</sub>	3 g/L
Organic stabilizer	2 g/L
Espycon 1030	2 g/L
5. Hot (80 °C) and cold washing

The degree of whiteness of fabric was slightly higher than that of half bleached fabric on Gaston County range. However, the process was more lengthy and consumed more chemicals than that on Gaston County Range.

So, it was decided not to use Brugman range as an alternative for Gaston County range.

### 2.3 The Third and Fourth Trial (Gaston County)

The third trial is the same as the first one, with a slight modification of the recipes. The fabric types were 27/57 and twill 2786.

■ Scouring recipe:

NaOH	25 - 28 g/L
Reductol KB	2 g/L
Espycon 1030	2 g/L

■ Half bleaching recipe:

H <sub>2</sub> O <sub>2</sub> (35%)	7.5 - 8 g/L
Na <sub>2</sub> SiO <sub>3</sub>	3 g/L
Organic stabilizer	1 g/L
NaOH	5 g/L

■ Full bleaching recipe:

H <sub>2</sub> O <sub>2</sub> (35%)	10-12 g/L
Na <sub>2</sub> SiO <sub>3</sub>	2 g/L
Organic stabilizer	2 g/L
NaOH	3 g/L
Espycon 1030	3 g/L

The performance properties of the fabric are shown in Table 2.

**Table 2: Performance Properties of 27/57 and 2786 Fabric Type Processed According to the Third Trial**

Sample	27/57		2786	
	W.I.	Wettability (sec.)	W.I.	Wettability (sec.)
Raw fabric	25	> 180	26	> 180
Desized	30	> 180	27	> 180
Scoured	30	90	29	1
Half bleached	58	10	63	1
Full bleached	65	1.5	76	0.5

W.I. = white index

Obviously, Table 2 shows that the response of the twill fabric (2786) to the treatment was better than that of the plain fabric (27/57). The properties of the twill fabric were acceptable by the production and quality control people. The properties of the plain fabric had to be improved.

The reason for that was that the twill fabric was not subjected to grey mercerization during its processing. Accordingly, a fourth trial was conducted using 27/57 fabric omitting the grey mercerization step and proceeding the same way as that of the third trial.

Table 3 shows the fabric properties according to the fourth trial.

**Table 3: Performance Properties of 27/57 Fabric According to the Fourth Trial**

Sample	W.I.	Wettability (sec.)
Raw fabric	28	> 180
Desized	32	> 180
Scoured	37	50
Half bleached	64	2
Full bleached	70	1.5
Optical brightened	87	1.5

Table 3 shows that the wettability and the white index were improved too much according to the fourth trial.

Moreover, optical brightened fabric was accepted from the production and quality control people as compared to hypochlorite - optical brightened fabric.

## 2.4 Conclusions

Based on the above trials, the most suitable way to process cotton fabric of articles 27/57 and 2786 to get optimal white index and wettability on Gaston County range is as follows:

1. Omission of grey mercerization
2. Desizing as usual (kamilaze)
3. Hot washing (90 °C)
4. Scouring using the recipe:

NaOH	25 - 28 g/L
Reductol KB	2 g/L
Espycon 1030	2 g/L

(Storing in J - box for 2.5 h/95 - 100°C)
5. Hot (90 °C) and cold wash
6. Half bleaching using the formula:

H <sub>2</sub> O <sub>2</sub> (35%)	7.5 - 8 g/L
Na <sub>2</sub> SiO <sub>3</sub>	3 g/L
Organic stabilizer	1 g/L
NaOH	5 g/L
Espycon 1030	3 g/L

(Storing in J - box for 2.5 h / 95 - 100°C)
7. Hot (90 °C) and cold wash
8. Full bleaching using the formula:

H <sub>2</sub> O <sub>2</sub> (35%)	10-12 g/L
Na <sub>2</sub> SiO <sub>3</sub>	2 g/L
Organic stabilizer	2 g/L
NaOH	3 g/L
Espycon 1030	3 g/L
9. Hot (90 °C) and cold wash
10. Drying

It is to be noticed that the fabric can be dyed and/or printed after half bleaching.

The fabric should be thoroughly washed after dyeing to achieve the fastness properties as demanded by Oko-Tex Standard 100. This should be achieved in the washing department.

## 3 Kerosene Substitution

### 3.1 Printing on White Ground

Half bleached fabric of 27/57 was sent to the printing department, and pigment printed using two different pastes. The pattern and colour numbers were 10240 and 51 respectively.

1. The first paste has no kerosene at all (full substitution) and consists of:

Imperon thickener N2282	30 g/kg
Ammonia	5 g/kg
Imperon Binder MTB	100 g/kg
Miner Daico Binder SME	100 g/kg
Water	x g/kg
Dye	50 g/kg
<b>Total</b>	<b>1 kg</b>

2. The second paste is of low content kerosene (partial substitution) and consists of:

Imperon thickener N2282	20 g/kg
Ammonia	5 g/kg
Imperon Binder MTB	100 g/kg
Miner Daico Binder SME	100 g/kg
White spirit	150 g/kg
Water	x g/kg
Solegal WET	5 g/kg
Dye	50 g/kg

In the mean time, scaling up to pilot trial should be done.

### 3.2 Printing on Dark Dyed Ground

Fabric article 27/57 was half bleached and dark dyed with three colours (see 1.2 of replacement of hypochlorite by  $H_2O_2$  in bleaching of pyjama fabric), namely:

1. Colour No 885 (Dark Blue, reactive)
2. Colour No 883 (Blue, vat)
3. Colour No 882 (Dark Green, vat)

These fabrics were printed using aqua printing paste (mock discharge), which is ready to use printing paste based on silicon dioxide and has highly covering power. The commercial name of the paste is Ebca discharge S.

Samples 1 and 2 were printed using pattern no. 10256, colour no. 10005, whereas sample 3 was printed using pattern 10256 and colour no. 10004.

Formation of the green colour on the printed fabric was conducted using the recipe:

Ebca discharge S	980 g/kg
Imperon Green KG	20 g/kg

The fabrics were dried and cured as usual (160 °C/ 5 min). Table 4 shows the fastness properties of these fabrics as compared with those of the conventional one (full emulsion).

**Table 4 Fastness Properties of Fabrics Printed using Different Thickening Agents**

Sample	Water	Rubbing		Alkaline Perspiration	Washing
		Wet	Dry		
Full substitution	4-5	2	2	4-5	4
Partial substitution	4-5	2	2-3	4-5	4-5
Full emulsion	4-5	1-2	2	4-5	4-5

Evidently, all the samples have practically the same fastness properties; however the dry rubbing fastness is slightly lower than that demanded by Oko-Tex Standard 100 (which is 3).

This trial shows that it is feasible to substitute kerosene, partially or fully, on lab scale, without affecting the fastness properties. Accordingly other trials should be carried out to improve the dry rubbing fastness (either through increasing the binder or optimizing the thermofixation step).

Formation of the red colour:

Ebca discharge S	990 g/kg
Imperon Red KB	10 g/kg

and the yellow colour:

Ebca discharge S	980 g/kg
Helezarin Orange R conc.	10 g/kg
Imperon Yellow KRE	10 g/kg

Three samples of white ground were also printed as comparative samples. The fastness properties are given in Table 5.

**Table 5: Fastness Properties of Fabric Printed with Ebca Discharge S on Dyed and White Ground**

Ground of sample	Wash	Rubbing		Alkaline perspiration	Water
		Wet	Dry		
Dark blue	4	1-2	2-3	4-5	4-5
White	4-5	2-3	2-3	4-5	4-5
Blue	4	2-3	2-3	4-5	4-5
White	4-5	2-3	3	4-5	4-5
Dark Green	4	1-2	2	4-5	4-5
White	4	1-2	2	4-5	4-5

It is evident that the fastness properties of the samples cope with Oko-Tex Standard 100. However, the rubbing fastness is, in general, not satisfactory.

### 3.3 Conclusion

Trials should be conducted to improve the rubbing fastness, either by:

1. Optimizing binder concentration, or
2. Optimizing thermofixation step, or
3. Final finishing step

## 4 Ecofriendly Processing of Shirt and Trouser Fabrics - Pretreatment

### 4.1 Fabric Specifications

Given below are the articles and specifications of various fabrics (pyjama, pant and shirt) that are subjected to the pretreatment step.

Article	Yarn count wxf	Weight per g/m <sup>2</sup>	Width (cm)	Type	% size add-on
3081	30x30	259.3	162	synthetic	11
2786	24x12	176.3	104	natural	13
3237				natural	13
3057				synthetic	11
3084	20x20	227.4	158	synthetic	11
3097	20x20	231.9	160	natural	13
2257	40x40	116	98	natural	13
2257	40x40	116	98	natural	13

\* grey mercerized; synthetic: PVA and CMC; natural:

### 4.2 Pretreatment Processes

1000 m of desized fabric, were processed on Gaston County Bleaching Range as follows:

1. Hot wash (90 - 95 °C)
2. Scouring using recipe:
 

NaOH	25 - 28 g/L
Reductol KB	2 g/L
Espycon 1030	2 g/L

 (Storing in J-box for 2.5 h / 95 - 100 °C)
3. Hot (90 °C) and cold wash
4. Half bleaching using the recipe:
 

H <sub>2</sub> O <sub>2</sub>	7.5 - 8 g/L
Na <sub>2</sub> SiO <sub>3</sub>	3 g/L
Organic stabilizer	1 g/L
NaOH	5 g/L
Espycon 1030	3 g/L

 (storing in J-box for 2.5 h / 95 - 100 °C)

5. Hot (90 °C) and cold wash
6. Drying

Table 6 shows the performance properties of these fabrics.

**Table 6: Properties of Fabrics**

Article	Pretreatment step							
	Raw		Desized		Scoured		Half Bleached	
	Wettability (sec.)	W.I	Wettability (sec.)	W.I	Wettability (sec.)	W.I	Wettability (sec.)	W.I
3081	> 180	34	> 180	33	4	46	2	65.5
2786	> 180	35	> 180	36	5	48	2	67.5
3237	> 180	30	> 180	31	3	48	2	71.1
3057	> 180	23	> 180	26	5	38	2	63.6
3084	> 180	35	> 180	36	4	39	2	65
3097	> 180	38	> 180	39	2	49	2	70.2
2289	> 180	33	> 180	37	120	47	2.5	69.5
2257*	> 180	33	> 180	38	> 180	44	> 180	56

\* grey mercerized.

Obviously, except the grey mercerized fabric article 2257, all the half bleached fabrics have wettability and acceptable white indices, that cope with those required for dyeing. The grey mercerized fabric has got poor wettability and manifests the lowest whiteness index in comparison with other samples.

### 4.3 Conclusion

Based on the aforementioned results, it is clear that: -

1. The suggested recipes of pretreatment are valid to all types of fabrics used for production of shirt, pant as well as pyjama articles.
2. It is recommended to stop carrying out grey mercerization, as mentioned in the previous report, to get high performance properties for fabric article 2257.

## 5 Dyeing and Printing

Pretreated Shirt Fabric were printed on white or dyed background using synthetic thickener. These samples were thermofixed and their properties were tested according to Oeko-Tex Standard 100. These properties are shown in Table 7, where it can be seen that all the fabric properties coped with the Oeko-Tex Standard 100, though the rubbing fastness are at the border, but it is still acceptable.

N.B. These samples were taken to OTI in Vienna, and tested for formaldehyde, where it showed values in the range of 18 ppm.

**Table 7: Fabric Properties of Printed Shirt or Trouser Fabric**

Article	Color No	Design No	pH	HCHO content (ppm)	Fastness properties				
					Water	Rubbing fastness		Perspiration	
						Wet	Dry	Alkaline	Acidic
3237	60	10240	6.2	21	4	2-3	2	4	4
2257	121	10242	6.4	20	4	3	2	4	4
2257	53	10072	6.5	27	4	3	2	4	4
2786	444	10156	6.3	18	4	3	2	4	4
3237	46	10141	6.4	22	4	3	2	4	4
3081	1	10224	6.4	35	4	3	2	4	4
Okotex Standard 100			4-7.5	75	3	3	2	3-4	3-4