

## **TERRY TOWEL INDUSTRY AND ITS PROCESSING**

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### **Abstract**

Terry or Turkish towels were originated in Constantinople, Turkey, wherein these fabrics were woven in handlooms. In the middle of 19th century this technique of weaving towels was further refined in the European countries and took a shape of power driven looms [1,2]

Terry fabrics basically belong to the group of pile fabrics, wherein an additional yarn is introduced/ inserted in such a manner that forms loop, called as pile, to give a distinct appearance. These fabrics can be produced either by weaving or by knitting, out of these two methods of terry fabric production, woven terry fabric, which is the first method invented, still has major share [3]. This is because the quality of knitted terry fabric is not comparable to that of woven terry fabric. Besides the methods employed to manufacture the terry towels, other factors such as use of fibres, parameters of yarn, parameters of weaving, and methods of chemical processing are also play a significant role in determining the quality of terry towels [4]

### **Introduction**

In India, terry fabrics are manufactured mainly in decentralized handloom and power looms sectors [5]. Most of terry fabric centres are situated around Chennai, Erode, and Sholapur. However terry fabrics are also manufactured in organized sector. But the volume of production of terry fabrics in organized sector is much lesser than that of the production in decentralized sector. Till last decade only 10-15% of total terry fabric production was produced in organized sector [6]. Some of the prominent terry towel manufacturers in organized sector are Bombay Dyeing, Modern Terry Towels, Abhishek Industries, Garware Wall Paper, Welspun Polyesters, Trimbak Industries, Sharda Terry Towel, Santogen Exports, Vanasthali Textiles, etc. Most of the organised sector units are engaged in catering to market of export and high quality segment of domestic market.

Terry or Turkish Towels were originally woven in handloom and originated in Constantinople of Turkey. Terry fabrics, basically belong to the group of pile fabrics, wherein additional loose (with lesser tension) yarn is introduced to form loops called as piles to give a distinct appearance and effect. In the present age, pile formation is microprocessor controlled with high level of accuracy and distinct features.

The estimated annual production of terry towels is 100,000 tons and is likely to go up to 115,000 tons with ongoing expansion and new investment by 2012 in the country. The leading players like Welspun and Trident together account for nearly 70% of the country's production from organized sector [7].

### **Government Initiatives**

In addition to the above, the Government announced on 7th December, 2008 and 2nd January, 2009, packages of measures to stimulate the economy. So far as the textiles sector is concerned, the measures, inter-alia, provide for the following:

- Additional allocation of US \$533.87 million to clear the entire backlog of Technology Upgradation Fund Scheme (TUFS).
- All items of handicrafts to be included under “Vishesh Krishi & Gram Udyog Yojana (VK&GUY)”.
- Provision of Additional funds for full refund of Terminal Excise Duty/Central Sales Tax.
- Enhanced back-up guarantee to EPGC to cover for exports to difficult markets/products.
- Refund of Service Tax on foreign agent commissions of upto 10% of Freight on Board (FOB)
- Value of exports as well as refund of service tax on output service while availing benefits under Duty Drawback Scheme.
- Credit targets of Public Sector Banks revised upward to reflect the needs of the economy.
- Guarantee cover under Credit Guarantee Scheme doubled to Rs.10 million with cover of 50%.

### **THE ROAD AHEAD**

The Indian Textiles Industry has an overwhelming presence in the economic life of the country. Apart from providing one of the basic necessities of life, the textiles industry also plays a pivotal role through its contribution to industrial output, employment generation, and the export earnings of the country. Currently, it contributes about 14% to industrial production, 4 percent to the GDP, and 17% to the country's export earnings. It provides direct employment to over 35 million people. The Textiles sector is the second largest provider of employment after agriculture. Thus, the growth and all round development of this industry has a direct bearing on the improvement of the economy of the nation.

The government strategizes to attract foreign investments in the textile sector by initiating trade talks with manufacturers and business groups in Switzerland, Italy and Turkey. The aim is to tap foreign capital towards establishing green field units in textiles machinery, fabric and garment manufacturing and attracting investments in the field of technical textiles. India offers various incentives to foreign investors like low-cost labour and intellectual right protection. The government has allowed 100 per cent FDI in the textiles sector. India has a vertical and horizontal integrated textiles value chain, and represents a strong presence in the entire value chain from raw materials to finished goods.

The textile ministry expects Textile Industry to more than double to \$115 billion by 2012 from the current \$50 billion. India's share of global textile exports is

expected to increase from the current 4.0 per cent to around 7.0 per cent over the next three-years. The textile ministry is also pursuing trade agreements with the US and the European Union, which together account for almost 40 per cent of the country's textile exports. The government is looking at new markets in Russia, China, South East Asia, the Middle East, Japan and Latin America, under the new export policy. India's textile exports have shot up over 15 per cent from \$19.14 billion in 2006-07 to \$22.13 billion in 2007-08.

Till last decade, Indian terry towel industry was dominated by decentralized Handloom and Power-loom sectors of Panipat, Karur, Erode, Mumbai, Sholapur, Ahmedabad and Delhi constituting the share of over 80% of the total production of Towel Industry. But, for the last 10 years, many of the organized sectors have entered in this segment [9].

Organized Sectors are mainly moving from mid low end to mid high end market whereas decentralized Sholapur, Panipat are concentrating more on low end and domestic market. Some of the high quality power loom fabrics from decentralized sectors are being slowly accepted in leading markets of USA and EU. Many of the Indian companies are also expected to enter in the World Market predominantly through acquisition and branding with this segment in the years to come.

### Future Prospects

The usage of towels in domestic market is constantly increasing with the expansion of hospitality services and opening of Trade Centers and Malls. The Market for Terry Towel has been growing rapidly. The Indian domestic Textiles industry is worth Rs.1,75,000 Crore. The Terry Towel Sector is zooming with the new EXIM Policy and increase in demand from US Markets. USA is the World's single largest buyer for Made-ups and Terry Towels. India, China and Pakistan together supply 65% towels, 81% of sheets and 79% of comforters imported by USA. While India has a dominant position in America's terry towel import, with a share of around 26%, India's home textile contributes around 22% i.e. US \$ 4.1 billion to India's textile export of US \$ 19 billion. However, the share of terry towel is just 5.8% of total home textile export i.e. US\$ 255 million in 2005-06 and US\$ 239 million in 2006-07, and there is a room to grow. Till recent time, marketing effort was concentrated in USA, but many are looking for other markets of the EU and other parts of the World. In view of this the Company is confident of serving new markets with higher profitability on its revival.

Structural Changes as far as textile industry is concerned are given in Table 1&2 and represented in Graph 1.

**Table 1: Structural Change: Asian Dominance in Home Textiles**

<b>Textiles and Clothing</b> US\$708bn	<ul style="list-style-type: none"> <li>• China:36%</li> <li>• India :4%</li> </ul>
<b>Textiles</b> US\$286 bn	<ul style="list-style-type: none"> <li>• China:33%</li> <li>• India :5%</li> </ul>

Home Textiles US\$40 bn	<ul style="list-style-type: none"> <li>India, China and Pakistan: 85%</li> </ul>
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**Table 2: Structural Change: Non-India players facing challenges**

China	Pakistan	Bangladesh
<ul style="list-style-type: none"> <li>Big Importer of cotton</li> <li>Losing export Competitiveness</li> <li>Focus shift from textiles to higher value-added industries</li> <li>Wage inflation</li> <li>Rising power costs</li> <li>Stricter environmental compliance</li> <li>Focus on domestic consumption</li> <li>Yarn capacity closures</li> <li>Yuan appreciation</li> </ul>	<ul style="list-style-type: none"> <li>Cotton Importer</li> <li>Energy issues</li> <li>Geopolitical issues</li> <li>Compliance issues</li> </ul>	<ul style="list-style-type: none"> <li>Negligible Cotton Production</li> <li>Environmental compliance issues</li> <li>Workers' safety issues</li> </ul>

**Graph 1: Structural Changes: More Prominent in Home Textiles**



## TERRY TOWEL PROCESSING

The main fiber which is used in towels is cotton. As cotton fiber is not sensitive to alkali or chlorine bleach but is to acids, all the dyeing and finishing processes must be planned with these conditions. Like other textile materials the dyeing and finishing stage of terry towels generally follow the workflow

## PRETREATMENTS OF TERRY TOWELS

Cotton needs a pretreatment before dyeing. Fiber preparation ordinarily involves scouring to remove foreign material and thus ensures even access to dye liquor from the dye bath. This was done before the Spinning Stage, but after words we

took the yarns and put sizing on them, this must be removed. The steps of pretreatment are shown below:

- Desizing
- Scoring
- Bleaching

Desizing is intended to remove size from the fabric to ensure even bleaching, level dyeing and soft handle. Desizing processes differentiate according to the sizing agent used. The classical desizing process consists of removing the starch from towel fabric using enzymes. This desizing process simply involves liquefying the film of size on the product. Bacterial, malt and pancreas amylases are used as desizing agents.

**Enzymatic Desizing:** This classical desizing process consists of removing the starch from towel fabric using enzymes. This desizing process simply involves liquefying the film of size on the product. Bacterial, malt and pancreas amylases are used as desizing agents. Enzymatic desizing is the classical desizing process of degrading starch size on cotton fabrics using enzymes. Enzymes are complex organic, soluble bio-catalysts, formed by living organisms that catalyze chemical reaction in biological processes. Enzymes are quite specific in their action on a particular substance. A small quantity of enzyme is able to decompose a large quantity of the substance it acts upon. Enzymes are usually named by the kind of substance degraded in the reaction it catalyzes.

The enzymes generally employed for desizing are:

- $\alpha$  – amylase
- $\beta$  – amylase
- amyloglucosidase

Amylase is the enzyme that hydrolyses and reduced the molecular weight of amylose and amylopectin molecules in starch, rendering it water soluble enough to be washed off the fabric. Effective enzymatic desizing requires strict control of pH, temperature, water hardness, electrolyte addition and choice of surfactant. Enzyme sources are either from animal origin (slaughter house waste – pancreas, clotted blood, liver etc.), vegetable origin (malt extract – made from germinated barley), and bacterial (produced by growing cultures of certain micro organisms). Bacterial enzymes are preferred because of their activity over a wider pH range and tolerance to variations in pH. Since desizing is carried out on grey fabric, which is essentially non-absorbent, a wetting and penetrating agent is incorporated into the desizing liquor. Bacterial enzymes are commercially available in three grades:

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variations in pH. Since desizing is carried out on greige fabric, which is essentially non-absorbent, a wetting and penetrating agent is incorporated into the desizing liquor.

## **DYEING OF TERRY TOWEL**

It is over thirty years since reactive dyes for cellulose were introduced and they now account for about 25% of the total dye consumption on that fibre. There emerged after the results of the work on the mechanisms of organic reactions were in place and their enabled their development to be characterized by the study and application of reaction mechanisms involved in the dye-fibre reaction. This factor has paid handsome dividend. The work continues, increasingly gaining cost-effectiveness by enhancing reaction mechanisms, such as polymerization, have met with little success and the simple nucleophilic substitution and addition mechanisms of dye fixation remain totally dominant.

The following factors rightly justify the usage of reactive dyes world wide

Bright shades

Good Fastness properties

Easy application

Moderate cost

Eco-friendliness

**Bright shades:** The reactive dyes are the brightest dyes available for the cellulosic fibres and have a full range of shades.

**Good Fastness properties:** Colour Fastness may be defined as "the resistance of a material to change in any of its color characteristics, to transfer its colorant(s) to adjacent materials, or both, as a result of the exposure of the material to any environment that might be encountered during the processing, testing, storage, or use of the material"

**Wash Fastness:** Textile materials coloured with reactive dyes have very good wash fastness properties. The wash fastness rating is about 4-5. This is attributed to the very stable covalent bond that exists between the dye molecule and the fibre.

**Light Fastness:** Textile materials coloured with reactive dyes have very good light fastness. The light fastness rating being about 6. These dyes have a very stable electron arrangement and provide very good resistance to the degrading effect of the U.V component of sunlight. There are, however, some reactive dyes with only fair light fastness

**Bleaching fastness:** The reactive dyes are stable to peroxide bleaching and so are suitable for dyeing cotton yarns to be used as effect threads. Strong reducing agents and chlorine, however, destroy the chromogens.

**Easy application:** Reactive dyes offer a great flexibility in application methods with a wide choice of equipment and process sequences and so have become very popular. These are applied through exhaust and continuous systems both very comfortably. Following is the list of equipments used for the application of these dyes:

a) Exhaust/Batch/Dis-Continuous Dyeing Systems

Jigger Open Width 3-5:1

Winch Rope Form 20:1

Jet/Soft Flow Rope Form 15:1

Beam Dyeing Open Width 10:1

Star Frame Open Width

b) Semi-Continuous Dyeing Systems

Pad-Batch

Pad-Jig

Pad-Roll

c) Continuous Dyeing Systems

Pad-Thermosol

Pad-Steam

**Moderate cost**

Reactive dyes as compared to vats are of lesser costs considering the fastness properties of both. The dyeing process involved in vat dyeing is also costly which involves certain steps like reduction and oxidation. On the other hand reactive dyeing is free from these steps.

**Eco-friendliness**

Many consumers also appreciate the eco-friendliness of fiber reactive dyes. Some companies process the dyes with natural ingredients and materials, focusing on creating a product with a minimum of harmful waste. Since the dyes are colorfast, they will not bleed into wash water, leading to a reduction in dye-laden water runoff, which can be harmful for the environment.

**Aquarius Dyeing: Relax your exhaust dyeing process [11]**

Aquarius is an open width dyeing machine for terry towels. It offers shorter process time with lower water, energy and steam consumption.

Aquarius meets the advantages of both exhaust and pad-batch processes in one single machine, combined with the fact that the fabric is gently transported in

open width form without tension making it possible to achieve best results. Additional advantages are:

- Appearance and handle of towel
- Less fabric weight loss (approx. 3-5%)
- Lowest water, steam and power consumption

The advantages of this concept are mainly based on the high number of interchanges between fabric and bath, during pre-treatment, dyeing and wash-off. This effect is supported by the foulard-squeezer, reducing the liquor content of the fabric after the dyeing section on each cycle. Therefore dye liquor absorption by the toweling re-entering into the dyeing section is very high, contributing to an excellent appearance and colour yield.

### Package Dyeing:

For package dyeing, yarn is wound on dye tubes as packages, each with a hollow center that allows liquid to flow through it. The packages are stacked on perforated, hollow posts, and dye liquor is pumped through these. Package machines are enclosed and can be pressurized so dye liquor can reach temperatures above atmospheric boiling point (100°C) for faster dyeing. The term yarn-dyed is associated with quality in woven fabrics. A pattern with dyed yarns looks sharper than one printed. The fabric will probably be more colorfast, and it is also reversible. The yarn dyeing process takes place between spinning and weaving steps

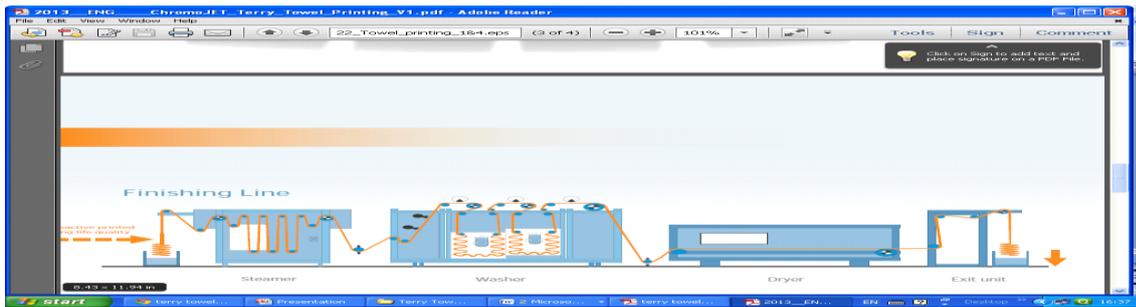
## PRINTING OF TERRY TOWELS

Printing is local dyeing in zones according to patterns. Thickeners ensure that these zones defined by the engraved pattern are adhered to. The type and size of the artistic design determine the printing process and method of dye paste application. Various printing types like direct printing, discharge printing and resist printing and techniques like roller printing and full screen printing are available for the colorist to realize the print idea.

### Croma JET Printing [12]

Printing Line Entry unit Length control Dryer Exit unit





### ChromoJET characteristics

- **ChromoJET is the only digital printing system for terry products and other pile fabrics.**
- ChromoJET is a **well proven technology** which has been adapted to print on terry products.
- The jets are injecting the dye deep into the terry fabric, so **any desired penetration** can be achieved.
- ChromoJET works with **all dyestuff groups** (reactive, acid, disperse, pigment, ...).
- The **modular concept** offers to extend the number of colours and jets from 8 colours/64 jets to 16 colours/
- 256 jets at any time to increase flexibility and productivity.

### ChromoJET specifications

- **Printer type:** Digital jet printer with high speed valves
- **Fabric thickness:** 2 – 20 mm
- **Fabric weight:** 200 – 600 g/sqm
- **Processing:** Roll to roll or piece to piece
- **Max. fabric width:** 2.2 m
- **Number of colours:** 8, 12 or 16
- **Jets per colour:** 64, 128 or 256
- **Resolution:** 50 dpi and 72 dpi
- **Print speed:** 30, 60 or 120 sqm per hour (depending on number of jets per colour and resolution)
- **Printpaste/Dyestuff classes:** Commercially available reactive, disperse, direct, acid, cationic and pigment dyes

**Viscosity:** up to 100 cps

**Pre treatment:** not needed

### Advantages of ChromoJET

- Maximum efficiency in short runs
- Lower cost for stock goods – just in time delivery
- No screens needed – unlimited repeat sizes
- Design change ”on the fly”
- Low paste cost due to standard commercially available dyestuff

- High fastness level
- Brilliant shades
- No fabric pre-treatment needed
- Adjustable penetration
- Spot colours with easy cleaning of paste supply system

## **FINISHING OF TERRY TOWELS**

Final finishing includes all the finishing treatments applied to the fabric after dyeing and printing it can be divided into two:

1- Chemical (or Wet) Treatments

2-Mechanical (or Decorative), Treatments

### **Chemical Treatments:**

Softening, hydrophilling and antimicrobial treatments are among the chemical finishing processes of terry towels

**Hydrophilic Treatment:**

Silicones are added to the towel to give hydrophilic properties. It is also used to give a soft handle.

### **Softening:**

The three basic types of softeners which are used on towels are cationic softeners, non-ionic softeners and silicones. Cationic softeners give good softness, but also some yellowness, so are only used for colored towels. Non-ionic softeners have less softening effect but are used in white towels due to the colorlessness of the chemicals. Silicones are the best and the most expensive of the softeners. Hydrophilic silicones also affect the hydrophilicity of the towel positively. There are also applications of enzymatic softening using cellulases.

### **Antimicrobial Treatment:**

Towels can be treated with antimicrobial finishes in order to prevent mold and mildew, reduce odor and minimize spread of harmful organisms. Two types of antibacterial and deodorant finishes are available. The first is applied during fiber-forming process, whereas the other is incorporated into the finishing process. The second approach is more versatile and widely adapted. Chemical entities are responsible for imparting antibacterial attributes including fungicides and bactericides. Obtaining antimicrobial properties by using antimicrobial fibres is achieved by anchoring the antimicrobial agent in the fiber. Trevira Bioactive (R) is an example of antimicrobial fiber used in towels which has proven to fully retain its antimicrobial effect after 100 domestic or 50 commercial wash cycles.

### **Mechanical Treatments:**

The main aims of dry treatments are to give the towels fuller volume, and dimensional stability and Dryness

### **Tumble Drying:**

The towel is given a fluffy and soft hand, and some particles are removed during drying. The common way is to use continuous tumbler dryer generally called Turbang®, which is the brand name of the machine brand. The second way is to use tumble dryers which are a huge version of domestic tumble dryers.

### **Stentering:**

Stentering or tentering is a controlled straightening and stretching process of cloth which has been pulled out of shape due to the many vigorous finishing processes. The selvages of the cloth are attached to a series of pins/hooks/clips as it is fed through a stenter machine which is an oven of controlled temperature. During the process, as the pins/hooks/clips are gradually placed further apart width ways, the cloth is slowly and permanently brought out to the desired width. Stentering gives the fabric particular dimensions of length and width, and eliminates creasing.

### **Cutting and Sewing:**

In this stage, towels pass through four steps

- Longitudinal cutting
- Longitudinal hemming
- Cross cutting
- Cross hemming

These processes are achieved by scissors and standard sewing machines by workers or by machines specialized in towel cutting or sewing or even by automatic machines which can carry out some of or all of the mentioned processes. Lengthwise cutting machines are used for the first step of this stage, longitudinal cutting of towels which have been produced on the weaving loom as several panels joined side by side. In these machines, there are several cutters which cut lengthwise between adjacent towel panels in order to separate them. The cutting process can be carried out by means of a pressing blade on a motorized roll in the lengthwise cutter.

Next, longitudinal hemming is achieved by lengthwise hemming machines, most of which are usually equipped with two 401 chain stitch sewing machines, one on the right side and one on the left side, for the longitudinal hemming of towels. Labels can be attached during lengthwise hemming. After lengthwise hemming, towels pass through cross cutting as the third step. Transversal cutting machines carry out product stacking and automatic discharge. The cut product is stacked in layers one on the other.

## **CONTINUOUS PRETREATMENT AND DYEING OF TERRY TOWEL FABRIC [13]**

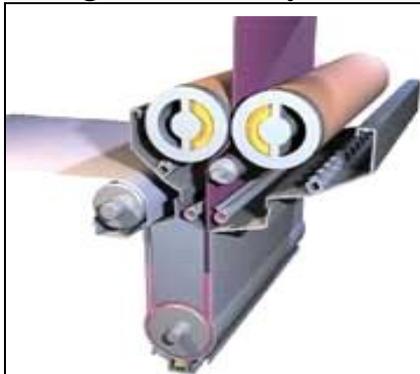
Küsterns high performance machines ensure uniform dyeing, perfect steaming and excellent fastness.

For dyeing Küsterns provides the S-roll padder with two swimming rolls. Even in case of large fabric widths this padder achieves exactly the same color from one

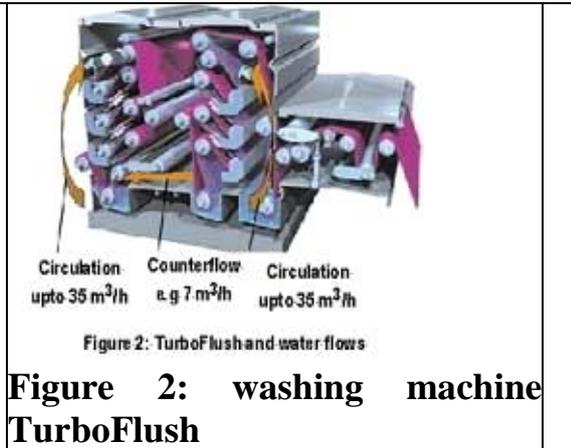
edge of the fabric to the centre and to the other edge. By the 2 S-rolls a completely uniform nip pressure is achieved, even at working widths of 3000 mm and above. This is absolutely necessary for uniform dyeing. The technology of the dyeing padder with two S-rolls is unique worldwide.

This padder can be equipped with different dyeing troughs. Small liquor contents lead to economical dyeing solutions and a high flexibility. Low wastage amounts occur during color changes. Furthermore, a tailing length is substantially shortened. High turbulences in the dyeing trough lead to an intensive exchange. One example for a dyeing trough with small liquor content in combination with a long web path under liquor is the U-Shaft, which is shown in combination with two S-rolls in Figure 1. The level of the trough contents is kept constant by a level control system. This works closely together with the highly recommendable dosing system, which mixes the color online and feeds it into the dyeing trough. By this way the dyeing liquor has exactly the same formulation from the first drop to the last, the level of the trough content is constant and only the needed amount of dyeing liquor is prepared.

Small liquor contents and the dosing system in combination with a quick cleaning device lead to highest flexibility. All relevant parameters are computer-controlled. The control system also includes a temperature control as well as a tailing correction system.



**Figure 1: Dyeing padder**



**Figure 2: washing machine TurboFlush**

The Küsters dyeing padder may be introduced in different ranges like a Pad Steam range, a Pad Flex Steam range or a CPB centre. It is also possible to design a range in a way that it is suitable for continuous dyeing as well as for CPB dyeing.

### **Perfect Steaming**

Uniform pretreatment and dyeing results depend on uniform steam conditions in a steamer. Küsters provides steamers for both processes. They are equipped with precision rolls; drives for the rolls are available. To achieve best steam conditions for both purposes a cloud control system is used. This cloud control system measures the steam conditions at the bottom of the steamer. By this way it is possible to introduce only the amount of steam which is really necessary for the process. This steam is introduced at the top of the steamer. Numerous steamers

are already equipped with the cloud control system. By this way it was possible to reduce the steam consumption substantially and to improve economics of continuous processes.

### **Excellent Fastness**

Especially in case of processing terry towel washing plays an important role. In most cases production speeds are below 60 m/min. The objective is to achieve highest fastness with low water and energy consumption. Another important point is the cloth guiding through the machine without any creases or deviations of the fabric.

Küsters recommends the washing machine TurboFlush (Figure 2) for the washing of terry towel fabric. This machine is equipped with a highly efficient circulation system. The circulation system causes a high turbulence in the washing machine and an intensive contact and exchange between the washing liquor and the fabric. This intensity does not depend on the production speed as the circulation is done by a pumping system. High washing efficiencies are obtained over a wide range of production speeds, starting already at very low speeds.

Each TurboFlush has two circulation systems. Each circulation system has a flow rate of up to 35 m<sup>3</sup>/h. Water, which enters the machine, e.g. as fresh water or by a counter flow, is circulated several times before leaving the machine. If the machine is entered by a flow rate of 7 m<sup>3</sup>/h the water circulates 10 times between entering and leaving a TurboFlush. Figure 2 shows this different flows in the machine. Furthermore in the TurboFlush there are 6 small troughs and 2 application pipes. By leaving the application pipe and every small trough the liquor is applied on the textile again, so that in total washing liquor is applied to the textile 80 times in this example. Furthermore in every small trough and in the troughs at the bottom of the machine a turbulent washing takes place.

These are the main reasons for the high efficiency of the TurboFlush even at low production speeds, as the turbulences and the contacts between washing liquor and textile are not introduced by the textile but by the circulation systems.

It is possible to equip each circulation system with an automatic drum filter to extract loose fibers. This filter is automatically cleaned. Of course the filters are suitable for the full circulation flows. The TurboFlush is essentially a completely steam tight machine, which works at boiling temperature.

As also shown in Figure 2 the TurboFlush has small troughs at its bottom with low liquor contents. This leads to shorten set up times as only small amounts of water have to be heated to boiling temperature. This results also in very small water quantities which have to be exchanged during changing lots.

Another important point is the short distance between the rolls in the TurboFlush. This leads to an optimum cloth guiding and avoids creases and deviations of the web.

Many ranges exist which are equipped with the TurboFlush, even for the treatment of terry towel. This machine has proved in many applications that

excellent fastness are achieved with minimum water and energy consumption. The washing results are also achieved at low production speeds. For the treatment of terry towel additional equipment is available for the TurboFlush which gives a further enhancement to the fluff and bulk of the terry towel material.

The most interesting result in washing is fastness. In many cases during washing after dyeing same fastness could be achieved with less water, but until now a suitable measurement and control system is not available for this purpose. Küsters actually develops a measurement device, which was already presented during ITMA 2003 in Birmingham. With this measurement device it will be possible to determine the concentration of dyestuff in the washing bath. It will be possible to adjust the water consumption of a washing range exactly to the desired fastness of the product. Trials have been done and show that in several cases water consumption could be reduced substantially. This measurement system will be available soon. It will also be possible to install this measurement system in already existing Küsters washing machines.

### **Flexnip application for bleaching and dyeing**

The Flexnip is a machine for the application of chemicals to the fabric. It is used for wet in wet processes as it allows to add the chemicals to the textile. This machine is suitable for the application of bleaching liquor to the fabric as well as for the application of chemicals in case of VAT dyeing. In case of reactive dyeing this machine is also suitable to achieve dark shades. Numerous ranges in the US are equipped with the FlexNip for the dyeing of terry towel fabrics. Making use of the combination of Küsters S-roll paddlers and the FlexNip led to high savings in dyestuff consumption for both reactive dyes and vat dyes. In case of reactive dyestuff the consumption could be reduced about some 20%. Range layout for pretreatment and dyeing

### **Processing of terry towel fabrics has the following characteristics:**

Large production amounts per lot. Growing production amounts, especially in Asia High economic pressure. Increasing quality demands from the customers with constant results all over the year. To meet these characteristics Küsters designed continuous pretreatment and dyeing ranges adapted to the demands of Asian Terry Towel finisher. These ranges are suitable for a start with small production amounts and to get extended if production amounts grow. Different ranges are available for production amounts of 6 t/day, 12 t/day, 25 t/day and 50 t/day. Of course further extensions of these ranges are possible for increasing production amounts.

### **The modular system gives the following solutions**

In case of small daily production amounts a CPB bleaching is recommended. This includes the step of desizing as well. Washing after bleaching is done on a TurboFlush washing range, followed by a can dryer. CPB dyeing will be done

on the same padder as used for CPB bleaching. Washing after dyeing will be done on the same range as washing after bleaching.

For growing production amounts dyeing is done on a CPB padder. Desizing and bleaching are done on a continuous range. The washing line of this range is also used for washing after dyeing. As an alternative it is possible to use a separate padder with one S-roll for bleaching. Dyeing is done continuously. Washing after bleaching is done on the washing line of the dyeing range.

For high production amounts a continuous bleaching range and a continuous dyeing range are proposed. Especially for continuous dyeing of dark shades a combination of a Küsters dyeing padder with 2 S-rolls and a FlexNip lead to best results. This is in many cases proved by ranges in the US. This shows that the proposed ranges can grow with increasing production amounts. All range proposals make use of the above described Küsters machines with their unique advantages.

**Economical point of view**

From the economical point of view a continuous treatment of terry towel fabrics is highly recommended, especially in comparison with a discontinuous treatment. Continuous treatment leads to a low consumption of water and energy. Furthermore the handling properties and the internal logistics for the batches are very easy in case of a continuous treatment in open width, especially in case of large production lots.

Additionally Küsters provides outstanding machines like the Küsters S-Roll padder, the FlexNip, the TurboFlush and the steamers. All of these machines are to be combined in a modular system, exactly adapted to the needs of the customers. Furthermore they all give their tribute to an economical production by low liquor contents, low wastage and low water and energy consumption in combination with optimized finishing results.

An excellent example for the economy of Küsters machines is the water efficiency of the Turbo-Flush. Figure 3 shows data which were measured during washing trials. In this case two ranges were compared. One range was made from three Compacta up-and-down-washing machines with a cloth content of 30 m each. Between the washing machines intermediate squeezers were situated. The other range was made from three TurboFlush with a cloth content of 20 m each, also with intermediate squeezers between each washing machine.

Tests were done by washing out of caustic soda. The test results show that a TurboFlush achieves at a water amount of 3 l/kg the same washing results as a Compacta at a water amount of 6 l/kg. As a result washing with the TurboFlush is found to be very efficient and economical.

## **ORGANIC TOWELS**

The processing of textiles should be cost effective and environment-friendly. Innovative and efficient strategies to achieve these goals are needed.

Washcloths, hand towels, bath towels: pesticides, bleaches, and dyes. The journey from the cotton field to the towel rack leaves a pretty large and cavernous footprint. Not only does towel manufacturing put harmful chemicals in our soil and waterways, the pesticide-heavy cotton business has long been associated with child labor abuses in Egypt and other areas. Additionally, according to the Consumer Foundation, the same chemicals that threaten wildlife and aquatic life through runoff pose serious harm to human health when towels are used before laundering.

Greenies know choosing bathroom linens means more than just picking out colors. Towels made from organic or sustainable fabrics don't require the heavy chemical use that conventional crops do, which means our soil and water is left untainted and harvesting the plants is a much safer process for workers. Likewise, towels made from sustainably harvested natural fibers typically come from resources that are rapidly renewable. Ultimately, buying eco-friendly towels helps you go green because fewer chemicals are used in farming and manufacturing, which means you're effectively combating global warming! So the next time you're in the market for new towels, choose unbleached, undyed cotton or 100 percent organic bamboo or hemp towels dyed with low-impact vegetable dyes.

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