

## 6<sup>th</sup> Sem. B.Tech ( Fashion & Apparel Technology)

### PCFT4303 GARMENT PROCESSING & FINISHING

#### **Module– I (14 hours)**

**Brief study on Machineries for dyeing of Fabric** - Jigger, Padding Mangle, Winch, rotary drum, H.T.H.P dyeing, Jet dyeing machine, their functions and uses.

**Garment Dyeing : different Garment dyeing method and procedure** for knitted and woven garments. Dyeing processes and fastness properties.

#### **Module–II (10 hours)**

**Garment Printing** – study of different method of printing example flat bed printing, screen printing and roller printing. Study of different type of printing used on Garment – Khadi Printing. Foam Printing, ,Metallic Printing, Fluorescent Printing, Plastizol Printing, High Density printing. Transfer Printing techniques.

**Garment Finishing** – Finishing process for garments made of woven fabric, Process for finishing garment made of denim fabric, Finishing of Knitted Garment, Enzyme Finishing for garments, Garment Finishing machinery. Fire retardant, foam and soil release finish for garment.

#### **Module III (10 hours)**

Functional finishing of garment for specific use- medical application, environ protection, space application, marine application, sports application, defence application etc.

**Care of Garment** – Suitable techniques for removal of stains on clothing (due to coffee, tea, curry, blood, oil, ink, mildew, paints, rust, etc. Techniques of Dry cleaning for clothing of different textile fibre, Equipment in laundering. Use of washing machine. Indigenous Laundering agent and their uses.

#### **REFERENCE BOOKS:**

1. Dyeing and Chemical Technology of Textile Fibres E. R. Trotman
2. Technology of Bleaching, V. A. Shenai
3. Technology of Dyeing, V. A. Shenai
4. Finishing of Garments and Knits, NCUTE Publication.
5. Finishing of Garments & Knitwears, NCUTE pilot programme
6. Garment Manufacturing Technology, NCUTE Publication
7. The care of Textile Product, Phyllis G.Torota **MODULE -1**

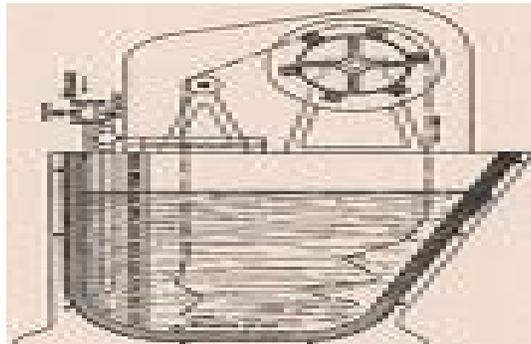
## **MODULE 1**

### **Brief study on Machineries for dyeing of fabric**

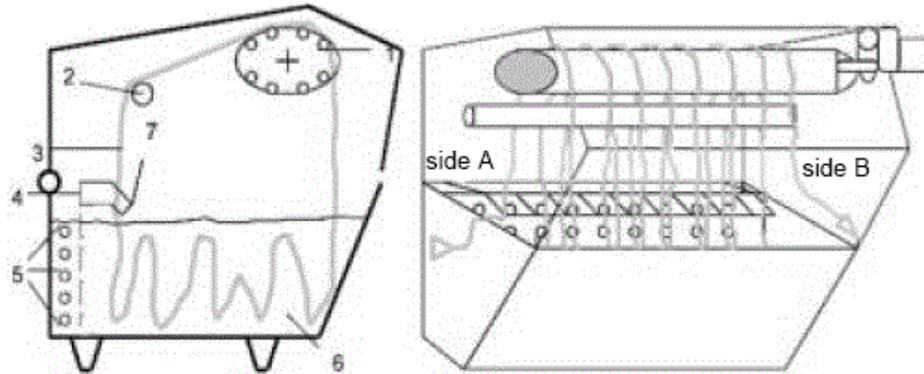
#### **Lecture Note 1**

#### **WINCH DYEING MACHINE**

A dyeing machine consisting essentially of a dye vessel fitted with a driven winch (usually above the liquor level) which rotates and draws a length of fabric, normally joined end to end, through the liquor.



Winch dyeing <http://textilelearner.blogspot.com/2011/12/modern-concepts-of-theory-of-dyeing.html> machine is a rather old dyeing machine for fabrics in rope form with stationary liquor and moving material. The machine operates at a maximum temperature of 95-98°C. The liquor ratio is generally quite high (1:20-1:40). Winch dyeing machines are a low cost design that is simple to operate and maintain, yet versatile in application proving invaluable for preparation, washing or after treatments as well as the dyeing stage itself. In all winch dyeing machines a series of fabric ropes of equal length are immersed in the dye bath but part of each rope is taken over two reels or the winch itself. The rope of fabric is circulated through the dye bath being hauled up and over the winch throughout the course of the dyeing operation. Dye stuff and auxiliaries may be dosed manually or automatically in accordance with the recipe method.



- |                          |                   |
|--------------------------|-------------------|
| 1 – Winch                | 5 – Heating coils |
| 2 – Guide cylinder       | 6 – Liquor        |
| 3 – Fabric rope          | 7 – Rack          |
| 4 – Perforated separator |                   |

### **Description and Dyeing Method on Winch Dyeing Machine**

The basic principle of all winch dyeing machines is to have a number of loops or ropes of the fabric in the dye bath, these ropes are of equal length, which are mostly immersed in the liquor in the bath. The upper part of each rope runs over two reels which are mounted over dye bath. At the front of the machine, above the top of the dye liquor, is a smaller reel, which is called jockey or fly roller.

The fly roller remains free wheeling along with fabric rope. At the back of winch tank is the winch wheel, which pulls the fabric rope from the dye bath over the jockey reel for dropping in the dye bath for immersion. From the dropped location, the fabric rope travels back to be lifted and fed to winch wheel.

The dyeing process on winch **dyeing machines** is based on higher M:L (material to liquor ratio) as compared with other dyeing machines. The process is conducted with very little tension. The total dyeing time is lengthier as compared to other machines.

### **Advantages of Winch Dyeing Machine**

1. Construction and operation of winch are very simple.
2. The winch dyeing machines are suitable for wet processing operations from desizing to softening.
3. The winch dyeing machine is suitable for practically all types of fabrics, which can

withstand creasing in rope form processing.

4. The tension exerted on winch is less than jigger dyeing machine , the material thus dyed is with fuller hand.
5. The appearance of the dyed goods is clean and smooth on winch dyeing machines.

### **Limitations of Winch Dyeing Machine**

1. Batch dyeing operations needs trimming, sewing, opening out the rope, loading and unloading for individual lots separately.
2. Since several lengths of fabric are run over the winch reel into the liquor and sewn end to end, continuous length processing is not possible in a single batch.
3. Fabric is processed in rope form which may lead to crease marks, particularly in heavy, woven, thin and light synthetics.
4. Most of the machine works under atmospheric conditions.

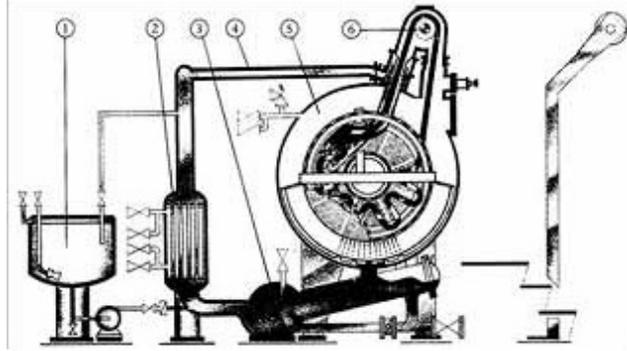
### **Lecture Note 2**

#### **Jet Dyeing Machine.**

It was found that in using winch machines there were some inherent problems. The Jet dyeing machines came up in the 1970's, were specifically designed to overcome those shortcomings.

In the Jet dyeing machine the reel is completely eliminated. A closed tubular system exists where the fabric is placed. For transporting the fabric through the tube, a jet of dye liquor is supplied through a venturi. The Jet creates turbulence. This helps in dye penetration along with preventing the fabric from touching the walls of the tube. As the fabric is often exposed to comparatively higher concentrations of liquor within the transport tube, little dye bath is needed in the bottom of the vessel. This is just enough for the smooth movement from rear to front. Aqueous jet dyeing machines generally employs a driven winch reel along with a jet nozzle.

The following diagram explains the functioning of a Jet dyeing machine:



### **Types of Jet Dyeing Machine:**

In deciding the type of dyeing machine, the following features are generally taken into consideration for differentiating.

Shape of the area where the fabric is stored i.e. long shaped machine or J-box compact machine and type of the nozzle along with its specific positioning i.e. above or below the bath level.

Depending more or less in these criteria for differentiation following types of Jet Machines can be said to be as developments of the conventional jet dyeing machine.

Overflow Dyeing Machine

Soft-flow Dyeing Machine

Airflow Dyeing Machine

### **Advantages of Jet Dyeing Machine :**

The Jet Dyeing Machine offers the following striking advantages that makes them suitable for fabrics like polyesters.

Low consumption of water

Short dyeing time

Can be easily operated at high temperatures and pressure

Comparatively low liquor ratios, typically ranges between 1:4 and 1:20

Fabrics are handled carefully and gently.

### Lecture Note 3

#### **Soft Flow Dyeing Machine:**

In the soft flow dyeing machine water is used for keeping the fabric in circulation. The conceptual difference of this equipment from a conventional jets that operates with a hydraulic system is that the fabric rope is kept circulating during the whole processing cycle (right from loading to unloading). There is no stopping of liquor or fabric circulation for usual drain and fill steps. The principle working behind the technique is very unique. There is a system for fresh water to enter the vessel via a heat exchanger to a special interchange zone. At the same time the contaminated liquor is allowed to channel out through a drain without any sort of contact with the fabric .

#### **Key Features of Soft flow Dyeing Machine:**

Significant savings in processing time.

Savings in water that is around 50%.

Excellent separation of different streams results in optimum heat recovery and a distinct possibility of further use or a dedicated treatment.

#### **Principle of Soft Flow Dyeing Machine:**

Textile material can be dyed using batch, continuous or semi continuous process.

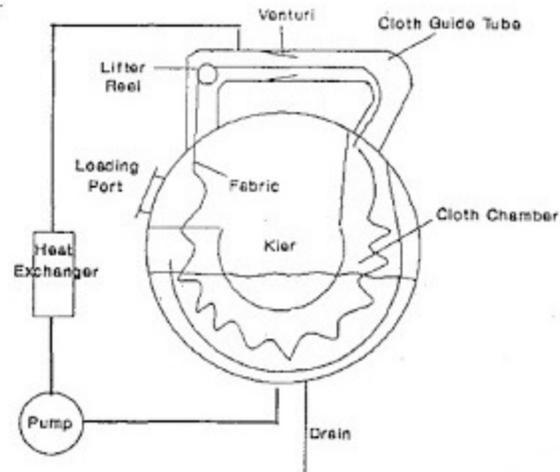
Batch processes are the most common method used to dye textile materials. There are three general types of batch dyeing machines:

- In which fabric is circulated
- In which dye bath is circulated
- In which both the bath and material are circulated.

Jet dyeing machine is the best example of a machine that circulated both the fabric and the dye bath. Jet dyeing is used for knitted fabrics. For Terry-towels soft flow dyeing is use.

In jet dyeing machine the fabric is transported by a high speed jet of dye liquid.

As seen in the figure below, this pressure is created by venturi. A powerful pump circulates the dyed bath through a heat exchanger and the cloth chamber. Cloth guide tube helps in circulation of fabric.



### Lecture Note 4

#### Types of Soft Flow Dyeing Machine:

A few of the commercially popular brands along with their particular technical specifications are discussed here.

#### Multi Nozzle Soft Flow Dyeing Machine:

##### **Technical Features:**

Very low Liquor ratio - around 1:1

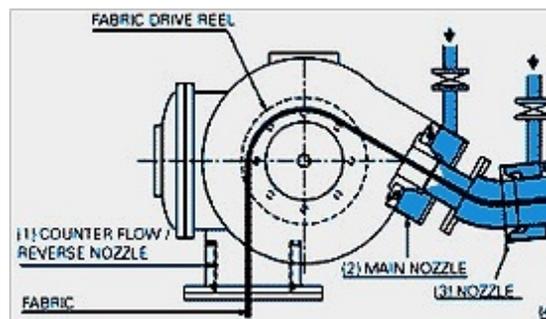
Can reach high temp. up to 140°C

Easily dye 30 to 450 g/ sq meter of fabrics (woven & knitted fabrics)

Number of very soft-flow nozzles

No pilling effect

Wide capacity



Multi Nozzle Soft flow Dyeing Machine

## **High Temperature High Pressure Soft Flow Dyeing Machine :**

### **Technical Features:**

Compact body made of stainless steel.

High efficiency heat exchanger for quick heating/cooling.

Heating rate - around 4°C/min up to 900°C - around 3°C/min up to 135°C at steam pressure of 6 Bar.

Cooling Rate- around 4°C/ min at water pressure of 4 bar and 15°C.

Maximum working temp is 135°C.

Maximum working pressure of 3.2 bar.

Control manual as well as automatic.

Heavy duty stainless steel pump.



## **High Temperature High Pressure Soft Flow Dyeing Machine :**

1. The vigorous agitation of fabric and dye formulation in the cloth increases the dyeing rate and uniformity. It minimizes creasing as the fabric is not held in any one configuration for very long. The lower liquor ration allows shorter dye cycles and saves chemicals and energy.
2. In soft flow dyeing machines the fabric is transported by a stream of dye liquor. However, the transport is assisted by a driven lifter reel.
3. These machines use a jet having lower velocity that that used on conventional jet

dyeing machines.

4. The soft flow machines are gentler on the fabric than conventional jet machines.

### Lecture Note 5

#### **Jigger Dyeing Machine:**

Jigg or jigger dyeing machine is one of the oldest dyeing machines used for cloth dyeing operations. Jigger machine is suitable for dyeing of woven fabrics, up to boiling temperature without any creasing. Jigs exert considerable lengthwise tension on the fabric and are more suitable for the dyeing of woven than knitted fabrics. Since the fabric is handled in open-width, a jig is very suitable for fabrics which crease when dyed in rope form.



Some woven textiles conveniently dyed on jigger are ,

Taffettas

Plain woven

Satins

Poplins

Ducks

Suiting and Shirting material.

But have limited application on fabrics which are tension sensitive such as crepes , flat crepes , knits , net fabrics and elastomeric warps etc.

## **Machine Description**

The jigger machines have two main rollers which revolve on smooth bearings and are attached to with a suitable driving mechanism , which can be reversed when required. The fabric is wound on one of the main rollers and fed from the other. The fabric move from one roller to the other through the dye liquor trough located at the lower part of the machine. There are various arrangement of guide rollers at the bottom of liquor trough, and during each passage, the cloth passes around these guide rollers.

The concentrated dye liquor is usually introduced directly into the dye bath in two equal portions, which are added just before commencing the first and second ends. The liquor is agitated by the movement of the fabric through the dye bath. Several horizontal spray pipes are fitted across the full width of the trough in order to expedite fabric rinsing.

Live steam injected into the bottom of the trough through a perforated pipe across the width of the jig heats the liquor. Some modern jigs also have heat exchangers for indirect heating.

Covering the top of the jig minimizes the heat loss to the atmosphere, keeps the temperature uniform on all parts of the fabric and minimizes exposure of the liquor and the cloth to air. Minimizing exposure to air is important when using sulphur or vat dyes since these dyes can be oxidized by atmospheric oxygen.

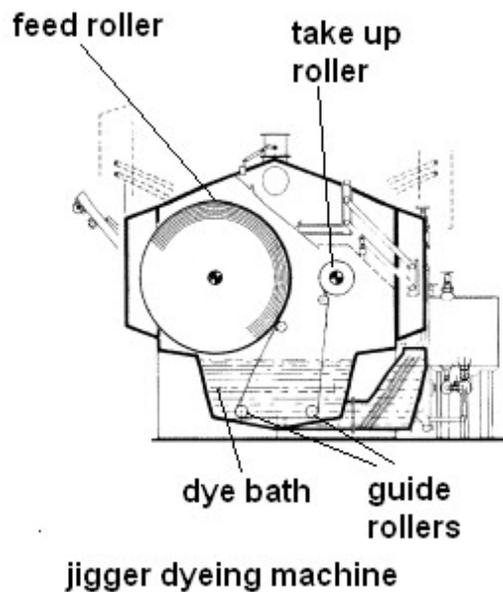
A few meters of leading fabric, similar in construction to the cloth under process, is stitched to each end of the cloth batch, to allow the entire length of the fabric to pass through the dye bath during the dyeing process. When jig processing is completed, the fabric is run onto frame via a nip or suction device to remove extraneous water during unloading.

Modern machines such as automatic and jumbo jiggers have full automation in drive , tension regulation and control , fabric speed and metering, smooth and jerk less stop and start , counters for number of turns , gradual and noiseless reversal, automatic

temperature regulation and control etc.

### Lecture Note 6

#### Dyeing Process by Jigger Dyeing Machine:



The dyeing process on jigger is regarded as a series of intermittent padding operation followed by dwelling periods on the main roller, during which the dyeing action and diffusion takes place. The factors controlling the rate of dye absorption are:

- The amount of interstitial dye liquor retained in the interstices of the fabric weave.
- The exhaustion of the interstitial liquor in the dwell period between successive immersions.
- The degree of interchange of liquor during one immersion (interchange factor).

In the dyeing on jigger machines the cloth revolves on two main rollers , The open-width fabric passes from one roller through the dye bath at the bottom of the machine and then onto a driven take-up roller on the other side. When all the fabric has passed

through the bath, the direction is reversed. Each passage is called an end. Dyeing always involves an even number of ends. The dye bath has one or more guide rollers, around which the cloth travels, and during this immersion, achieves the desired contact with the dye liquor. During this passage, the fabric picks up adequate quantity of dye liquor, excess of which is drained out but still a good quantity is held in the fabric. During rotation of rollers, this dye penetrates and diffuses into the fabric. The real dyeing takes place not in the dye liquor but when the cloth is on the rollers, since only a very small length of fabric is in the dye bath and major part is on the rollers. Therefore the speed of cloth during immersion in dye liquor has a very little effect on percentage of shade produced.

Some critical problems related to the conventional jigger dyeing machines ( which are minimized in the modern day machines) are side-to-centre color variations, called listing, and lengthways color variations, called ending.

Other problems are

- Temperature control from side-to-side and end-to-end of the roll
- Tension control from end-to-end
- Constant speed control from end-to-end
- Prevention of creases
- Prevention of air

*Lecture Note 7*

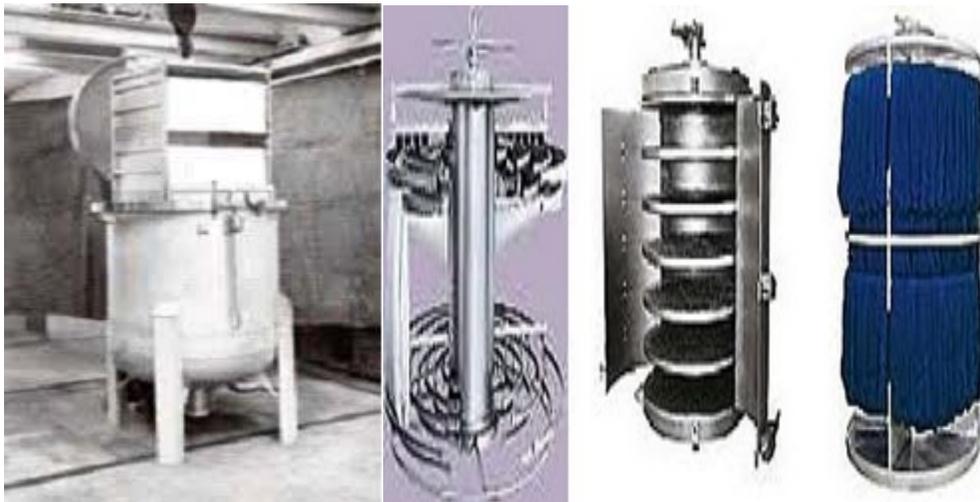
**Limitations of Jigger Dyeing**

1. Jigs exert considerable lengthwise tension on the fabric and are more suitable for the dyeing of woven than knitted fabrics.
2. In textile preparation due to the swelling and dissolution of size, which makes the fabric slippery and unstable in roll form?
3. The low liquor ratio makes washing-off difficult.
4. There is little mechanical action in a jig machine and it is less suitable where vigorous scouring is required before dyeing.
5. More effects or water marks may arise on some acetate and nylon fabrics because of pressure flattening the structure of the rolled fabric.

## **Hank Dyeing In HTHP Machines**

The HTHP dyeing machines can be used for dyeing and bleaching of yarn in hank form, by using suitable carriers on which the hanks can be loaded.

The fiber dyeing carriers can also be used in which the hanks are piled, just like in kier dyeing and bleaching can be done. This method is useful for hard twisted and coarser yarns, which are difficult to penetrate under normal atmospheric conditions of cabinet dyeing machines. The hanks are loaded into suitable dyeing carriers, which are having either straight sticks or circular sticks for loading of hanks. The hanks of different sizes can be accommodated as in the case of cabinet dyeing machines. The carriers are then put into the dyeing machine kier and rest of the process is carried out as in case of cheese dyeing . The flow rate and reversal of dye liquor direction are optimized as per the quality of the yarn.



### **Lecture Note 8**

## **Garment Dyeing**

Garment dyeing is the process of dyeing fully fashioned garments (such as pants, pullovers, t-shirts, jeans, sweaters, dresses, bathrobes, casual jackets, shirts, skirts, hosiery) subsequent to manufacturing as opposed to the conventional method of

manufacturing garments from pre-dyed fabrics. Most garments are made of cotton knit goods and/or cotton woven fabrics, although several other fabrics can be found in the whole or in part such as wool, nylon, silk, acrylic, polyester and others. Due to cost savings and fashion trends, garment dyeing has been gaining importance and popularity in the past years and will continue to do so in the future.

### **Why garment dyeing?**

Traditionally, garments are constructed from fabrics that are pre-dyed (piece dyed) before the actual cutting and sewing. The advantage of this process is the cost effectiveness of mass producing identical garments of particular colors. A major drawback with this approach is the risk associated with carrying a large inventory of a particular style or color in today's dynamic market

Paddle machines and rotary drums are the two types of equipment regularly used for garment dyeing. Rotary drum machines are sometimes preferred for garments, which require gentler handling, such as sweaters. A high liquor ratio is required for paddle machines, which is less economical and may limit shade reproducibility. Many machinery companies have developed sophisticated rotary dyeing machines, which incorporate state-of-the-art technology. Following machines are generally used for garment dyeing

### **Different Garment dyeing machines:**

#### **i) Paddle Dyeing Machines**

A process of dyeing textiles in a machine that gently move the goods using paddles similar to a paddle wheel on a boat. This is a slow process, but there is extremely little abrasion on the goods. Horizontal Paddle Machines (over head paddle machine) consist of a curved beck like lower suction to contain the materials and the dye liquor. The goods are moved by a rotating paddle, which extends across the width of the machine. Half immersed paddles cause the material to move upwards and downwards throughout the liquor. The temperature can be raised to 98<sup>0</sup> C in such system. In lateral / oval paddle machines consist of oval tank to enhance the fluid flow and the processing the goods. In the middle of this tank is a closed oval island. The paddle

moves in a lateral direction and is not half submerged in the liquor and the temperature can be increased up to 98<sup>0</sup> C.

HT Paddle Machines work according to the principle of horizontal paddle machine; however, the temperature can be raised up to 140<sup>0</sup> C. PES articles are preferably dyed on HT paddles. In paddle machines, the dyeing can be carried out with 30:1 to 40:1, lower ratios reduces optimum movement of the goods, lead to unlevel dyeing, crease formation. For gentleness, the blades of the paddle are either curved or have rounded edges and the rotating speed of the paddle can be regulated from 1.5 to 40 rpm. Circulation of the liquor should be strong enough to prevent goods from sinking to the bottom. Paddle machines are suitable for dyeing articles of all substrates in all forms of make ups. The goods are normally dyed using PP/PET bags.

### Lecture Note 9

#### **ii) Rotary Drum Dyeing Machines.**

These machines work on the principle of “movement of textile material and a stationary liquor”. The rotary drum dyeing machine consists of rotating perforated cylindrical drum , which rotates slowly inside a vessel of slightly bigger in size. The internal drum is divided into compartments to ensure rotation of goods with the drum rotation, and the outer vessel holds the required quantity of dye liquor. High temperature drum machines are capable of processing the garments up to 140<sup>0</sup> C.

Features of modern rotary-dyeing equipment include the followings:

1. Lower liquor ratio
2. Gentle movement of goods and liquor (minimizes surface abrasion)
3. Rapid heating and cooling
4. Centrifugal extraction
5. Variable drum speed with reversal capability (adaptable to a wide variety of goods)
6. Continuous circulation of goods (improves migration control)
7. Easy of sampling
8. Variable water levels with overflow rinsing capabilities
9. Large diameter feed and discharge lines (minimizes filling and draining time)
10. Microprocessor controls
11. Lint filters

12. Pressure dyeing

13. Auto-balancing drums

14. Can be used to reduce abrasion on delicate garments or to minimize tangling, is a compartmental chamber, sometimes referred to as a "Y" pocket .

15. The rotary drum machines are very simple to operate and are quite compact in size.

16. The cost of unit is also not high.

Drum dyeing-centrifuging machines are also called "multipurpose drum machines" or "multi-rapid dyeing centrifuging machines" since these machines can perform scouring, dyeing, centrifuging and conditioning successively with automated controls. The goods are treated in a perforated inner drum housed within an outer drum (dyeing tank). Inner drums without dividing walls are provided with ribs that carry the goods along for a certain time, partially lifting them up out of the liquor. These machines can operate at very low liquor ratios and can dye the goods up to 98 -140<sup>0</sup> C. This is suitable for knits as well as other garments. Liquor circulation can be intensified using additional jets. Drums can be rotated in both the directions.

### **iii) Tumbler Dyeing Machines.**

These machines are being used for small garments either in loose form or in open mesh bags. Design wise the tumbler dyeing machines are similar to the commercial laundering machines.

The principle of operation is to load the material into perforated inner SS tanks, which rotates round a horizontal shaft fixed at the back of the drum. The drum is divided into compartments for moving the goods with rotation of drum. A variety of tumbling machines has higher rotation speeds and can spin dry at the end of the cycle. These are similar to dry-cleaning machines.

Rotating drum machines are more efficient and cleaner to operate than paddle machines. The more vigorous mechanical action often promotes more shrinkage and bulking, which may be desirable for some articles. In order to handle higher quantities and large production of similar pieces the latest machines are provided with several automatic features and sophistication.

#### **iv) Toroid Dyeing Machines.**

In these machines the garments circulate in the liquor in a toroidal path with the aid of an impeller situated below the perforated false bottom of the vessel. Movement of the goods depends completely on the pumped action of the liquor. High-temperature versions of this machine operating at 120 to 130°C were developed in the 1970s for dyeing fully-fashioned polyester or triacetate garments. The liquor ratio of such machines is about 30:1.

#### **v) The Gyro box**

The machine has support in the form of a large wheel, which is divided into 12 independent non radial compartments. The goods are placed in these compartments.

The wheel runs at a moderate speed of 2-6 rpm.

The main advantage of this machine are,

- 1.Reduced M:L
- 2.Different types of garments can be dyed simultaneously.
- 3.Flexible loading
- 4.Fully automatic operation.

The roto dye machines are suitable for dyeing pure cotton,wool,polyester,cotton blends in the form of T shirts, sweaters, bath rugs and accessories , socks and stockings.

#### **Advantages of Garment Dyeing**

- Handling of smaller lots economically
- Enables various special effects to be achieved
- Distressed look can be effectively imparted
- Unsold light shades can be converted into medium and deep shades
- By the time the garment has been in a boiling dye bath and then tumble-dried, it will have adopted its lowest energy state and will not suffer further shrinkage under consumer washing conditions.

#### **Disadvantages of Garment Dyeing**

- High cost of processing.
- A little complicated dyeing
- Garment accessories like zips, buttons, etc impose restrictions. The garments produced from woven fabrics create many problems and it has been found that

the existing textile treatment styles as developed for piece dyed fabric cannot be just assembled for garment wet processing operation such as garment dyeing, unless they have been engineered from the original design stage for garment dyeing.