

# Machinery and Equipment in Modern Dyeing Process

Dyeing is the process of adding color to textile products like fibers, yarns, and fabrics. Nowadays modern/computerized machinery used in dyeing industry.

Modern dyeing machines are made from stainless steels.

## machinery

Steels containing up to 4% molybdenum are favored to withstand the commonly acid conditions. A dyeing machine consists essentially of a vessel to contain the dye liquor, provided with equipment for heating, cooling and circulating the liquor into and around the goods to be dyed or moving the goods through the dye liquor. The kind of machine employed depends on the nature of the goods to be dyed. Labor and energy costs are high in relation to total dyeing costs: the dyers aim is to shorten dyeing times to save steam and electrical power and to avoid spoilage of goods.



The winch is the oldest piece of dyeing machine and takes its name from the slated roller that moves an endless rope of cloth or endless belt of cloth at full width through the dye liquor. Pressurized-winch machines have been developed in the U.S.

# Beam Dyeing

The beam dyeing machine operates with the same principle as that of package dyeing machine. It can be effectively used to dye yarn or fabric. The process works like this, fabric or yarn in open width is rolled on to a perforated beam. The beam then subsequently slid into a vessel that is closed and pressurized. The colour impregnates the fabric as the dye liquor is allowed to go on circulating through the perforations in the beam. Usually the beam machines are designed in such a manner so as to hold a single beam or multiple beams in a batch.

## Features

- Able to adjust water level in accordance to fabric volume.
- Even dyeing and superior dyeing quality.
- Optimized circulation system along with high performance pumps.

## Advantages

- The fabric is put under controlled tension, and is wound on to a perforated beam. This results in elimination of creases from the fabric. It also ensures total control of dimensions of the roll of fabric.
- The fabric is not allowed to do any movement during the process of dyeing. This actually means that there is no application of mechanical action on to the fabric. As shown in the figure, there is no movement of the fabric as the hydrostatic pressure of the pump forces the dye liquor through the fabric roll.

# Paddle Dyeing

Paddle dyeing machines are generally used to dye many forms of textiles but the method best suits to dye garments. Heat is generated through steam injection directly into the dyebath. The machine works like this, the paddle circulates both the bath and garments in a perforated central island. It is here only that the chemicals, water and steam for heat are added. The overhead paddle machine is nothing but a vat with a paddle that has blades of full width. The blades generally takes a dip of few centimeters into the vat. This action stirs the bath and pushes the garments down, thus keeping them totally submerged in the dye liquor. The process steps are:

- Chemical mixing
- Load preparation
- Pre-dyeing treatments
- Dyeing cycle
- Post-dyeing treatments
- Rinsing
- Unloading
- Liquor discharge
- Disposal

## Advantages

- Steam heated
- Very efficient Liquor Flow
- No harm to garments Structure
- An uniform Patchless Dyeing
- Low liquor ratio
- Rapid heating and cooling
- Quick drop and fill

Paddle dyeing machine offers itself as a suitable dyeing platform for all the types of piece goods. This typically includes rugs, socks, bed spreads, and other types of garments and fabrics.

## Hank Dyeing

Hank dyeing machine are mostly used for dyeing of patterned wool carpets. There are mainly four types of Hank Dyeing machines used. They are the following, single stick Hussong-Type Machines the double-stick machine, double-stick cabinet machine, and lastly circular carrier machine. Out of this four, the first category of Hussong-Type Machines are the most popular one. The diagram is illustrated below.

In the Hussong type machines hanks needs to be hung on removable sticks, from the underside of the dyeing vessel lid. The lid is then vertically lowered onto the dyeing vessel. The dyeing vessel consists of a simple box that has a perforated false bottom. A reversible impeller, that is placed vertically in a weir chamber at one corner of the machine is used for circulating liquour. Heat is generated by closed steam coils located beneath the false bottom. While on the smaller machines heat is generated by live steam injection.

The Hussong machine is the traditional apparatus. It has a long, square-ended tank as a dye bath into which a framework of poles carrying hanks can be lowered. The dye liquor is circulated by an impeller and moves through a perforated false bottom that also houses the open steam pipe for heating. In modern machines, circulation is improved at the points of contact between hank and pole. This leads to better leveling and elimination of irregularities caused by uneven cooling. In package-dyeing machines dye color may be pumped in rather two directions:

1. Through the perforated central spindle and outward through the package or
2. By the reverse path into the outer layers of the package and out of the spindle. In either case levelness is important.

Some package-dyeing machines are capable of working under pressure at temperatures up to 130°C.

## Features

- Temperature control is done by electro-mechanical or programmable logic controllers.
- Machine capacities can range from 10 kg sample machines –1 ton machines.
  - Yarn loads up to 4000 kg can be dyed by coupling together of machines.
- Typical liquor ratios are 1:15 to 1:25.

## Package Dyeing

A series of technical developments in the recent years has resulted into package dyeing being developed into a highly sophisticated as well as an economic process. Latest design Package Dyeing machines are amenable to accurate control and automation. These features would likely to lead to increases in the application of package dyeing. The term package dyeing usually denotes for dyeing of yarn that has been wound on perforated cores. This helps in forcing the dye liquor through the package. With the start of dyeing cycle, the dye liquor goes on circulating throughout the vessel and tank. This happens till all the dye is used up or fully exhausted. The dye flows through to the yarn package with the help of the deliberate perforations in the tube package. Once full exhaustion is brought about, the carrier of coloured yarn is consequently removed from the vessel. A large centrifuge removes excess water from the packages. Finally the yarn is dried using an infra red drying oven. The image shows the process working of a Package dyeing machine.

<http://www.standardcon.com/image2/configure.gif>

## Types

## Vertical Spindle Machines

Vertical spindle machines are common today. The packages are press packed onto the vertical carrier spindles so as to increase the payload. It also aids in the dye liquor circulation and minimising the liquor to fiber ratio. Machineries of this sort can operate at liquor ratios as low as 6:1. The following Figure shows a typical package dyeing machine where the yarn packages are held on multiple spindles. An overhead crane system makes yarn carrier to be entered and removed from the machine room.

## Horizontal Spindle Machines

This is an alternative configuration for the vertical spindle machine. Here, the dyeing kier is mounted horizontally and the yarn carrier is introduced from a trolley. This arrangement effectively replaces the need for crane. Horizontal Spindle Machines has simplified the design of the dyehouse building.

## Tube Type Machines

Tube type machines have a series of vertical or horizontal tubes into which package carriers get inserted. The tubes that form the individual dyeing vessels are linked by common circulation pumps and pipe work. These type of machines offers the advantage of flexibility than the above mentioned types. This is because individual tubes can easily be blanked off to change the overall load limit of the machine.

# Jet dyeing

It was found that in using Winch machines, there were some inherent problems. So the Jet dyeing machines when they 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, so 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

In deciding the type of dyeing machine the following features are generally taken into consideration for differentiating. They are the following. Shape of the area where the fabric is stored i.e. long shaped machine or J-box compact machine. Type of the nozzle along with its specific positioning i.e. above or below the bath level. Depending more or less in this 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

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

## Winch Dyeing

Winch dyeing machines comes with the lucrative options of low cost design, simplicity in operation and maintenance yet uncompromising features when it comes to versatility.

Mostly woollen fabrics are dyed by using Winch Dyeing machine. The dyeing machine derives its name “Winch” as the fabric rope gets circulated in the machine by way of a mechanical action of a horizontal rotor or reel, called as a winch or sometimes wince. The cross-section of the winch rotor may be circular or elliptical.

As shown in the diagram below, the winch dyeing machine has a front compartment, a perforated partition separates it from the main dyeing chamber. It is this front compartment where dyestuff and dyeing auxiliary additions are made. Gradually they move to main dyeing vessel from there. The process works like this first a series of fabric ropes are immersed in the dye bath. This fabric ropes must be of equal lengths. A part of each rope is then taken over two reels or over the winch itself. In the subsequent course of dyeing operation a rope of fabric is circulated through the dye bath and the winch. The dyestuff and auxiliaries are dosed manually or automatically according to the recipe method.

<http://www.standardcon.com/image2/winch-dyeing-machine.jpg>

## Technical features:

- Nozzle system that gives high liquor flow that ensures a smooth process
- Savings in utility consumption and reduction in the production cost
- Can scour, bleach and dye various kind of fabrics in Ease of operation and maintenance

## Sample Dyeing

As the name suggests these machines are made available as sample to the buyer's needs. These machines are quite popular in the industry. It is successfully applied for dyeing of various types. For example it is used for the atmospheric dyeing of substrates like fabrics, fibers, yarns at heightened liquor ratios either for development or for simulating bulk processing. Some of the types of sample dyeing machine are discussed here.

The Sample Dyeing Machine that is highlighted here comes with some unique features, that includes:

- Latest technology that uses around 16 high temperature glass dye tubes that are interchangeable.
- Capacity ranges from 200cc - 2000cc.
- Sample holders for fibers, yarns or fabrics are made of stainless steel.
- Electronic temperature controller that is digital controlled.
- Double Speed agitation.

The model featured here is known as the infrared sample dyeing machine

Some of the very striking features of this model are given here:

- State-of-the-art unique touch screen control.
- Easy availability of single, double or even triple bath versions.
- Data interpretation can be done graphically.
- Fully self-functional dye bath.
- Wide range of beaker option.

The next model featured here is the Laboratory dyeing machine

Features of this model are: Laboratory Dyeing Machine

- Infinitely variable stroke speed of the machine.
- Unique cooling coil.
- Upto 16 dyeing positions.
- Option of tubes in stainless steel or glass.

This is a very Ubiquitous Jet Sample Dyeing Machine. Features of the model that is shown above include:

- Operation made easy by using a touch screen.
- CPU facilitated fully digitalized functions. Ubiquitous Jet Sample Dyeing Machine

- Fabric circulation speed is controlled easily.
- Proper display of setting and current temperature.
- Comes with an unique Alarm system to sort out easily any mechanical problem.

# ultramodern

The conical-pan loose-stock machine is a widely used machine. Fibers are held in an inner truncated conical vessel while the hot dye liquor is mechanically pumped through. The fiber mass tends to become compressed in the upper narrow half of the cone, assisting efficient circulation. Levelling problems are less important as uniformity may be achieved by blending the dyed fibers prior to spinning.

In an entirely new concept, the Gaston County jet machine circulates fabric in rope form through a pipe by means of a high-pressure jet of dye color. The jet machine is increasingly important in high-temperature dyeing of synthetic fibers, especially polyester fabrics. Another machine is the jig. It has a V-shaped trough holding the dye color and guide rollers to carry the cloth at full width between two external, powered rollers, the cloth is wound onto each roller alternately, that is, the cloth is first moved forward, then backward through the dye color until dyeing is complete. Modern machines, automatically controlled and programmed, can be built to work under pressure.