INDUS INSTITUTE OF HIGHER EDUCATION
NEAR NATIONAL Stadium KARACHI

SUBMITTED TO:
Sir Haseeb-us-salam
(Dyeing of synthetic fiber and blends)

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TOPIC:
MODERNIZATION IN JET DYEING MACHINE
What is "Jet Dyeing Machine" - Definition & Explanation

DEFINITION:

A high-temperature piece-dyeing machine that circulates the dye liquor through a Venturi jet, thus imparting a driving force to move the fabric. The fabric, in rope form, is sewn together to form a loop.

OR

A dyeing machine which dyes the cloth by forcibly contacting the jet flow of dyestuff solution. It executes efficient dyeing in such a manner that the tension on the cloth is decreased as much as possible, and that the cloth dyes evenly with a relatively small amount of dye stuff.

EXPLANATION:

Jet dye machines resemble backs in that the fabric is sewn into a continuous loop which is circulated through the machine. However, the cloth transport mechanism is dramatically different in these machines. A high-speed jet of dye liquid created by a venturi transports the fabric through the cloth guide tube of the jet machine. A jet machine has a cloth guide tube for each loop of fabric being processed. A powerful pump circulates the liquor through a heat exchanger outside of the main vessel and back into the jet machine. The fabric travels at high velocity of 200-800 meters per minute while it is in the cloth guide tube.

Jet dye machines are usually pressurized to provide for high-temperature dyeing capability. High-temperature jet dye machines are especially suitable for delicate fabrics made of texturized polyester. The jet principle is also used in atmospheric machines designed for dyeing temperatures up to 100°C.

Fiber, yarn, and fabric can all be dyed in machines which hold the material stationary and circulate the dyebath. Jet dyeing is the best example of a machine that circulates both the fabric and the dyebath. Jet dye machines are excellent for knit fabrics but woven fabrics may also be dyed using jet machines.
Principle & Mechanism:

1) Dyestuff solution is partially taken in from the bath, and released from a venturi-tube into the flow of the dyestuff solution circulating through an enclosed bent passage.

2) The cloth is guided into the central zone of the circulating dye bath, conveyed through the bath, and dyed.

3) As the cloth is naturally circulated along the flow, the tension of the cloth is much decreased from that of other dyeing methods.

Structure explanation, Shape, and/or System diagram:

1) The machine consists of a treatment bath, a dyestuff solution feeder, a heat exchanger, an auto-controller, and a pump.

2) The heating steam energy is saved by a small dye bath rate realized by circulating the cloth at a high speed and increasing its contact chance with the dyestuff. It enables the cloth to be evenly dyed without a large amount of dye bath.

3) Electric power consumption is saved by an inverter type variable-speed pump.
Jet dye machines provide the following advantages

1. Rapid circulation of fabric through the machine minimizes creasing because the fabric is not held in any one configuration for very long at a time.
2. Lengthwise tension on the fabric is low so the fabric develops bulk and fullness of handle.
3. Dyeing at high temperature of about 130°C gives rapid dyeing, improved dye utilization, improved fastness properties, and makes possible the elimination of carriers which are required when dyeing at lower temperatures.
4. The lower liquor ratio used in jet dyeing allows shorter dye cycles and saves chemicals and energy.
MODERNIZATION IN SOFT FLOW JET DYEING MACHINE:

SOFT FLOW JET DYEING MACHINE:

The so-called "soft flow" machines use the same principle of a transport tube as a jet machine where the fabric is transported in a stream of dye liquor. However, transport of the fabric in soft flow jet machines is assisted by a driven lifter reel. These machines either eliminate the high velocity jet or use a jet having lower velocity than that used on conventional jet dying machines. The soft flow machines are more gentle on the fabric than conventional jet machines. Jet machine offering capability of very low liquor ratios.

Soft-flow dyeing machines with continuous movement of the bath and the fabric:

This model of jet uses water to keep the fabric in circulation. The concept that distinguishes this equipment from conventional jets operating with a hydraulic system is that the fabric rope is kept in circulation during the entire processing cycle (from loading to unloading) without stopping either the liquor or the fabric circulation for normal drain and fill steps.

The principle behind this technique is that fresh water enters the vessel via a heat exchanger and arrives at a special interchange zone whilst at the same time the contaminated liquor is channeled to the drain without coming into contact with the fabric or the new bath in the machine.
The features of this machine lead to significant savings in processing time (17 - 40 %), water (about 50 %).

**Soft flow "U" Type Jet Dyeing Machine**

**Salient Features:**

* Capacity is from 50 to 350 kgs.
* Less Liquor Ratio
* Less Electricity
* Less Thermic Energy
* Less Chemical / Colours
* It is designed to operate very soft Dyeing on both knitted and woven fabric constructions of varying qualities.
* Less Pollution
* Less Price
* More Safety
* High Production
* Less Maintenance
* No Cracking Problem
* High fabric speed
Hi Tech Turbo Jet Dyeing Machine:

Specifications:

Performance (Subject to the kind of fabrics):

<table>
<thead>
<tr>
<th></th>
<th>200 kgs/batch</th>
<th>300 kgs/batch</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liquor Ratio</td>
<td>1:6 to 10</td>
<td>1:6 to 10</td>
</tr>
<tr>
<td>Max. Working Temp.</td>
<td>140 °C</td>
<td>140 °C</td>
</tr>
<tr>
<td>Max. Working Pressure</td>
<td>5 kg/cm²</td>
<td>5 kg/cm²</td>
</tr>
<tr>
<td>Main Pump Power</td>
<td>18.75 kW</td>
<td>18.75 kW</td>
</tr>
<tr>
<td>Total Power</td>
<td>21.75 kW</td>
<td>21.75 kW</td>
</tr>
<tr>
<td>Fabric Speed</td>
<td>400-600 Mts/min</td>
<td>400-200 Mts/min</td>
</tr>
<tr>
<td>Heating Rate 30°C to 130°C by 8 kg/cm²</td>
<td>30 Min</td>
<td>30 Min</td>
</tr>
<tr>
<td>Saturated Steam</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cooling Rate 130°C to 80°C by 20 Cooling water</td>
<td>20 Min</td>
<td>20 Min</td>
</tr>
</tbody>
</table>
Space Requirement

<table>
<thead>
<tr>
<th></th>
<th>Length</th>
<th>Width</th>
<th>Height</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>13500 mm</td>
<td>2000 mm</td>
<td>3000 mm</td>
</tr>
<tr>
<td></td>
<td>13500 mm</td>
<td>2600 mm</td>
<td>3500 mm</td>
</tr>
</tbody>
</table>

Special Features (High Productivity):

- 50% increase of loading capacity than the conventional jet.
- 30% shorter dyeing time than the conventional jet.

Bigger flow-rate and higher fabric speed operation never obtained in the conventional jet save dyeing time very much, about 30% shorter than the conventional. And also leveling the inner pressure of dyeing tube, bigger header tank and the special dual inner case at whole range of dyeing tube make its loading capacity much more about 50% more, because of the uniform distribution of the fabric in the dyeing tube. It minimizes some resistance and friction coefficient also under high speed circulation of fabric and by new concept of design on the body structure. It makes possible relaxation of polyester and island yarn fabric, specially it is well operated to dye high-grade fabric such as micro fiber, mixed yarn, and spandex.

High Fabric Speed: (Higher than traditional design for about 30%)

- Smaller fabric turning angle change the traditional downward running machines turning angle between fabric tank and nozzle from 90 to 135. This can effectively lower the fabric speed loss when the fabric is turning.
- New big angle delivery tube design-this can lower fabric’s speed loss in the delivery tube and avoid the interference of turbulent dye liquor. The over all result is faster fabric speed, larger flow volume shorten process time increase work efficiency.

Super Low Tension:

- Lower the height difference between the tank and delivery tube, which can effectively lower than tension during fabric running.
- Big diameter wheel design-this can lower the surface tension between the wheel and fabric.

Much Wider Application:

Remarkably innovated construction from the usual jet dyeing machine by adopting the special dual inner case in whole of dyeing tube, the unique header and the new nozzle position stabilize the fabric running in whole range of dyeing temperature, retraining the foaming an improving widely the fabric running at low temperature, enables it today the high count yarns the microfiber’s high density, Acetate Rayon, Nylon Plain Taffeta, Taffela, Spandex / Lycra Fabric etc. ever difficult to dye in the conventional jet. Beside the usual 60 - 750 g/m woven or knitted, filament or spun fabric and then widens its application epochmakingly. Of course, not only for dyeing but also for creping / Relaxing, weight
Reduction by custinc soda and enzyme, and Auti-Flame Processing, "Hi-Tech Turbo" is applied.

**Easy Operation :**

- Fully integrate human engineering into the machine design. No need for foot stand for operation.
- Simple and easy nozzle change design. Save the working time for changing nozzle when working with different fabrics.
- Customer can tailored optional equipment. Customer can choose the optional equipment to suit their factory in order to achieve automation and save labor expense and time.

**Standard Features :**

- Machine body and major wetted parts made of 316/316L highly corrosion resistant stainless steel.
- Heavy duty stainless steel centrifugal pump provides high flow rate to compliment the high fabric speed.
- Litter reel driven by frequency p.s. Controlled motor, for speed up to 600-800 m/min.
- Service tank with valve system.
- Highly efficient heat exchanger for fast heating and cooling.
- Reversing Nozzle ejects the fabric rope back into kier to release the tangling automatically Manually level indicator Gauge glass cockset

**Hisaka's Mild Circular CUT-MF JET DYEING MACHINE:**

3 special features: low nozzle pressure, consistent and low liquor ratio
Hisaka’s Mild Circular CUT-MF is a high-temperature, high-pressure jet (circular rapid) dyeing machine which allows low nozzle pressure, consistent and low liquor ratios.

It achieves improved reproducibility and quality in synthetics and their blends with natural fibers.

What is notable is that it eliminates trouble such as pilling, felting, friction marks and creasing in synthetic/natural blends.

Even difficult materials that only allowed the use of soft jet dyeing machines can be dyed smoothly.

\[\text{Special features of Mild Circular CUT-MF}\]

1. High-quality dyeing of natural/synthetic blends

- Trouble such as pilling, felting, friction, creasing occurrence eliminated
- Consistent speed under a nozzle pressure less than half of the conventional model made possible through the adoption of a new structure

\textbf{Example:} Tetron/wool weave

Conventional nozzle pressure 1.0 (10\(^{-1}\)MPa), fabric run 150m/min.

Model:

MF: nozzle pressure 0.35 (10\(^{-1}\)MPa), fabric run 150m/min.

2. Consistent liquor ratio for dyeing in different volumes

- Considerable reduction made in the minimum amount of liquor required through the adoption of a special inner trough and lower nozzle pressure
- Improved reproducibility

\textbf{Example:} Liquid volume in a range of 350 -1,200L in Mild Circular CUT-MF-
15kg×3 rolls = 45kg, 360L, liquor ratio 1:8
15kg×7 rolls = 105kg, 840L, liquor ratio 1:8

3. Jet dyeing at consistent liquor ratio

- Dyeing of micro PES fiber at lower liquor ratio (lower than 1:8) made possible
- Reduction in running costs and total amount of water use

4. Smoother running

- No more clogging up in the rear of the chamber at lower temperatures through the adoption of a special inner trough
- Uniform, balanced transport of fabric throughout the tube made possible through the optimization of the posterior slope
- Consistent movement of fabric maintained at all temperatures

5. Running under consistent, lower tension

- Consistent and low tension running made possible through improved circulation and liquid separating structure
- Processing without tacking made possible (ex. bare gray sheeting)

∇Mild Circular CUT-MF processing data

<table>
<thead>
<tr>
<th>Fabric</th>
<th>Weight (g/m²)</th>
<th>Fabric volume (kg)</th>
<th>Liquor volume (L)</th>
<th>Liquor ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tencel weave</td>
<td>540</td>
<td>153</td>
<td>1450</td>
<td>1:9</td>
</tr>
<tr>
<td>Rayon/PET stretch weave</td>
<td>320</td>
<td>167</td>
<td>1300</td>
<td>1:8</td>
</tr>
<tr>
<td>PET/CD car upholstery</td>
<td>1060</td>
<td>107</td>
<td>850</td>
<td>1:8</td>
</tr>
<tr>
<td>PET voile</td>
<td>180</td>
<td>196</td>
<td>1200</td>
<td>1:6</td>
</tr>
<tr>
<td>Nylon/polyurethane circular knit</td>
<td>380</td>
<td>80</td>
<td>600</td>
<td>1:8</td>
</tr>
</tbody>
</table>

Broad fabric compatibility: from micro PES to heavy fabric
Hisaka's high-temperature, high-pressure jet (circular) dyeing machine Super Rapid CUT-SR is compatible with a broad range of materials from micro PES to heavy fabric. It allows high-quality dyeing, high productivity and running at a low liquor ratio, as well as stable fabric flow at all temperatures.

\section*{\textbf{Special features of Super Rapid CUT-SR}}

\subsection*{1. High quality/productivity}

- Reduced dyeing time (30\% shorter than the conventional model *1) and improved capacity (50\% *2)
  Heating and 'keeping' time dramatically shortened as the use of large-volume nozzles, which was found difficult in conventional models, has been made possible. (Improved in-trough balance due to the adoption of a new structure)

  Productivity 50\% higher than the conventional model has been achieved due to uniform transport of fabric.

  *1) polyester weight-reduced taffeta (80 rolls) *2) interlining, woven acrylic etc.

- High-quality dyeing
  Large-volume liquor flow and low tension running allow level dyeing and desired degree of softness. Consequential prevention of pilling and creasing results in higher quality with more volume.

\subsection*{2. Versatility (more variety and application)}

- Allows the application of broader fabric volume, from the sheerest to the heaviest of knits and weaves
- Allows the application of broader fabric kinds, from micro PES, synthetic blends, spandex, acetate, nylon to natural fibers
- Compatible with various types of processing such as untwisting, relaxing, weight reducing (alkali, enzyme) and flame-resistant finishing
- Nozzle and flow tube combinations can be optimized to produce multiple hand and surfaces

3. Low liquor ratio

- Total water consumption reduced
  Improved liquor separation in effluent drainage due to the adoption of a special inner trough
- Operation with lower liquor level
  Stable running made possible with improved consistency in fabric transport

4. Stability

- Stable running
  - Total innovation made in the structure, introducing a special inner trough in the lining of the whole tube
  - Running stability dramatically improved for lower-temperature operation and when foaming occurs
  - Stable running at all temperatures has been achieved, with low-temperature surging common with synthetic and blend knits and weaves dispelled
- Consistent quality
  High-quality reproduction with no individual fluctuations possible due to stable running.

Rapid Jet Dyeing Machine
(Fabric / Piece Dyeing Machine)

We are manufacturing rapid jet dyeing machine, textile dyeing machine, rapid jet dyeing machinery and textile dyeing machinery.
**Economical Long Tube Rapid Jet Dyeing Machine**

Even difficult materials that allow processing by soft flow jet dyeing machines are dyed smoothly in this method. For example, M/s – Alignment of lining can be prevented. Most suitable direct fabric and multiple materials such as non– woven and blended materials etc.

**Vastly Improved Smoother Running Condition**

Dyeing of fiber lower liquor ration (lower than 1.8) reducing of running coat and total water consumption with effluent treatment cost.

**Running at stable, Lower tension**

No more clogging up in the back of the chamber at room temperature to get better result of Bo-finish & of shirting & suiting also.

Our latest design required slop on rear construction improves smoother fabric transportation and stable loading condition to get tangle free operation during the low & high temp. Process.

**Low liquor ration dyeing**

More uniform circulation and better liquid better separating structure contributes to stable and lower tension running while process.

**Exclusive Features :**

- Liquor ration – 1:5 to (Wet Fabrics)
- Adjustable ball type nozzle.
- Main vessel & basket – SS 316 L
- Motor – 10 HP, To 15 HP
- Fabric drive reel with A.C Motor & Frequency controller.
- High temp. Upt to 140°C
- Working pressure – 4Kg. / Cm²
- Capacity. 25 to 200 Kg