

Water saving in Textile and Garment factories (Dyeing, Washing and Finishing)

Promotion of Sustainability in the Textile and Garment Industry in Asia - FABRIC

Day 4: Presentation 2

Water Saving– Denim dyeing

Mohammad Abbas Uddin Shiyak, PhD, CText FTI

Assistant Professor and Head
Department of Dyes and Chemical Engineering
Bangladesh University of Textiles

Md Anwarul Islam, MSc
Consultant, Reed Consultancy



Contents

- **Denim dyeing**
 - ✓ Rope dyeing
 - ✓ Slasher dyeing
- **Water saving opportunities**



At the end of this module, you will be able to

- Understand the denim dyeing process
- assess possible changes and impacts in process steps and production technologies
- apply process specific low water consumption technologies

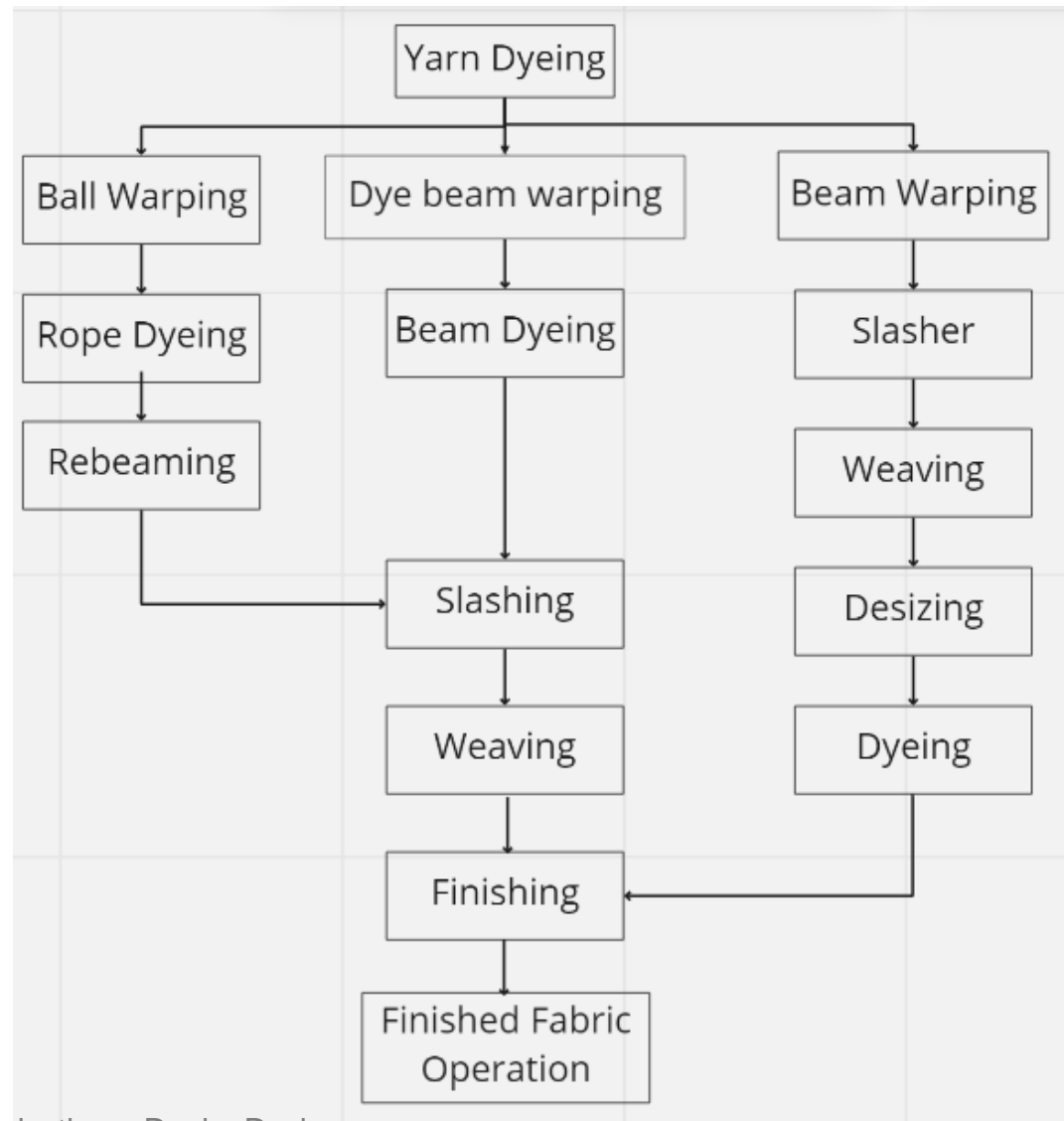
Denim dyeing process

Fundamentals of Denim

- Denim is a type of woven fabric predominantly a 3/1 warp faced twill but also produced from weaves like: Left hand twill, right hand twill, broken twill, cross hatches, cords, dobby's, structures
- Denim is dominantly made of cotton fibers and in some cases, it is blended with other types of fibers to add special features.
- Usually 4 oz. to 16 oz. / sq.yds in weight
- It is a rugged and sturdy fabric in feel.



Flow chart of Denim production

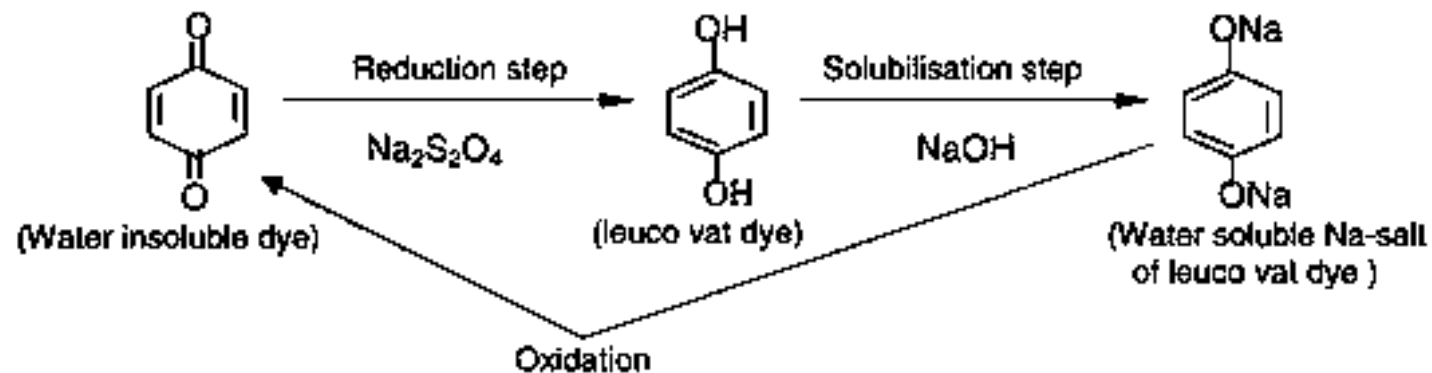


Fundamentals of Denim dyeing

- Warp yarn is coloured
- Colour may be blue, black, green or it's variation
- Weft yarns are always in its natural color
- A Surface Dyeing technique where colors are only attached on the surface of the fabric or yarn instead of getting into to the core of the yarn/fabric
- Assists in easy fading during garment wash

Fundamentals of Denim dyeing

- Mostly water insoluble indigo or sulphur dye are used
- Soluble-Oxidation-Insoluble on the surface
- Reducing agent, alkali, and oxidizing agent (e.g. air)
- pH, amount of reducing agent, immersion time, temperature, oxidation time



Colour of Denim

- Indigo blue
- Indigo black
- Sulfur black
- Sulfur black bottoming – indigo topping
- Indigo bottoming –Sulfur black topping
- Sandwich – Sulfur black-indigo-sulfur or vice versa



Bottoming Effect (Sulfur Dye + Indigo)



Topping Effect (Indigo + Sulfur Dye)

Dyeing Methods

- Slasher/ Open warp/ Sheet dyeing
- Rope/Ball warp/ Chain dyeing

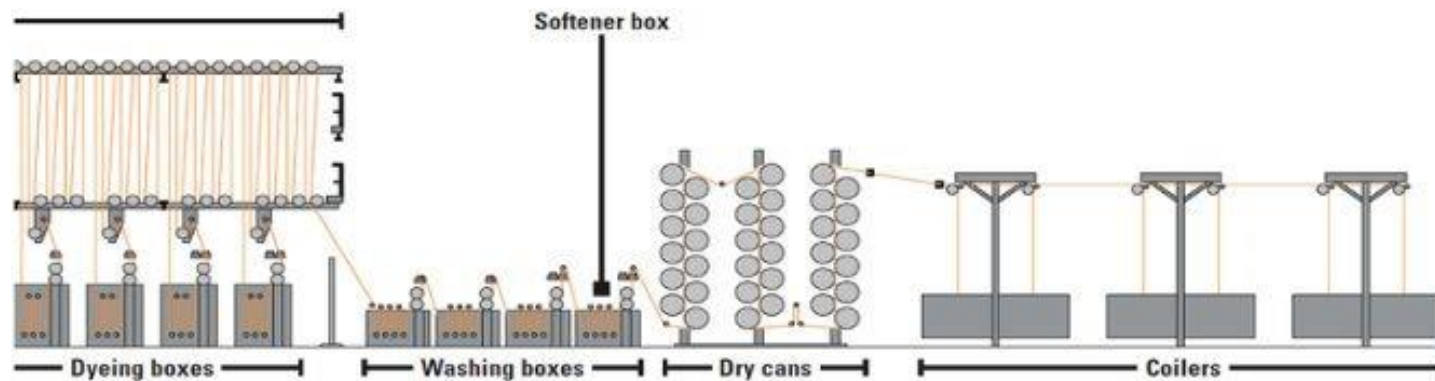
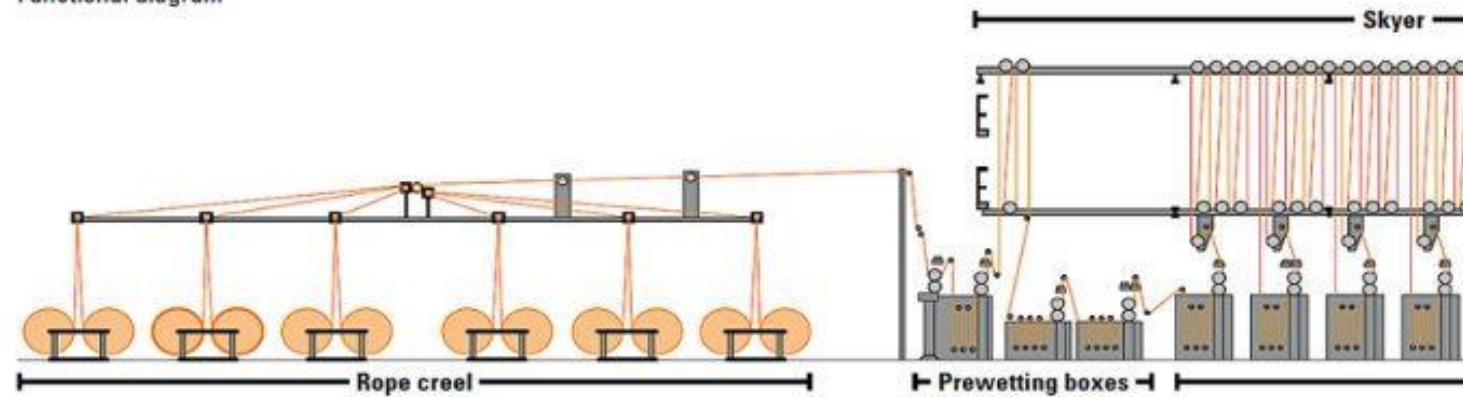
Rope Dyeing

- The warp yarns are passed through a special comb and lease rods and wound in the form of ropes in ball warp.
- The rope length generally remains up to 2500 meters. Each rope contains 350-400 ends.
- Machine capacity is up to 36 ropes and 14400 threads depending on the size and the width.
- The ropes are dipped into 6-8 dye baths.
- Multiple dipping of the ropes are carried out for ensuring better penetration.
- Skying of the ropes are carried out after each dip for air-oxidation. The shade is built up due to this.
- The yarn count ranges from 1-16 Ne

Rope Dyeing

Rope range

Functional diagram



Rope Dyeing

Advantages	Disadvantages
No cross-shade variation	A lot of space is required
Wastage of thread is low	Immersion time and oxidation time is comparatively higher
Productivity is high and flexible production	An additional step of opening ropes after dyeing is necessary
Less reducing agent consumption	Less flexibility in changing color
No time loss during lot change	The production cost is high
Versatility in denim production	

Creeling for Rope beam



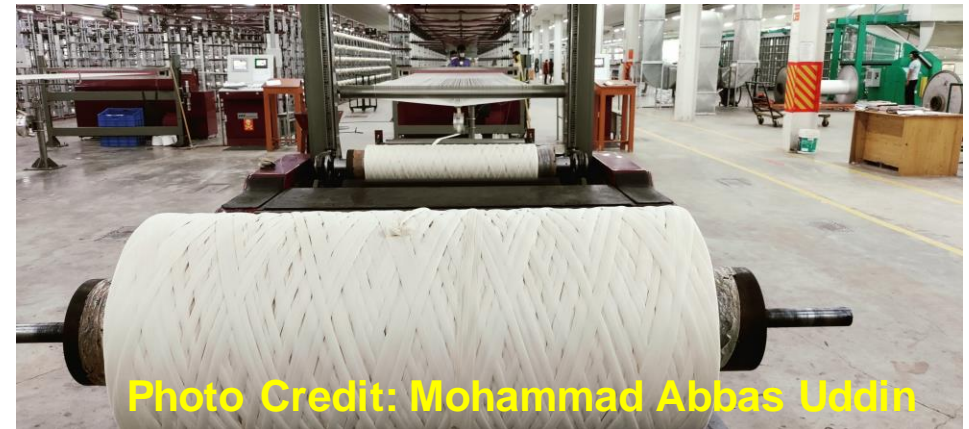
Photo Credit: Mohammad Abbas Uddin

Winding with Automatic slicing in Denim



Photo Credit: Mohammad Abbas Uddin

Ball Roap beaming



Ball stockers

- up to 42 beams can be stocked. With automatic loading and unloading



Photo Credit: Mohammad Abbas Uddin

Rope dyeing

up to 42 ropes can be dyed together, which in turn can make 3 beams from 14 ropes each



Photo Credit: Mohammad Abbas Uddin

Rope Dyeing Machine

Morrison



Photo Credit: Mohammad Abbas Uddin

Rope Dyeing Machine

Karl Mayer



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Rope dyeing

up to 42 ropes can be dyed together, which in turn can make 3 beams from 14 ropes each



Photo Credit: Mohammad Abbas Uddin



Airing



Washing

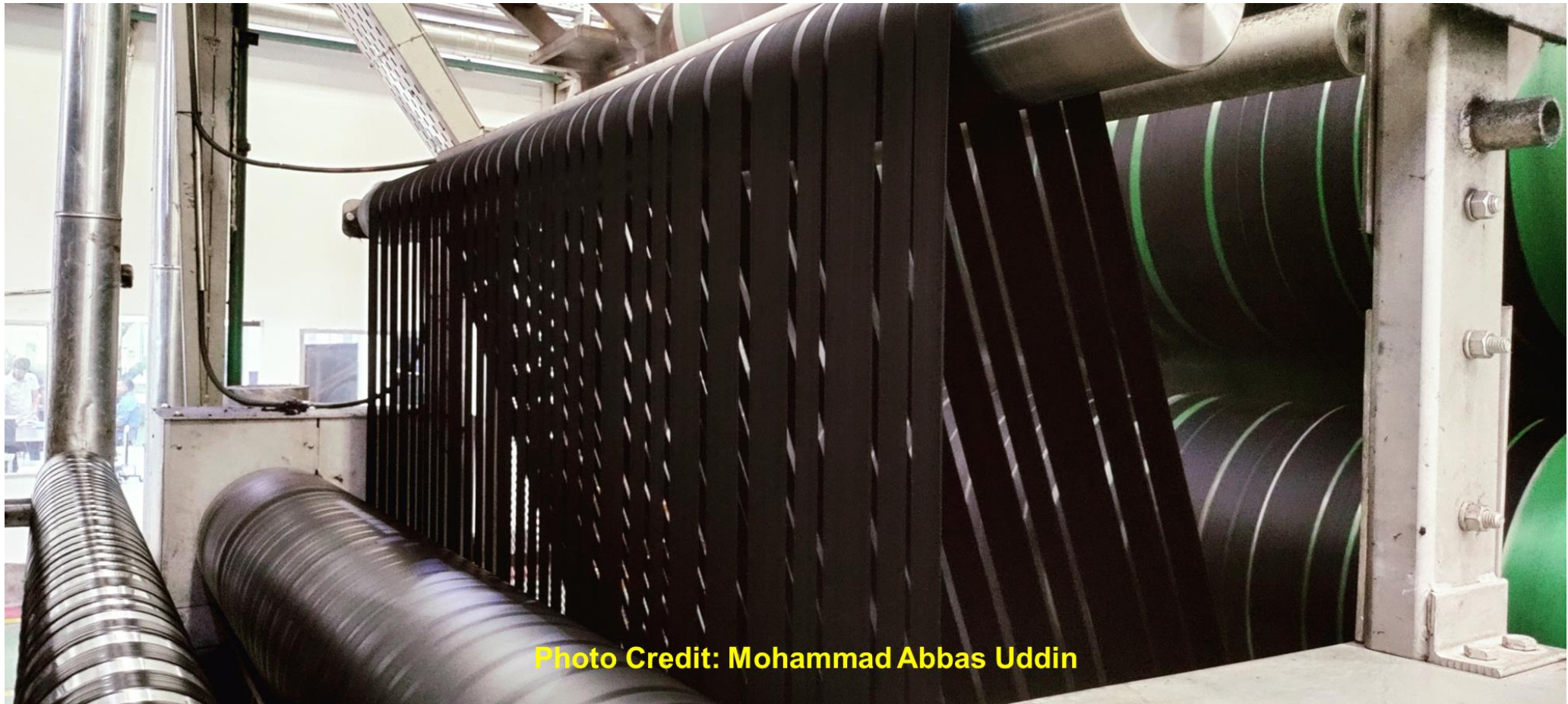


Photo Credit: Mohammad Abbas Uddin

Shade check at the floor – Rope by rope in light box



Photo Credit: Mohammad Abbas Uddin



42 tray/container with 42 ropes coming out after dyeing



Photo Credit: Mohammad Abbas Uddin

Rope dyeing machine



Photo Credit: Mohammad Abbas Uddin

Airing in Rope dyeing



Photo Credit: Mohammad Abbas Uddin

Softener followed by calendaring



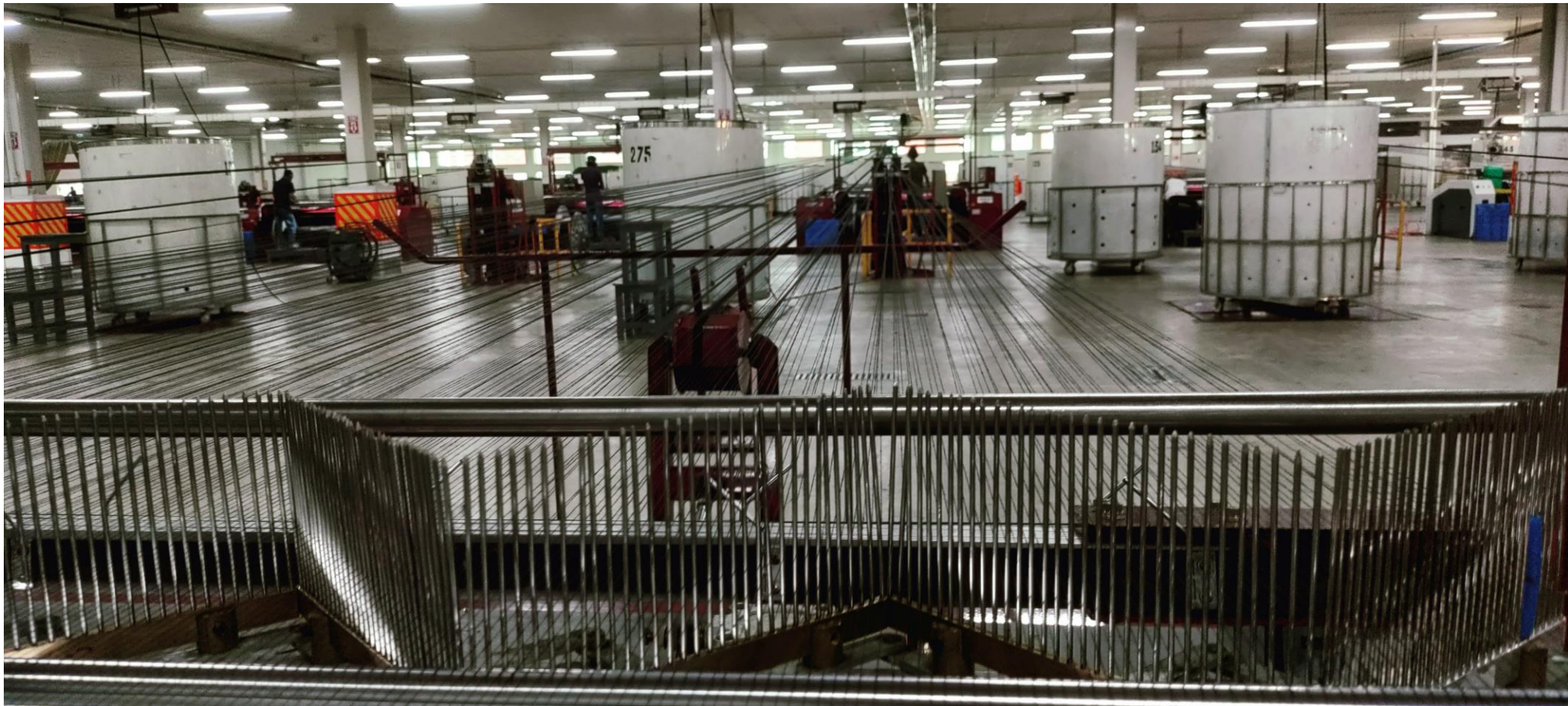
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Calendaring machine



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Rebeaming machine



Rebeaming machine



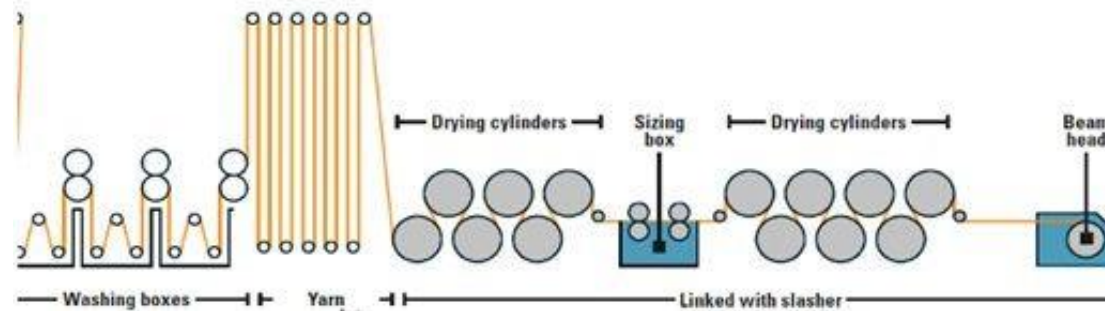
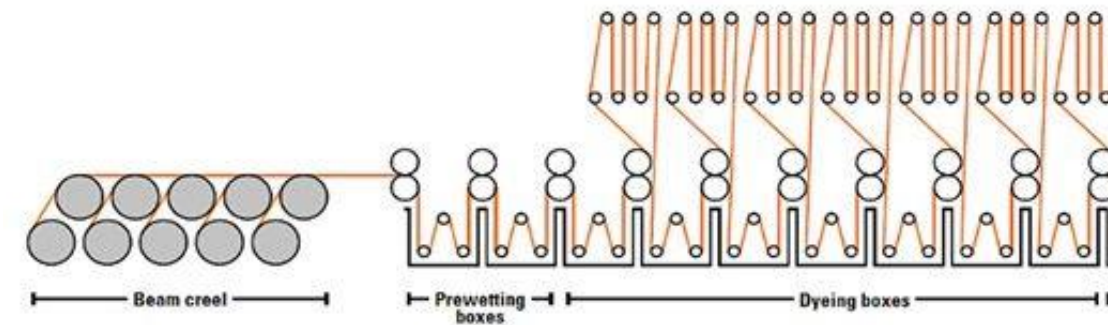
Slasher Dyeing

- 6-10 dye-baths per vat. Less time is required as each yarn is independently subjected to treatment.
- Warp beams supply warp yarns. The machine capacity is 9500 warp yarns having 300-750 warp yarns per beam.
- Yarn count and denim fabric design determine the number of total warp yarns.
- The yarn count ranges from 1-30 Ne.

Slasher Dyeing

Sheetdyeing, slasher-dyeing

Functional diagram



Slasher Dyeing

Advantages	Disadvantages
Less space is required due to compact design	Possibility of cross-shade variation
Oxidation and immersion times are less	Possibility of yarn rupture
Continuous process	Productivity and flexibility in production are low
Flexibility in changing color	Extra time needed for lot change
Production cost is low	No versatility in denim production
	Reducing agent consumption is high

Slasher dyeing machine



Photo Credit: Mohammad Abbas Uddin

Slasher dyeing machine



Photo Credit: Mohammad Abbas Uddin

Slasher dyeing machine



Photo Credit: Mohammad Abbas Uddin

Padding



Photo Credit: Mohammad Abbas Uddin

Padding liquor



Liquor Circulation tank in slasher machine



Three chamber washing as grey stage

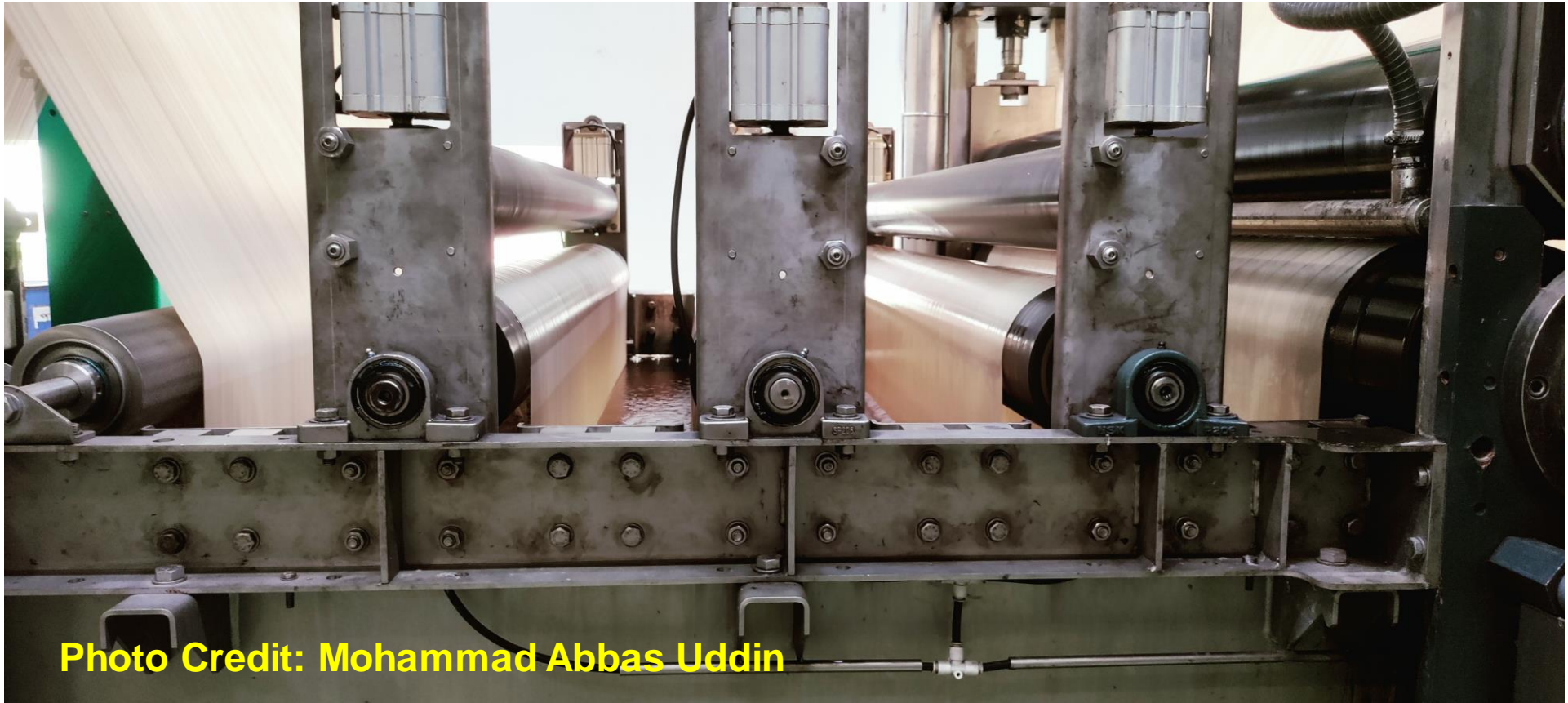


Photo Credit: Mohammad Abbas Uddin

Three chamber washing as grey stage



Photo Credit: Mohammad Abbas Uddin

Three chamber washing as grey stage



Photo Credit: Mohammad Abbas Uddin

Three chamber washing after dyeing



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Singeing plus sanforising machine



Mercerising machine



Photo Credit: Mohammad Abbas Uddin

Stenter machine



Photo Credit: Mohammad Abbas Uddin

Water efficiency – Four ways

- Common Good practices
- Machine modification
- Chemical use
- Process modification

Common good practices

Drainage of washing liquid around 50C hot



Photo Credit: Mohammad Abbas Uddin

Calendaring machine – Cooling water goes to WTP



Photo Credit: Mohammad Abbas Uddin

Machine modification

Padding liquor

Using 1000 L trough
instead of 3000 L depth



Photo Credit: Mohammad Abbas Uddin

Counter current washing

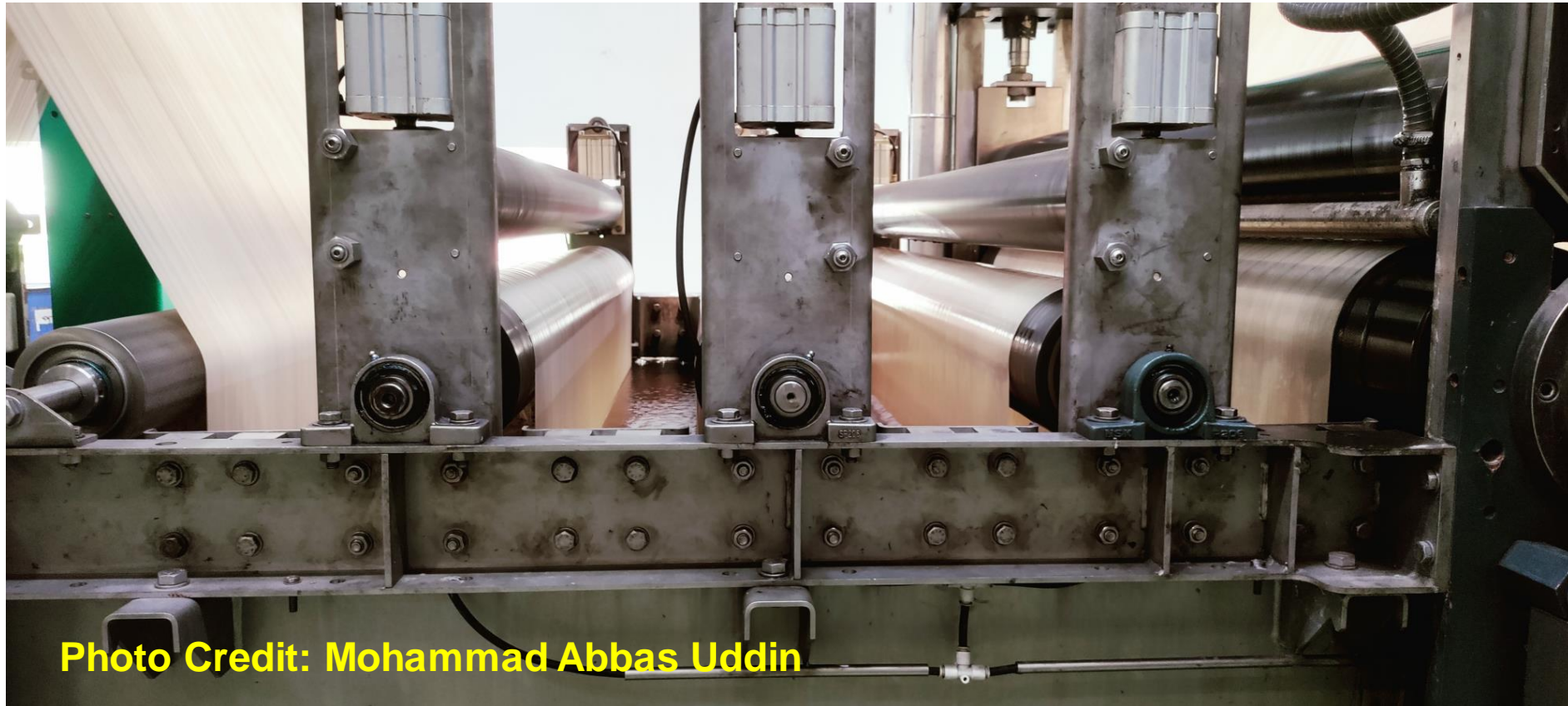


Photo Credit: Mohammad Abbas Uddin

Change of chemicals

- Using chemical like Asufix that improves the fixation
- Effective desizing that requires less wash
- Reuse of liquid indigo/sulphur

1000 L indigo tank



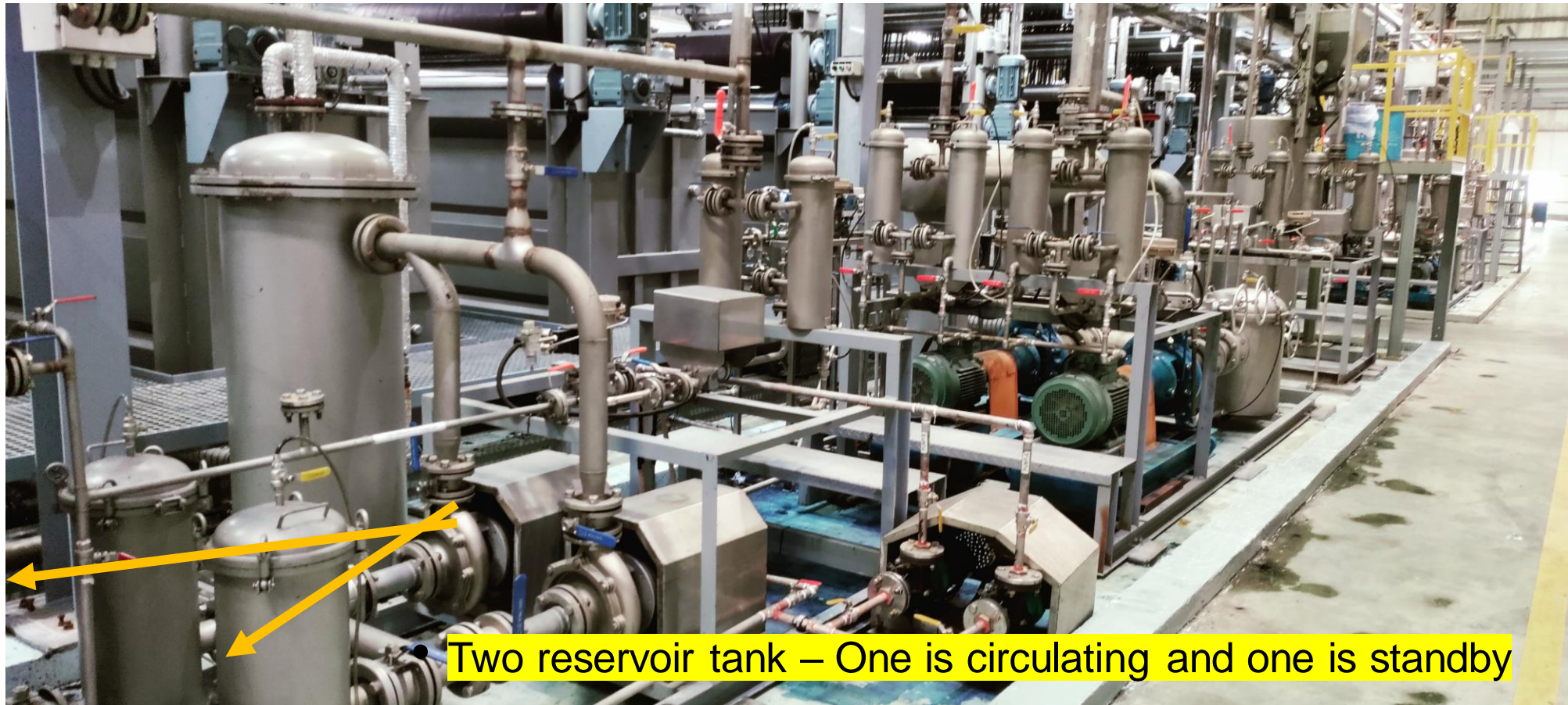
Photo Credit: Mohammad Abbas Uddin

Circulation tank

It is level with padding trough and always circulating. Indigo/dye are fed into the hopper and through the pump fed into the tank in certain concentration, which is controlled by control panel in the lab. The dosing is set through the control panel. In this way, the concentration in the padding trough kept constant.



Circulation tank of indigo



• Two reservoir tank – One is circulating and one is standby

Control panel – controls dosing of production machinery



Reservoir for liquid return



Photo Credit: Mohammad Abbas Uddin

Reuse of hydrose and colour



Liquid spectrophotometer for concentration measurement

Autotitration to calculate residual hydrose and indigo directly in gpl

Process modification

Padding – Dye solution spray



More add-on liquor

- Ring dyeing rather than penetration
- Increasing number of dipping
- Or increasing dipping time.



Photo Credit:
Mohammad Abbas Uddin

Airing

Airing height kept 20-30 fit high to increase the oxidation time, which will offer increased fixation before moving into the next trough for dipping



Photo Credit:
Mohammad Abbas Uddin

Conclusion

Key points to consider

- Denim dyeing is similar to woven dyeing or special as in Ball dyeing
- Water can be saved in various ways including machine and process modification
- Counterwashing technique in washing system
- Reuse of colour liquor is important for reduction of water use
- Process control could enhance right first time colour, hence water saving



Reference

- <https://www.textiletoday.com.bd/coloring-the-denim/>
- <https://www.textileblog.com/production-strategy-slasher-dyeing-rope-dyeing-denim/>
- Clean By Design: <https://www.nrdc.org/resources/green-textile-redux-clean-designs-10-best-practices-offer-even-greater-pollution-reduction>
- Handbook of Textile and Industrial Dyeing, Vol 1, Woodhead Publishing

**Deutsche Gesellschaft für
Internationale Zusammenarbeit (GIZ) GmbH**

Registered offices
Bonn and Eschborn

Friedrich-Ebert-Allee 32 + 36
53113 Bonn, Germany
T +49 228 44 60 - 0
F +49 228 44 60 - 17 66

Dag-Hammarskjöld-Weg 1 - 5
65760 Eschborn, Germany
T +49 61 96 79 - 0
F +49 61 96 79 - 11 15

E info@giz.de
I www.giz.de