

Indigo and sulphur rope dyeing in Denim

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The indigo dye Rope dyeing is the latest dyeing technology in Denim. Rope dyeing is considered a superior dyeing technology, where the dyeing uniformity is achieved better than other Indigo dyeing technologies like slasher dyeing.

Sulphur rope dyeing in denim

The technical features of dyeing of sulphur dye are given as follows.

1st wash tank → Causticizing by taking 25 % Caustic soda.

2nd wash tank → Hot wash at 70-80°C.

3rd wash tank → Cold wash at 30°C.

In first and second dye bath, take sulphur dye 7 to 9 % on the weight of yarn sheet, with temperature at 95°C. The solution contains the following:

- Solubalised sulphur dye = 150 g/l.
- Sodium sulphide (reducing agent) is added to increase its reducing power.
- Sodium hydroxide = 10 – 12 g/l.
- Wetting agent = 3 – 4 g/l.
- Antioxidant sulphide (Glucose solution = 4-5 g/l), which is added to prevent the oxidation of sulphide solution.
- In third, fourth and fifth dye bath is cold wash.
- In sixth dye bath use H₂O₂ (50%) + Acetic acid (2:1 by weight), where H₂O₂ acts as an oxidizing agent as it acts on neutral pH 7 and hence after cold wash, the solution is slightly alkaline, thus in order to make it neutral add Acetic acid.
- In seventh and eighth dye bath = cold wash.
- Back wash Box no 4th washing is done with detergent & soda ash at 70 to 80°C.
- Back wash Box No. 5th & 6th = Hot wash at 60 – 70°C.
- Back wash Box No.7th = Add the softener 30 g/l. It is cationic softener with pH 5 – 6. As during oxidation of sulphur, strength is reduced by 10% on the yarn sulphur are of two types.(i) Free sulphur and (ii) Reacted sulphur.

The free sulphur will react with moisture in the atmosphere to form

$H_2O + S \longrightarrow H_2SO_4$, which tenders the yarn, now at acidic pH reaction is much faster. During sulphur dyeing, the yarn strength is reduced by 12 – 15 % as compared to Indigo dyeing.

Indigo rope dyeing in denim

The passage of yarns in rope dyeing is pre scouring → hot wash → Cold wash → Dye bath → Hot wash → Application of softener (Cationic).

Pre-scouring

- The objectives of pre-scouring are the removal of wax content from cotton, removal of trapped air from cotton yarns and wetting the yarn at temperature of 95°C.
- In pre-scouring, sodium hydroxide is used and its quantity depends upon the quantity of cotton fibers used in the mixing. Generally, 3–5% of sodium hydroxide removes the wax by the action of soapanification.
- Wetting agent:** It is anionic in nature. **Sequestering agent:** Even with the use of water softening. It is very difficult to find the desired softness in water (about 1-3 ppm), so we use the sequestering agent to make the water soft.
- The trapped air should be removed as it will cause uneven dyeing. In 1 kg of yarn, there is approx. 2 liters of air and one liter of air decomposes, 2 liters of Sodium hydroxide. Therefore, air will cause uneven dyeing and increase consumption of sodium hydroxide.
- Absorbency of yarn may be checked after scouring.

Hot wash

As some sodium hydroxide is carried by the yarn after pre-scouring, hence a hot water wash is given at 80–90°C. If this is not done, yarn which will go into the dye-bath will change the pH values of dye – bath.

Cold wash

After hot wash, high yarn temperature is brought back to its room temperature, with the help of cold wash applied to the rope.

Indigo Dyeing

- Indigo is not a perfect vat color. It may be called a trash vat color. The constant of substantivity for other color is 3.0, for indigo it is only 2.7, so there is a need of 5 to 6 dye baths and make the use of multi – dip and multi -nip facility to increase the penetration.
- The dyeing is done on room temperature as indigo belongs to IK class of vat dyes, where dyeing is done at room temperature and oxidation is done by air only and not by chemicals, if oxidizing agent are used, they will cause stripping of colors.
- Indigo is not soluble in water, so it is reduced with sodium hydrosulphide. Then caustic soda is added to make sodium salt of vat color to make it soluble.

To reduce 1 kg of indigo, 700 gms of sodium hydrosulphide is required.

- When caustic is added to indigo, it is an exothermic reaction, which is allowed to cool down, before sending it to feeder, where sodium hydrosulphide is added. Reducing agent is not added at first as it will be decomposed first, and thus increased consumption of it will increase the cost.
- pH of the dye bath should be kept between 10.5 to 11.5, as at this pH, sodium salt of indigo is mono phenolic form. At this form, the dye affinity is very high, therefore, after washing, there will be a better dye effect. At pH 11.5 to 11.7, this affinity is less, the dye effect will be less prominent. pH is controlled by the addition of caustic soda.

Washing

Wash at 60°C → wash at room temperature → Wash with softener.

Washing with softener

The rope will be opened at long chain beamer and if softener is not used, opening will be hampered. The cationic softener is generally 1.5% of the weight of the yarn and is expected to have pH range of 4 to 5.5. Softening is done at room temperature and if high temperature is used, there is always some chance of tendering of yarn.

Indigo belongs to a vat class of dyes and has a dark blue color with a bronze luster. It belongs to IK class of dyes and in this class, dyeing is done at cold wash and air oxidation is done to reoxidise the dye. It can be applied on both cellulosic and protein fibers. For protein fibers, a weaker alkaline solution is used. It can be reduced by NaOH and Na₂SO₄ in water to give monophenolate and biphenolate ions as complete solution. Reduced form of Indigo is called Leuco Indigo, as Leuco has got low affinity for cellulosic fiber.

References

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