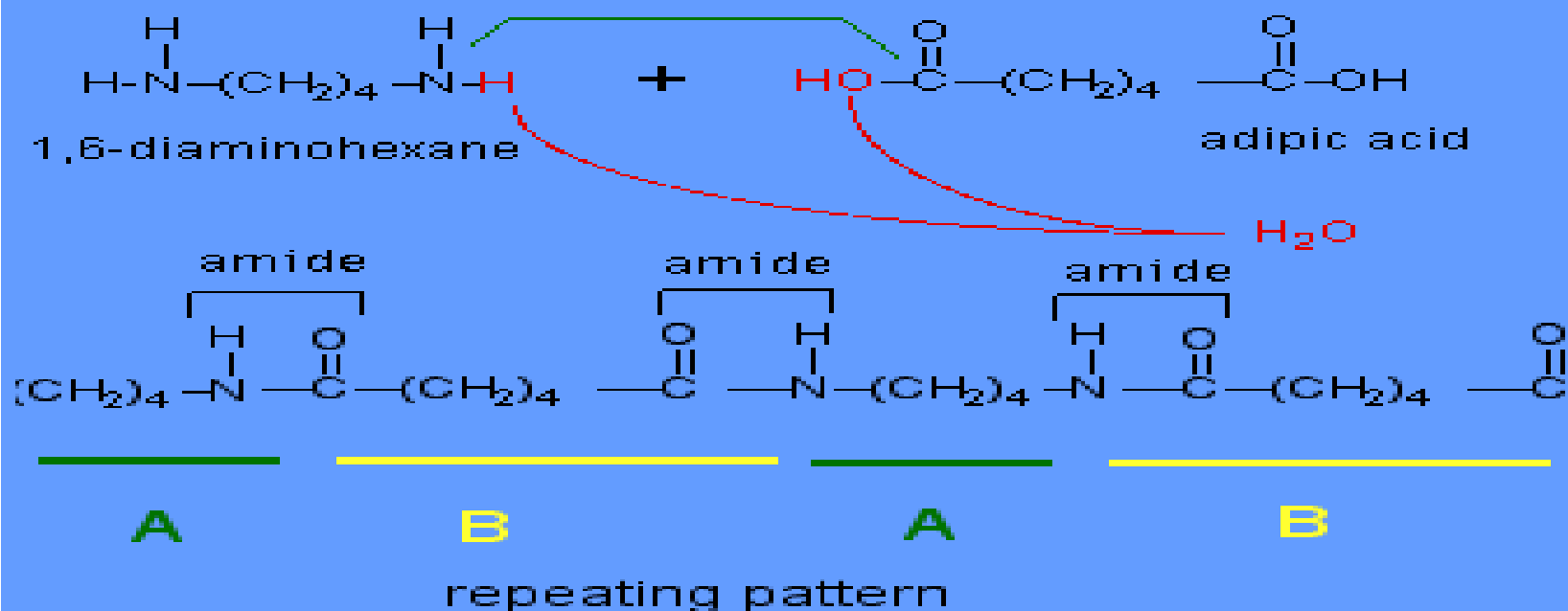


Dyeing of Polyamide Fibres

Polyamide - Nylon



Polyamides

- Nylon a Polyamide, it is a condensation polymers. The formation of a polyamide is same as the synthesis of a simple amide. One prominent difference is that both the amine and the acid monomer units each have two functional groups - one on each side of the molecule. In this polymer, the repeating units are identical.
- Nylon is made from 1,6-diaminohexane and adipic acid by elimination of water molecules (-H from the amine and -OH from acid as shown in red on the graphic).
- A simple representation is $-[A-B-A-B-A-B]-$.

Nylon 66

- Nylon 66, was discovered in 1931 by Wallace Cruthers at DuPont. It was the first fully synthetic fiber produced. It was introduced to women in nylon stockings in 1939 with huge success. During World War II, nylon production was used to make parachutes and other items needed by the military.
- Nylon is very similar in structure to the protein polyamides in silk and wool as shown earlier, but is far stronger, more durable, more chemically inert, and cheaper to produce as compared to the natural fibers.

Polyamide Fibres

- It's a Nylon fibre we generally know.
- It consists of multiples of six carbon chains, in which half the end of carbon being converted to carbonyl and other half to imino nitrogen.
- It is thermoplastic , is sensitive to heat and tension applied in various texturizing processes.
- Total temperature-tension history of yarn determines the degree of orientation in textured yarns.

Dyeing of Polyamide Fibres

- Acid, metal complexes, disperse reactive and disperse dyes are the important classes of dyes used in dyeing of nylon.
- Different types of bond are formed between fibres and dyes.
- The level dyeing characteristics of dyes and fastness properties of final dyeing depends on
 - Migration behavior of dye
 - Stability of bond between dye and fibre
 - Diffusion characteristics of dye properties as well as fibre history.

Process of Dyeing

- Polyamide fibre dyeing basically adopts **ADSORPTION** for dyeing itself.
- Dye should be dissolved in water at particular temperature---
 - And then dye molecules tend to leave the aq. phase and get adsorbed on fiber surface.
 - Adsorption proceed at particular rate depending on
 - Concentration of dye bath
 - Temperature of dyebath
 - Presence of auxiliaries (either retarding or exhausting)

Dyeing Process

- In the absence of the auxiliaries, the initial rate of adsorption is very high.
- As the concentration of the dye on the fibre surface builds up by high rate of adsorption, the rate of desorption goes on increasing due to equilibrium process.
- The process in which dye (adsorbed) tends to leave the fibre and enter the aq. phase is called stripping or desorption.
- At dynamic equilibrium both rates become equal and dye adherence to fibre takes place.

Example of Polyamide dyeing

- Considering a specific case of dyeing polyamide fibres with an acid dye----
 - Initially the amino groups at molecular chain ends get protonated.
 - Positive sites are being in the fibre created as a result.
 - After which anions of acid dyes are attracted and retained in vicinity of positive sites to maintain electrical neutrality.
 - These ions are held by different bonds as well (electrostatic, Van der Waals, and hydrogen).
 - The bigger the size of dye anion also slows desorption.
 - As a result their desorption becomes more difficult and dye gets adhered on nylon.

Choice of Dyes

- Polyamide fibres can be dyed with disperse dyes, acid dyes and certain direct dyes.
- The factors which influence the dyestuff choice are—
 - Levelling or coverage of differences bt degree of orientation and variation in end amino group content
 - Wash fastness
 - Light fastness

Factors responsible for choice of dyes

- Disperse dyes cover Barre effectively and fair light fastness but have poor wash fastness.
- Disperse reactive dyes offer both coverage and wash fastness.
- Metal complex dyes gave highest wash and light fastness.
- Acid and direct dyes gave good barre coverage and moderate light and wash fastness.

Barriness

- The dyeing of polyamide fabrics is often accompanied by barriness (levelling). This appears to be the result of successive dyeing of lightly and heavily coloured yarns, apparently because different yarns have not taken up the same quantity of dye in the dyebath.
- Chemical barriness has two origins. Firstly, adsorption
- barriness is caused by variations in the amine end-groups in the fibre and
- secondly, kinetic barriness is caused by differences in orientation within the polymer structure of fibre.

Factors responsible for Barriness

- Optical differences.
- Chemical and physical differences in fibre molecule.
- Barriness is also influenced by the type of dye used and its molecular size.
- If the type of barriness can be identified it may be possible to reduce it by careful dye selection.

Leveling Effect

- Leveling agents are basically surfactant. They form water soluble complexes with dye to give better level on material.
- Main types of levelling agents used for barre coverage of polyamide fibres are anionic agents, cationic agents and nonionic agents.
- Anionic levelling agents are generally the best for coverage for barre on acid dyes.
- Anionic /nonionic mixtures are best for acid milling dyes.
- Cationic agents are beneficial for metal complexes dyes.

Disperse Dyes for Polyamide Fibre

- This class of dyes best suited for polyamide fibres as
 - Very good coverage of barriness
 - No blocking effect
 - Simple dyeing procedure
 - Good light and wash fastness
 - Self leveling property
- Disperse dyes bound to fibre by hydrogen bonding at NH-CO grouping of the molecule and working in aq. dyebath permits them to migrate and level out.

Dyeing of Nylon on Jigger

- Jigger (having rollers) is used for dyeing woven fibre like nylon.
- Nylon is a hydrophobic nature, it's imbibed dye liquor is very small.
- This liquor is trapped between fabric and rotation of rolls.
- Pressure and friction exerted by batch on fabric make it penetrate into fabric and dye it.
- Extent of dyeing depends temperature as well, The temperature of fabrics on rollers should be maintained as close as dye liquor.

Critical Problems in Jigger Dyeing

- The major problems are --
 - Irregular dyeing called Tailing
 - side-to-centre color variations, called listing.
 - lengthways color variations, called ending.
 - 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

After Treatments

- The wet fastness of acid dye on Nylon can be considerably increased by an after treatment involving –
 - Treatment with 20% tannic acid (owf) and 4% formic acid (owf) at 95°C for 30 minutes.
 - Treatment with 1% (owf) tartar emetic (potassium antimonyl tartrate) at 90°C for 15 minutes.

Conclusion

- Dyeing of Polyamide fibres is governed by ---
 - Dyeing time
 - Dye concentration
 - Type of dye
 - Nature of leveling agent employed
 - Temperature of dyeing bath
 - Coverage of barriness
 - pH of dye bath