Ecofriendly Processing to minimize textile effluent

Lecture-32
Ecofriendly processing

Ecofriendly Processing aims at minimizing the negative effects of textile effluent on the environment. All aspects from origin to the disposal of textile chemicals have to be taken into account.

The textile wet processing units discharge a large quantity of effluent comprising of a wide range of chemicals such as dyes, auxiliary chemicals, which contain metal ions as well.
Unfixed Reactive dye waste

• Particularly in the case of Reactive dyes, due to incomplete fixation of the dyestuff, high concentrations of unfixed hydroxylates may be present in the waste liquor.

• Some metal complex dyes have metals such as copper, chromium and nickel.

• The pollution load in the effluent varies in the different steps of chemical processing.
Wet cleaning vs Dry cleaning

- According to Horstmann, a systematic approach to shift average production towards clean technology should be followed as per the given sequence:

  - Avoid>Reduce>Reuse>Recycle>Biograde

- Environmentally speaking, wet cleaning has many advantages over dry cleaning including minimal emissions, less toxic raw materials and no hazardous waste.

- With dry cleaning, the concerns are primarily with air emissions, while in wet cleaning waste water management is the main concern.
Required changes in Cellulose dyeing

• The continuous dyeing of cotton using reactive dye is gaining importance over the traditional batchwise techniques owing to the major advantages in terms of uniformity of shades in long yardages, high productivity, low utility cost in terms of consumption of dyes, chemicals, water, energy and low effluent generation.

• Continuous dyeing provides fabrics with a uniform visual appearance, freedom from creasing.

• Changes in the dyeing process of cellulose using reactive dyestuff by continuous application requires many changes for making the process ecofriendly. Some of these factors are:

  • The need of superior quality
  
  • Ecofriendly application method
  
  • Cost reduction by minimising the use of energy and water
The use of Supercritical CO$_2$ in textile dyeing as one of the ecofriendly process

- The conventional dyeing of textiles requires that an excess of dye is dissolved or in some way "taken-up" in an aqueous or solvent solution.
- The dye mix is then pumped into a vat containing holding the textile.
- Typically there is agitation or the dye is re-circulated several times through the cloth.
- At the end of the cycle, the dye mix is pumped to the waste treatment facility.
- Dyes are notoriously difficult to treat.
- The process is decidedly unfriendly to the environment.
The use of supercritical CO₂ in textile dyeing

• The use of supercritical CO₂ in textile dyeing is an environmentally friendly alternative. Instead of using an aqueous or solvent solution to "take-up" the dye, supercritical CO₂ is used.

• The process proceeds in the same manner as the conventional method, but instead of sending the spent mix to the waste treatment facility, the supercritical CO₂/dye mix is depressurized.

• The CO₂ changes to a gas and all the spent dye falls out and can be reused. In production systems the CO₂ is recycled for providing for a completely closed systems and an entirely environmentally friendly approach to textile dyeing.
SCF for dyeing

- The operation of SCF machine is very simple, it follows in this manner:
  - Supercritical CO$_2$ flows into the dye make-up vessel where it dissolves the dye.
  - It continues to the dye vessel which contains the textile cocoon.
  - Dyeing can continue in a static bath or a specially designed pump re-circulates the mix several times through the cocoon.
  - At the end of the cycle, the mix flows to the dye collection vessel where depressurization occurs causing the spend dye to drop out.
  - The CO$_2$ can then be recycled and the "spent" dye reused.
## Use of Enzymes as another ecofriendly process

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Electrochemical Dyeing

- Vat and sulphur dyeing involves both a reducing and an oxidising step, which are carried out with chemical oxidants and reducing agents. The environmental concerns associated with the use of these chemicals are many. An attractive alternative technique is to reduce and oxidise the dye by means of electrochemical methods.

- With direct electrolysis the dye itself is reduced at the surface of the cathode. In indirect electrolysis the reducing power of the cathode is transferred to the solution by a soluble reversible redox system.

- With this reversible redox system the reducing agent is continuously regenerated at the cathode, which thus allows full recycling of the dye bath and the reducing agent. Direct cathodic reduction in an electrochemical cell is applicable to sulphur dyes. Vat dyes are reduced by indirect electrolysis.
Preference of bioscouring replacing Alkaline treatment

• Advantages of bioscouring:
  
  • – Ecofriendly (less harsh chemical – caustic soda)
  
  • – Less water needed for rinsing
  
  • – Reduces effluent load
  
  • – Reduces water consumption
  
  • – Saves energy
  
  • – Saves cost
  
  • – Fully retains cellulose structure