Textile Industry

• Apparel Industry i.e., manufacture wearing apparel such as shirts, suits, work cloths, etc.
• Fibers used in textile industry can be broadly classified as:
  (1) Cotton
  (2) Wool
  (3) Synthetic, and
  (4) Regenerated
Cotton Textile Mill

• Integrated cotton textile mill produce its own yarn from the raw cotton.
• Production of yarn from raw cotton includes steps like:
  – Opening and cleaning
  – Pickling
  – Carding (process of brushing raw or washed fibers to prepare them as textiles)
  – Drawing,
  – Spinning,
  – Winding,
  – Warping (the set of lengthwise threads attached to a loom)
• All these operations are dry operation and do not generate liquid wastes.
Sources of wastewater Generation

In textile mill liquid waste originate from the following operations:

• **Slashing or sizing** (filling of starch): The warp thread is sized with starch to give *tensile strength* and *smoothness* necessary for subsequent weaving.
  
  – Starch used is cellulose derivative.
  
  – The sized cloth is referred as ‘grey goods’ and it contains 8 to 15% slashing compound, which must be removed by finishing.
  
  – Waste originate from this section due to spills and floor washing.
  
  – Substitution of starch with low BOD sizes (e.g., carboxy methyl cellulose) can reduce BOD load by > 40%.
Sources of wastewater Generation

- **Weaving:** The sized threads goes for weaving to prepare cloth.

- **Scouring and desizing:** It is carried out to remove natural impurities and sizing compounds.
  - *Enzymes are normally used*, acids may also be used to hydrolyze starch in desizing.
  - Caustic soda, soda ash, detergents, etc. are used in scouring.
  - Replacement of soap with low BOD detergents may reduce 35% BOD load.
  - About **50% of pollution load** of the mill is originated from this operation.

- **Bleaching:** Oxidizing chemicals like peroxides and hypochlorites are used to remove natural colouring materials.
  - This section contributes to about **10% of pollution load**.
Sources of wastewater Generation

• **Mercerising**: Passing the cloth through 20% caustic soda solution. The process **improves strength, elasticity, luster, and dye affinity of cloth**.
  
  – Waste from this section is recycled after NaOH recovery.
  
  – Negligible waste generates from this section with low BOD and high alkalinity.

• **Dyeing**: It is carried out using different dyes and auxiliary chemicals, e.g., naphthol dyes, vat dyes, sulphur dyes, direct dyes, etc.
  
  – Different chemicals are used along with different dyes and colour is developed either by chemical oxidation or air oxidation or reduction depending on the type of dye.
  
  – Colour from the dyes vary widely and although those are not usually toxic, they are aesthetically objectionable.
  
  – Thickened dyes along with printing gums and necessary auxiliaries are used for printing and subsequent fixation.
  
  – After fixation of the print, the fabric is given thorough wash to remove unfixed dyes.
Sources of wastewater Generation

- **Finishing section**: Imparts various finishes to the fabrics. Chemicals such as *starch, dextrines, natural and synthetic waxes*, synthetic resins etc. are used.

Flow diagram of cotton textile mill
### Composition of Wastewater

- Wastewater contains starch, carboxymethyl cellulose, NaOH, detergents, peroxides, hypochlorites, dyes and pigments, gums, dextrins, waxes, sulphides, sulphates and soap.
- Composition of composite cotton textile mill:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Textile 1</th>
<th>Textile 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>9.8 to 11.8</td>
<td>5.9 to 11.0</td>
</tr>
<tr>
<td>Total alkalinity, mg/L CaCO$_3$</td>
<td>1735</td>
<td>--</td>
</tr>
<tr>
<td>BOD, mg/l</td>
<td>760</td>
<td>150 – 250</td>
</tr>
<tr>
<td>COD, mg/l</td>
<td>1420</td>
<td>370 - 600</td>
</tr>
<tr>
<td>Total solids, mg/l</td>
<td>6200</td>
<td>TDS = 1800 – 4000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>TSS = 150 - 1000</td>
</tr>
<tr>
<td>Chromium, mg/l</td>
<td>12</td>
<td>2 - 4</td>
</tr>
</tbody>
</table>
Effect of the wastewater on receiving

• Rapid depletion of DO, settlement of solids and subsequent degradation lead to rapid DO depletion and anaerobic condition.

• Alkalinity and sulphides can have toxic effect on aquatic life.

• Some dyes are also toxic and due to colour make water unfit for different uses.

• Sulphides make water corrosive, particularly concrete structures.
CPCB: Wastewater Discharge Standards

- **Common Parameters:**
  - pH: 5.5 to 9.0
  - SS, mg/l: 100
  - BOD\(_3\): 150
  - Oil & Grease: 10
  - Bio-assay test: 90% fish survival after 96 hr in 100% effluent

- **Special Parameters**
  - Chrome (dye): 2.0 mg/l
  - Sulphide: 2.0 mg/l
  - Phenolic compound: 5.0 mg/l as (C\(_4\)H\(_2\)OH)
  - SAR: 26

- The limit of BOD can be lowered to 30 mg/L according to the requirement of the state boards.
Treatment of the wastewater

- Serious consideration should be given for reducing the strength and volume of the wastewater by chemical substitution, chemical and grease recovery and recycling of water.

- Biological treatment of kiering and scouring waste without any pretreatment is difficult.

- The treatment consists of:
  - Segregation, equalization, neutralization, chemical precipitation, chemical oxidation and biological oxidation.
  - Alum ferrous sulphate, ferric sulphate, ferric chlorids are the coagulants used.
  - Lime or sulphuric acid is used for pH adjustment.
  - Composite waste, if free from toxic substances may be treated efficiently as sewage. The wastewater normally contains N & P required for biological treatment.
Treatment of the wastewater

- Trickling filter, ASP, WSP are effective.
- Extended aeration is most effective, even without equalization and pretreatment, this eliminates necessity of sludge digestion.
- UASB reactor (30 h HRT) + aerobic CSTR is also successful. In UASB organic matter and colour removal up to 50%.

Flow diagram of treatment of cotton textile mill wastewater