Option No: 1 WATER RECYCLING in Jet Dyeing Machine & Recycling and Reuse of water in printing Machine.

- Jet Dyeing machine:

  In Jet Dyeing machine they saved 1200 lit of water per lot. In a day cycle each jet dyeing machine, the 4 lots are processed. The total amount of water saved in 11 machines is

  1 jet dyeing machine = 1200 lit of water saved

  Therefore 11 jet dyeing machine = 1200 × 11 × 4

  Water saved = 52,800 lit/day

- Recycling and Reuse of water in printing Machine:

  One Printing machine requires 1500 lit/hr for continuous cleaning of the blanket, therefore in 24 hrs it requires 36000 lit of water. The ETP plant water is filtered and recycled for its use in cleaning process. Therefore the amount of recycled water used in 7 machines is 36000 × 7 = 2,52,000 lit/day.

  The amount of fresh water saved is 2,52,000 lit/day.

Cost Analysis:

- Investment: Nil
- Saving: 12361 $ (618,050 Rs)
- Payback Period: Immediate

Environmental benefits:

- It reduces the consumption of fresh water.
- It also reduces the energy.

Option No: 2 Fuel switch over change- the fuel from lignite to biomass.

Gujarat Cleaner Production Centre
Earlier they are using Lignite as a fuel for steam generation in boiler. Now industry has switched their fuel from Lignite to Biomass.

- **Typical calorific values of Biomass vs Fuel**

<table>
<thead>
<tr>
<th>Moisture (%)</th>
<th>kWh / kg</th>
<th>kcal / kg</th>
<th>Weight kg / m³</th>
<th>kg / kg = 1 liter fuel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bark fir</td>
<td>50%</td>
<td>2.14</td>
<td>1.84</td>
<td>280</td>
</tr>
<tr>
<td>Briquettes</td>
<td>20%</td>
<td>4.9</td>
<td>4.214</td>
<td>660</td>
</tr>
<tr>
<td>Forest wood chip dry</td>
<td>40%</td>
<td>2.89</td>
<td>2.511</td>
<td>240</td>
</tr>
<tr>
<td>Forest wood chip fresh</td>
<td>55%</td>
<td>2</td>
<td>1.72</td>
<td>310</td>
</tr>
<tr>
<td>Miscanthus</td>
<td>10%</td>
<td>4.4</td>
<td>3.78</td>
<td>140</td>
</tr>
<tr>
<td>Rapeeseed</td>
<td>9%</td>
<td>6.83</td>
<td>5.87</td>
<td>700</td>
</tr>
<tr>
<td>Sawdust</td>
<td>6%</td>
<td>4.2</td>
<td>3.629</td>
<td>160</td>
</tr>
<tr>
<td>Stover rapeeseed</td>
<td>15%</td>
<td>4.17</td>
<td>3.58</td>
<td>115</td>
</tr>
<tr>
<td>Sunflower</td>
<td>9%</td>
<td>5.56</td>
<td>4.78</td>
<td>600</td>
</tr>
<tr>
<td>Wheat</td>
<td>15%</td>
<td>4.17</td>
<td>3.58</td>
<td>700</td>
</tr>
<tr>
<td>Wheat Straw</td>
<td>15%</td>
<td>4</td>
<td>3.44</td>
<td>100</td>
</tr>
<tr>
<td>Wood chip</td>
<td>20%</td>
<td>4.22</td>
<td>3.629</td>
<td>175</td>
</tr>
<tr>
<td>Wood granulate</td>
<td>8%</td>
<td>4.44</td>
<td>3.81</td>
<td>600</td>
</tr>
<tr>
<td>Woodlogs ash</td>
<td>45%</td>
<td>2.61</td>
<td>2.245</td>
<td>650</td>
</tr>
<tr>
<td>Woodlogs ash dry</td>
<td>20%</td>
<td>4.08</td>
<td>3.509</td>
<td>400</td>
</tr>
<tr>
<td>Coal</td>
<td>10%</td>
<td>7</td>
<td>6.02</td>
<td>750</td>
</tr>
<tr>
<td>Fuel gasoil</td>
<td>11.8</td>
<td>11.2</td>
<td>840</td>
<td>0</td>
</tr>
<tr>
<td>Natural gas</td>
<td>10.83</td>
<td>9.314</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
Energy data for selected agricultural by-products

<table>
<thead>
<tr>
<th>Product</th>
<th>Moisture (% dry basis)</th>
<th>Approx. Ash content (%)</th>
<th>LHV (MJ/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bagasse Sugarcane</td>
<td>18</td>
<td>4</td>
<td>17-18</td>
</tr>
<tr>
<td>Coconut husks</td>
<td>5-10</td>
<td>6</td>
<td>16.7</td>
</tr>
<tr>
<td>Coffee husks</td>
<td>13</td>
<td>8-10</td>
<td>16.7</td>
</tr>
<tr>
<td>Corn Stover</td>
<td>5-6</td>
<td>8</td>
<td>17-19</td>
</tr>
<tr>
<td>Corn cobs</td>
<td>15</td>
<td>1-2</td>
<td>19.3</td>
</tr>
<tr>
<td>Cotton husks</td>
<td>5-10</td>
<td>3</td>
<td>16.7</td>
</tr>
<tr>
<td>Groundnut shells</td>
<td>3-10</td>
<td>4-14</td>
<td>16.7</td>
</tr>
<tr>
<td>Miscanthus</td>
<td>14</td>
<td>1-3</td>
<td>19-20</td>
</tr>
<tr>
<td>Oil-palm fibres</td>
<td>55</td>
<td>10</td>
<td>7.8</td>
</tr>
<tr>
<td>Oil-palm husks</td>
<td>55</td>
<td>5</td>
<td>7.8</td>
</tr>
<tr>
<td>Poplar wood</td>
<td>5-15</td>
<td>1.2</td>
<td>17-19</td>
</tr>
<tr>
<td>Rice hulls</td>
<td>9-11</td>
<td>15-20</td>
<td>13-15</td>
</tr>
<tr>
<td>Rice straw and husk</td>
<td>15-30</td>
<td>15-20</td>
<td>17-18</td>
</tr>
<tr>
<td>Switchgrass</td>
<td>8-15</td>
<td>6</td>
<td>18-20</td>
</tr>
<tr>
<td>Wheat straw and husk</td>
<td>7-15</td>
<td>8-9</td>
<td>17-19</td>
</tr>
<tr>
<td>Willow wood</td>
<td>12</td>
<td>1-5</td>
<td>17-19</td>
</tr>
</tbody>
</table>
• Typical biomass fuels net calorific values

<table>
<thead>
<tr>
<th>Biomass source</th>
<th>Biomass feedstock</th>
<th>kWh/kg</th>
<th>MJ/kg</th>
<th>toe/t</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agricultural residue</td>
<td>Fresh fruits</td>
<td>4.1</td>
<td>14.7</td>
<td>0.35</td>
</tr>
<tr>
<td></td>
<td>Citrus fruits</td>
<td>4.1</td>
<td>14.7</td>
<td>0.35</td>
</tr>
<tr>
<td></td>
<td>Dry fruits</td>
<td>4.1</td>
<td>14.7</td>
<td>0.35</td>
</tr>
<tr>
<td></td>
<td>Olives</td>
<td>5.0</td>
<td>18.1</td>
<td>0.43</td>
</tr>
<tr>
<td></td>
<td>Vineyard</td>
<td>4.9</td>
<td>17.8</td>
<td>0.42</td>
</tr>
<tr>
<td></td>
<td>Wheat</td>
<td>4.8</td>
<td>17.1</td>
<td>0.40</td>
</tr>
<tr>
<td></td>
<td>Maize</td>
<td>4.5</td>
<td>16.3</td>
<td>0.38</td>
</tr>
<tr>
<td></td>
<td>Barley</td>
<td>4.5</td>
<td>16.2</td>
<td>0.38</td>
</tr>
<tr>
<td></td>
<td>Oats</td>
<td>4.6</td>
<td>16.6</td>
<td>0.39</td>
</tr>
</tbody>
</table>

**Cost Analysis:**

• Investment: 17777 $ (888,850 Rs)

**Environmental benefits:**

Biomass fuels produce virtually no sulfur emissions, and help mitigate acid rain.

Biomass fuels "recycle" atmospheric carbon, minimizing global warming impacts since zero "net" carbon dioxide is emitted during biomass combustion,
i.e. the amount of carbon dioxide emitted is equal to the amount absorbed from the atmosphere during the biomass growth phase.

Biomass combustion produces less ash than coal and reduces ash disposal costs and landfill space requirements. The biomass ash can also be used as a soil amendment in farm land.

**Option No:3 Provide Inverter on Different Machine.**

Whenever DC power is present and while AC loads are not outgrowing the DC needs, Inverters are the most cost effective solution to secure critical AC applications.

The output power range (from 500Va to 225kVA) and DC input voltage (24Vdc, 48Vdc, 60Vdc, 110Vdc, 220Vdc), industrial inverters will provide a pure and stabilized AC power at an efficiency up to 96%.

**Cost Analysis:**
- Investment: 22223 $ (1,111,150 Rs)
- Saving: 163198 $ (8,159,900 Rs)
- Payback Period: 1.7 Months

**Environmental benefits:**
It result in energy saving.

**Option No: 4 Provide A.C Inverter in Jet Dyeing Machine.**

**Cost Analysis:**
- Investment: 667 $ (33,350 Rs)
- Saving: 1225 $ (61,250 Rs)
- Payback Period: 6.5 months

**Environmental benefits:**
It result in energy saving.

**Option No: 5 Reduce raw water tapping in Jiggers, J.T 10, MERCERIZER, SOAPER.**
It was found that in Jiggers, J.T 10, Mercerizer, Soaper; the water tapping was of bigger size. Hence, excess water was used. It is proposed to reduce the size of these tapping and reduce flow. This will save 5% of total consumption of water. This can be saved by providing reducers or providing orifice in main headers of tapings.

**Cost Analysis:**
- Investment: Nil
- Saving: 4694 $ (234,700 Rs)
- Payback Period: Immediate

**Environmental benefits:**
It results in water and energy saving

**Option No: 6 Batch washing instead of countineous washing of fabrics in Jets.**

**Cost Analysis:**
- Investment: Nil
- Saving: 1978 $ (98,900 Rs)
- Payback Period: Immediate

**Environmental benefits:**
It results in water and energy saving.

**Option No: 7 Provide A. C. Invertors on Fans of Stenter- Chambers.**

It was found that there were five chambers in each stenter. The fan attached to all the chambers were operated at fast speed. It is proposed to provide A.C inverters and operate fan on chamber at 45 Hz frequency to save 15% power.

**Cost Analysis:**
• Investment: 6667 $ (333,350 Rs)
• Saving: 9867 $ (493,350 Rs)
• Payback Period: 8.1 Months

**Environmental benefits:**

It results in energy saving.

**Option No: 8 Replace existing Chocks with Electronics Ballast.**

**Cost Analysis:**

• Investment: 834 $ (41,700 Rs)
• Saving: 2812 $ (140,600 Rs)
• Payback Period: 3.6 Months

**Environmental benefits:**

It results in energy saving.

**Option No: 9 Replace existing tube Lights with energy efficient Metal Halide Lamps.**

In lighting systems, new developed energy efficient lamps are now available in market. These M.H. lamps consume 150 watts power against existing tube lights of 55 watts. But its Lux level is equal to 6 tube light. Thus net 50% power saving is possible.

**Cost Analysis:**

• Investment: 2667 $ (133,350 Rs)
• Saving: 4755 $ (237,750 Rs)
• Payback Period: 6.7 Months

**Environmental benefits:**

It results in energy saving.
Option No: **10 Implementation of COLD PAD BATCH DYEING.**

Pad Batch Dyeing is one of the widely used techniques for semi continuous dyeing process. It is mainly used in the dyeing of cellulosic fiber like cotton or viscose (knit and woven fabric) with reactive dye. Pad batch dyeing is a textile dyeing process that offers some unique advantages in the form of versatility, simplicity and flexibility and a substantial reduction in capital investment for equipment. It is primarily a cold method that is the reason why it is sometimes referred as the cold pad batch dyeing.

**Working of a Cold Pad Dyeing Process:**

The technique or process used in pad-batch dyeing starts with saturating first the prepared fabric with pre-mixed dye liquor. Then it is passed through rollers. The roller, or padders, effectively forces the dyestuff into the fabric. In the process, excess dye solution is also removed. After removal of excess dye stuff the fabric is subsequently “batched”. This batching is done by either storing it in rolls or in boxes. It takes a minimum of 4-12 hours. The batches are generally enclosed by plastic films. This prevents absorption of carbon dioxide and water evaporation. Finally as the reaction is complete the fabrics are washed. This is done by becks, beams, or any other washing devices.

Special Feature of Pad Batch Dyeing Process:

- Significant cost and waste reduction as compared to other conventional dyeing processes.
- Total elimination of the need for salt and other specialty chemicals. For example there is no need for anti-migrants, leaving agents and fixations that are necessary in conventional dyebaths.

- Optimum utilization of dyes that eliminates specialty chemicals cuts down chemical costs and waste loads in the effluent. All this results in a formidable reduction in waste treatment costs.

- Excellent wet fastness properties.

- Pad batch dyeing cuts energy and water consumption owing to low batch ratio (dye:water) required for the process. This is because unlike other dyeing processed it does not function at high temperatures.

- A uniform dye quality is achieved with even color absorbency and color fastness.
- As compared to rope dyeing, pad batch produces much lower defect levels.
- In pad batch dyeing, qualities like high shade reliability and repeatability are common. This is because of high reactivity dyes with rapid fixation rate and stability.
- Lastly Pad Batch Dyeing can also improve product quality. The fabric undergoing the cold pad batch dyeing process is able to retain a uniformly colored appearance. It shows added luster and gives a gentle feel. The fabric gives a brighter look in shades.

Some industry has adopted cold pad batch dyeing in place of hot pad batch dyeing as a trial base.

**Cost Analysis:**

- Investment: 17778 $ (888,900 Rs)
- Saving: 13667 $ (683,350 Rs)
- Payback Period: 15.4 Months

**Environmental benefits:**
It reduces the pollution load by 50% because; earlier the dye fixation of mono-functional dye is very less as compared to current bi-functional dye. Therefore, unfixed dye is going to final effluent.

**Option No: 11 Use of BI-FUNCTIONAL DYE inplace of REACTIVE DYE.**

In the printing unit of Chamaria reactive dyes are used in printing cotton varieties. The concentration dyes is minimum 0.5 to 3%. These dyes are mostly mono-functional dyes, mostly vinyl sulphone group of dyes. The fixation of the dye on cotton is maximum 60 to 65%. The rest unfixed dye comes into water during the washing of the fabric after fixation thus it pollutes the water. Any alternatives or if the dye is more fix on the fabric, the amount of unfixed dye will be reduce in water hence it will help to reduce the pollution.

**Bi-functional Reactive Dyes:**

A few dyes with two reactive groups have been known for 30 years. Some are based on two monochlorotriazine groups(MCT)- e.g. C.I. Reactive Red 120 and some on two masked vinyl sulfone groups (VS)-e.g. C.I. Reactive Black.

What might these Bi-functional and Poly-functional dyes be able to do that Mono-functional reactive dyes cannot?

Probability of Fixation: For each individual the probability of a “head’ is 50%, but tighter the probability of at least one “head” is 75%.

- Dye Fixation Efficiency:
<table>
<thead>
<tr>
<th>Number of Reactive Groups</th>
<th>Dye Fixation Efficiency (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>50</td>
</tr>
<tr>
<td>2</td>
<td>75</td>
</tr>
<tr>
<td>3</td>
<td>88</td>
</tr>
<tr>
<td>4</td>
<td>94</td>
</tr>
</tbody>
</table>

The dye fixation efficiency of Bi-function dye is 91%.

The dye fixation efficiency of Poly-functional dye is 98%.

**Cost Analysis:**

- Investment: Nil
- Saving: 5150 $ (257,500 Rs)
- Payback Period: Nil

**Environmental benefits:**

By adopting this process steam and pollution load reduced by 50% which is also huge saving.

Resulted in energy saving.
Lab Trials:

Water Colour after Wash:

Gujarat Cleaner Production Centre
RESIDUAL DYE IN WASH WATER

LABORATORY TRIAL RESULT

STRENGTH COMPARISON
DYE CONCENTRATION

MONO-FUNCTIONAL DYE

BI-FUNCTIONAL DYE

REUSE
Trial at Process House:
NAME OF THE INDUSTRY: JAY JACQUARD TEXTILES

KING = FUNCTIONAL DYE
REACTION TURQ. BLUE C 40 gpl

B1 = FUNCTIONAL DYE
REACTION TURQ. BLUE HCR 4C

LOCAL MADE, DYE
COLOR YIELD LESS
MORE retaining dye in water

STANDARD MADE, DYE
COLOR YIELD HIGHER
LESS retaining dye in water

WASHING OFF LIQUOR MONO & BIFUNCTIONAL DYE
b1-functional dye wash-liquor conventional dye wash liquor

Gujarat Cleaner Production Centre
Bi-functional dye wash-liquor  conventional dye wash liquor
Option no: 12 Energy Conservation in Lighting System- Switch off Tube Lights during day time.

Cost Analysis:
- Investment: Nil
- Saving: $133, 6,650 Rs
- Payback Period: Immediate

Environmental benefits:
Energy Saving and GHG Reduction


Cost Analysis:
- Investment: $3190, 159,500 Rs
- Saving: $4758, 23,750 Rs
- Payback Period: 8 Months

Environmental benefits:
Energy Saving and GHG Reduction

Option No: 14 Replace D.C. Motors by A.C. Motors with Variable Frequency Drive for main and mangle motors in Stenter.

Cost Analysis:
- Investment: $1556, 77,800 Rs
- Saving: $1910, 95,500 Rs
- Payback Period: 10 Months

Environmental benefits:
Energy saving and GHG Reduction

Option No: 15 Installation of Economizer on Boiler.

Cost Analysis:
• Investment: 8889 $ (444,800 Rs)
• Saving: 8889 $ / Annum (444,450 Rs)
• Payback Period: 12 Months

**Environmental benefits:**

Reduction in Energy uses.

Optimized and more efficient operation of Boiler

**Option No: 16 Improving Power factor by Installing Capacitor.**

**Cost Analysis:**

• Investment: 400 $ (20,000 Rs)
• Saving: 294 $ (14,700 Rs)
• Payback Period: 16 Months

**Environmental benefits:**

Energy Saving
Photographs of some implemented options in Textile Sector:

Option No 1 : Water recycling in Jet Dyeing Machine

Option No 2 : Fuel Switch-over- Lignite to biomass
Option No 3: Installation of Invertors

Option No 6: Batch washing in Jet Dyeing Machine

Option No 11: Use of Bi and Poly functional Dye in place of Mono functional dye.
Option No 11: Use of Bi and Poly functional Dye in place of Mono functional dye.
Some of Recent Developments in textile sectors are identified for future implementation. Like,

1) Waterless dyeing concepts such as Dyeing of polyester fibres from Supercritical Carbon Dioxide (sc-CO2)

- Polyester is accounting for approximately 25% of textile processing; overall polyester is predominantly a commodity fibre with mostly commodity dyes being consumed. Even commodity disperse dyes have quite high exhaustion rates in conventional water based dyeing technologies.

- The bigger problems with coloured effluent and water consumption are in fact in the processing of cotton which is not (yet) workable as of now with sc-CO2, despite of intensive research on the matter since 25 years. Due to high capital expenditure in machinery sc-CO2 technology would be restricted for certain high quality branded articles such as high quality sportswear which are a fractional share of the polyester market.

- Another interesting figure is: The water usage for dyeing is 16% of total water consumption in the textile industry during processing.

- The share of water cost in European textile industry is reportedly 6%, in Asia more than 10% (higher relative share mainly because labour cost share is considerably lower).

- This means the new technology is surely a major step forward for the companies who can commercialise the same, yet there is a long way before the extraordinary claim of revolution in the textile industry can be met by waterless dyeing technologies.

- Technologically yes, commercially and impact-wise it remains to be seen. But somewhere you have got to start. Certainly the endorsement of a big brand may be the catalyst for a change.

Technical Details of Waterless dyeing concepts such as dyeing of polyester fibres from supercritical carbon dioxide (sc-CO2)
• There is demand for novel coloration technologies, waterless dyeing and recycling dyeing methods. In particular, waterless dyeing concepts such as dyeing of polyester fibres from supercritical carbon dioxide (sc-CO2) are of major interest.

**Technical Intervention:**

• Above 74 bar and 31°C carbon dioxide will become a supercritical fluid. A supercritical fluid is any substance at a temperature and pressure above its critical point where distinct liquid and gas phases do not exist. Technically speaking, above the critical point, the carbon dioxide has properties of both a liquid and a gas, liquid-like densities and gas-like low viscosities and diffusion properties. This helps in dye dissolving as well as in shortening dyeing cycles.

• In polyester processing, advantages in waterless dyeing from SC-CO2 are full recycling, complete removal and recycling of CO2 after processing without need for drying, no discharge of effluent and no consumption of water. First of all it is a marketing tool for brands as well as for processing houses to be able to manufacture in a green process and hopefully getting better returns, in a very competitive global textile industry.

• The dyeing of polyester with SC-CO2 is workable, although not without difficulties, and cost wise reserved for financially strong companies being able to finance the capital expenditure for the investment of the dyeing machine.

• Dye selection and dye preparation or the disperse dyes, molecular structure and particle size in finishing, must be taken care of, due to solubility limitations in CO2. As a result, dyes selection are still somewhat limited and more research and development is required.

**Disadvantages:**

• The technology has some disadvantages, too. The dyeing is carried out at 260-280 bar and 130 °C. Such high pressures require a special design of the textile machinery and up-scaling requires a very significant investment. Pressures of 260-280 bar are unusual conditions for the textile industry and may cause mental restrictions. Also, due to use of suffocating gas CO2, a control device for monitoring CO2 concentrations in air has to be installed for industrial labor safety reasons.
Parameter dependency is reported to be quite high, means there may be issues with lab-to-bulk and bulk-to-bulk repeatability, depending on the design of the machine and availability of a suitable lab scale equipment. Classical colour measurement will face some new challenges in this application, due to non additive behavior of the dye components. Other issues are oligomer migration and surface precipitation of dyes.

2. ELECTRO CHEMICAL DYEING TECHNOLOGY

- Electro-chemistry refers to the use of electrical energy in initiating chemical reaction
- This replace traditional aid agents like sodium sulphides Na2S for sulphur dyes
- Large amount of chemical energy is wasted & COD value is produced
- By use of this process COD value is reduced in effluent is reduce.

3. PLASMA TECHNOLOGY FOR PROCESSING:

What is plasma?

- When substance in its gaseous phase absorbs enough energy, the outer electrons in the atom will escape the nucleus' control and become free electrons,
- This chemical status of a substance is called plasma
- This discharges electricity under certain physical conditions and reacts with other substances
- This leads to various chemical fusions and fissions
- Hence this plasma is suitable to surface treatment
- This PLASMA technology is being developed at Plasma Institute Ahmedabad India

Specific Cleaner Production Options for Textile Sector:

1. Eco-Friendly Substitution in Textile Industries:

Desizing:

- Desizing accounts 40-50 % of the total pollution load from preparatory processing.
- Use of acrylates as a size in place of starch reduces the BOD, due to the recovery of size.
• Starches can be partially substituted by PVA, CMC to reduce pollution in effluents.
• Use of newer enzymes, which degrade the starch size to ethanol of anhydro-glucose, enables the recovery of ethanol by distillation, thereby reducing the BOD load in the desized effluent considerably.

2. **Investigate the possibility of combining different treatments into a single step**

• Combining and scheduling processes reduces the number of chemical dumps.
• One-step desizing, scouring and bleaching of cotton fabric
• For cotton woven fabric and its blends with synthetic fibres, a three-stage pre-treatment process has been the standard procedure for many years, comprising:
  • Desizing
  • Scouring
  • Bleaching

New auxiliaries’ formulations and automatic dosing and steamers allow the so-called “Flash Steam” procedure which telescopes desizing, alkaline cracking (scouring) and pad-steam peroxide bleaching into a single step.

**Main achieved environmental benefits**

Combining three operations in one allows significant reductions in water and energy consumption.

**Operational data**

• Within the space of 2 - 4 minutes (with tight strand guidance throughout) loom-state goods are brought to a white suitable for dyeing. This is a big advantage, especially when processing fabrics that are prone to creasing
The chemistry is simple and completely automated with full potential for optimum use.

**One of the possible recipes consists of:**

- 15 - 30 ml/kg phosphorus-free mixture of bleaching agents, dispersant, wetting agent and detergent
- 30 - 50 g/kg NaOH 100 %
- 45 - 90 ml/kg H₂O₂ 35 %

The sequence of the “Flash Steam peroxide bleach” is:

- application of the bleaching solution
- steam 2 - 4 min (saturated steam)
- Hot wash off.

**3. Use of Natural Dyes in place of synthetic Dyes:**

The present scenario, several advantages conferred by natural dyes make them an attractive option over synthetic dyes. These are as follows:

- Biodegradable
- Non-toxic
- Environment Friendly
- Aesthetically appealing resulting in employment generation and utilization of wasteland.
- Easy extraction of colors by boiling the plants, berries, leaves, bark or flower heads in water