CHAPTER

V ECO - FRIENDLY MEASURES IN TEXTILE PROCESSING

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5.1 INTRODUCTION

“ECOLOGY” is a scientific study of the relationship between the living organisms and their relationship with natural environment.\(^1\) This concept has to be given due consideration in the field of textiles. For example, a “Natural Textile” may be assumed environmentally friendly by definition just because, it has been produced without bleaching and dyed with natural dyes. In general, the aim is predominantly to ensure the human safety aspects of the clothing without compromising fashion and function. Ecology in textiles can be explained in three specific areas, as below

**Production Ecology** refers to the process of production and manufacture of fibres, textiles and garments, which should be environment friendly and satisfy the rational conditions for the conservation of air purity, water purity, waste treatment and protection against noise.

**Human Ecology** based on the effect of garments on the users and on their near surroundings, concentration of substances, which could induce hazardous effects on humans during normal clothing.

**Disposal ecology** concerned with the disposal of a product once it has completed its useful working life span, adhering to suitable recycling methods as well as the natural biodegradability of the product.

The modern consumer is increasingly concerned about ecological issues, with human ecology having the highest priority. Therefore, if a textile product is to be promoted as having an ecological advantage, it is the human ecology aspect, which must be addressed first.

\(^1\) wikipedia.org/wiki/ecology.
‘Sustainable development’, ‘environment and development’, ‘green banking’ and ‘green economics’ signal a perceptible shift that has taken place over the last three decades, whereby development is more than ever before being planned to reverse natural resource destruction and conserve a healthy environment. In the era of eco-friendly environment, it has become very important for human beings to live in a world of hygiene and freshness. The necessities of human beings are not stopped with food, clothing and shelter alone, but to be extended with pure and safe air and water in a clean and livable environment.

5.2 SIGNIFICANCE OF WATER IN TEXTILE PROCESSING

Water is probably the most important natural resource in the world, since without it, life cannot exist and industry cannot operate. Water—a lifeline for human and industry, has no substitute. People have a right over life and the resources that sustain it, such as, water. It is estimated that 22 per cent of worldwide water use is industrial. The necessity of water to life is so important that water has been accepted as a natural right. The United Nations Human Rights statement on right to water says ‘The human right to water entitles everyone to sufficient, safe, acceptable physically accessible and affordable water for personal and domestic uses’. Water pollution is perhaps, the oldest form of environmental pollution.

Polluted air gets ‘self purified’ very quickly through dispersal (but remains in the atmosphere), lithospheric (soil) pollution takes several years to manifest itself, water pollution is easier to be seen and is not as quick to fade away as foul air. Over the recent years, human beings resort to using potentially harmful source of water.

The Government of India declared 2007 as “Water Year” to focus on water-related issues and launched a massive awareness programme in the country and the XI Five Year plan prioritized development of water resources. The India Water Portal (IWP) had gone one-step further in a journey towards a goal that was essentially a moral but increasingly a strategic imperative for India – safe, sustainable water for all. It was a virtual hub where the sharing and application of ‘water knowledge’ is done to fight poverty of access to clean water.

Quality of water depends on its source, season, colour, turbidity, pH value, Total Dissolved Solids (TDS), alkalinity, metal impurities (copper, manganese & aluminum) sulphate, chloride, silica & silicates. Quality of water can be improved to certain extent by flocculation, filtration, microstraining, clarifloculation, using dye bath conditioner, aeration, membrane filtration using scale inhibitors, reverse osmosis, ion exchange techniques and so on.

Textile industry is providing one of the most basic needs of people and holds the importance of maintaining sustained growth for improving quality of life. The phenomenal growth of the textile industry brought about prosperity, but also the deterioration of environmental surroundings called pollution. Textile wet processing (i.e. preparation, dyeing, printing and chemical finishing) has always been considered one of the major industrial sectors in terms of water consumption and pollution.
Table 5.1
Water Requirement for Cotton Textiles Wet Processing Operations

<table>
<thead>
<tr>
<th>Process</th>
<th>Requirements (in Litres/1000kg of Product)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sizing</td>
<td>500 - 8,200</td>
</tr>
<tr>
<td>Desizing</td>
<td>2,500 - 21,000</td>
</tr>
<tr>
<td>Scouring</td>
<td>20,000 - 45,000</td>
</tr>
<tr>
<td>Bleaching</td>
<td>2,500 - 25,000</td>
</tr>
<tr>
<td>Mercerizing</td>
<td>17,000 - 32,000</td>
</tr>
<tr>
<td>Dyeing</td>
<td>10,000 - 3,00,000</td>
</tr>
<tr>
<td>Printing</td>
<td>8,000 - 16,000</td>
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Over the last few decades ground water and the soil fertility are the two natural resources severally affected due to the salts and chemicals from the effluents of the dyeing factories. The wastewater discharged by textile processing units ultimately reaches the land and surface water. Any adverse impact of such wastewater ultimately reflects in surface water quality since rainwater carries all such harmful elements from land to surface water. The direct discharge of wastewater on water bodies like streams and rivers pollute the water and affect the flora and fauna. Scarcity of water in India poses a major threat to human life as well as industry.

The water used in the process is almost entirely discharged as about 100 litres of wastewater for every kilogram of fabric processed. Therefore, in order to tide over water scarcity, efforts are being taken to concentrate on Rain Water Harvesting, Water Conservation, Water Recycling, Cost-saving Waste Management Programme and Development of Clean Technologies and so on.
5.3 ROLE OF TEXTILE PROCESSING AND ITS IMPACT ON ENVIRONMENT

The world of textiles is based on the availability of the raw material fibres. Anything having a length much greater than its diameter and having sufficient strength was accepted as fibre in the initial stages for covering human body, with the fundamental purpose to protect the body from the adversities of the nature. The natural fibres, comprising proteins or carbohydrates which are biodegradable over due course of time served the purpose.

Civilization and social status of wearer, the culture, the fashion trends, have contributed towards innovative changes in the clothing style, and in turn in textiles manufacture. That is the reason as to why the number of fabric blends, chemicals, auxiliaries and the colorants used in extremely large quantity thus create water pollution.

The whole operation of textile processing is a value addition process, which converts the grey textile material like fibres, yarn or fabric into aesthetically pleasing and comfortable to wear apparel. The wet processing of textiles involves physical, chemical and physiochemical phenomena. It encompasses many streams of engineering and technology such as chemical engineering, mechanical engineering, biotechnology, computer applications and so on.

The inputs of wet processing are fibres and filaments (natural and synthetic fibres) dye stuffs and pigments (natural and synthetic), chemicals (basic and auxiliary) and energy (fuel, electricity and steam) and so on.
A way of colouration of textiles is printing, where the colour is confined to the boundaries as determined by the design to be printed. The volume of water used is minimal and the application is in a very short time.

Dyeing, another way of colouration can be performed on any form of textile such as loose fibre, yarn or cloth and that too in a batch wise or continuous manner. The choice depends on production scale, available material, demand, desired results and cost considerations.

Colour has been playing a dominant role in the life of man, since time immemorial. Clothing being one of the basic requirements of man, need to be coloured for expression of emotions and moods. Dye (colour psychology & perception) Colour is the first element of design to which consumers respond as it can stimulate, excite, depress, tranquilize, increase appetite and create a feeling of warmth or coolness. Colours are non-verbal communication and proper understanding of psychology of it helps to achieve what one wants. At all levels of supply chain, colour is one of the strongest links to create physical and emotional reaction.

Figure 5.1 explains various activities from fibre to fabric, finishing and sources of pollution.
Colouration of apparels is one of the most ancient human activities and unrivalled mastery in innovative application techniques is evident from the work of classical antiquity. With the advent of
industrial revolution, chemistry began to play a predominant role in offering to the textile industry new colourants and new methods of colouration. Among the style of colouration for creating new patterns and design, the dyeing and printing are common methods from ages. Today, no sector or segment of industry is untouched with the growing influence of dyeing.

Major synthetic dyes (about 9000 - commercial dyes) are manufactured in Germany, Switzerland, Italy, France, USA, UK, Japan, Russia, China and India. Synthetic dye production in the United States alone grew from 94 million pounds in 1923 to more than 250 million pounds in 1988 and the world wide consumption of dyes exceeds 7,00,000 tonnes per year in 2004. Germany imposed a ban in September 1994, on the import of garments and fabrics printed with azo dyes, which was a great shock to Indian industry. After this emphasis is laid on Eco friendly dyes and interest in herbal dyes increased world over.\(^3\) According to a survey carried out in 1996, over 80 per cent of the dyes used for dyeing cotton and viscose rayon were reactive dyes. Many of such dyes were produced in India and even exported.\(^4\) In India most of the dyes used are also reactive dyes on cellulosic fibre as they have a broad spectrum of bright colours, good wet fastness properties, a reasonable light fastness besides being cheap. The presence of salts in the exhaust dye liquor of reactive dyes causes tremendous harm to the vegetation and the agriculturist.

\(^3\) Wikipedia.org/wiki/DYE

5.4 PROBLEMS OF POLLUTION

Among the various branches of sciences, chemistry has played a major role in making life easier and better. However, just as a coin has two sides, massive production ‘Product Safety’ is the new mantra of real concern as number of allergies, cases of respiratory disorders, types of cancers, reproductive disorders, birth defects are increasing day by day.

In the twentieth century, it was realized that the environment needs to be protected from manmade pollution. Pollution of air and water due to fast spreading chemicals has started taking its heavy toll in terms of a variety of diseases, temporary or permanent crippling and even slow death.

Since textiles are related not only to engineering and technology, but also to the human personalities, moods, seasons, occasions and so on, the value addition can never be perfect and pleasing to all. Textile processing is a major contributor to the pollution load of the global environment. With the dawn of the 21st century, the inexorable environmental legislation places a stringent demand on industries on the level of pollutants that can safely dispose of.

Among the various planets in solar system, probably earth is the only planet, which contains active gases including Oxygen. The layer of ozone in our atmosphere shields us from the adverse effects of ultraviolet rays present in sunlight, absorbs the ultraviolet rays when sunlight passes through it while travelling to earth which may cause serious health hazards in human beings most serious of which are cataract and skin cancer.
Among 10 ozone depleting substances that have been listed, Chloro Fluoro Carbon (CFC) is used in chilling, air conditioning, packaging, computer chips and foam generation activities in textile industry. Carbon Tetra Chloride (CTC) is another important ozone depleting substance and its high level usage as solvent, dry cleaning agent, stain remover and in fire extinguishers in Indian textile industry can cause headache, weakness, lethargy, nausea, dizziness, vomiting and damage to liver and kidneys.

Uncontrolled economic growth, urbanization and industrialization can rip apart land, forests, mines, overuse ground water systems, dam, rivers, pollute water and air, and stuff the land with unknown poisons and erodes the rural resource base. On an average, about one million litres of effluent is discharged per day by an average sized textile mill having a daily production of 800kg. About 60 per cent of the energy is used by dyeing and finishing operations. Environmental problems associated with the textile industry are in the form of water pollution. Natural impurities extracted from the fibre being processed along with the chemicals used for processing are the main source of pollution. Effluents are generally hot, alkaline, strong smelling and coloured by chemicals used in dyeing process. Some of the chemicals discharged are toxic and other environmental issues include air emissions, notably Volatile Organic Compounds (VOC).

Unplanned developmental works and over exploitation of resources have made India’s living resources most vulnerable. Of the world’s top 12 priority biodiversity hot spots, two are in India. In a country like India, both poverty and economic growth pose serious environmental challenges and in the attempt to survive today, people are forced to forsake their tomorrow and overuse their environment.

Indian textile industry is gigantic that the untreated textile effluents released from these industries on open land seep into aquifers and increase the contamination of ground water. Places with large number of dyeing units within city such as Mathura (U.P) and Pali (Rajasthan) have reported large-scale contamination.

Major textile processing clusters, like Ludhiana for wool, Surat for manmade fabric processing, Ahamadabad for cotton, Tirupur for cotton hosiery process, Salem, Erode and Karur in Tamil Nadu for yarn and fabric processing sector were identified for concentration of textiles units and ground water pollution due to textile waste. The observations were as under

- Addition of pollutants waste load by the textile processing units in India was three times of the existing waste load
- Effluents generated by the Indian textile processing sector were to the tune of 5200 lakh kilolitres per annum
- Contribution of TDS was around 57 per cent of the total pollutants load added Contribution of pollutants was independent of the quantum of production of processed goods and some clusters with higher contribution in total production of processed fabric, contributed considerably less to pollution.
The waste generation through printing which cannot be treated and passed through the conventional effluent treatment systems, viz., *Hard-to-treat waste*; print paste thickeners which contribute to high amounts of total suspended solids which can be controlled only by careful monitoring of the parameters of printing process and machine, viz., *Highly dispersible waste*; main trace of heavy metals and other pollutants from degraded dye (banned azo dyes) and organic solvents used for cleaning of screens, viz., *Hazardous & toxic waste*; and large volumes of waste water in washing the printed fabric, viz., *High volume waste* are also adding to hazardous wastes.

Pollution of aquatic environments and soil is a worldwide problem that can result in uptake and accumulation of toxic chemicals in food chains and harm the flora and fauna of affected habitats.

Textile processing industry uses thousands of dyes and chemicals resulting in discharge of polluted liquid effluents that are treated in effluent treatment plants using different technologies like physiochemical treatment followed by biological treatment, activated carbon adsorption, sand filters, ion exchange, nanofiltration and reverse osmosis technology, depending on the nature of effluents. In spite of using nanofiltration and reverse osmosis, only up to 60 per cent water can be recycled. After multistage evaporation of rejects, about 15 per cent sludge generated, which is chemically hazardous packed in polythene / polypropylene bags could leach out reddish brown leachate, highly toxic in nature and could become a serious health hazard while flowing on land or percolating underground water table.
Many synthetic dyes, which have an azo group in the molecule with carcinogenic-amine have been banned since 1996, and the manufacturers of textiles have been asked to find suitable replacements. This provides an opportunity for the reintroduction of natural dyes.

The wet processes pre-treatments, colouration and chemical finishing of textile materials consume large amounts of water and chemicals in addition to significant requirements of energy. Wastewater has serious negative impact not only on underground and surface water bodies and on the land in the surrounding area, but also has an adverse effect on the aquatic ecological system. According to World Health Organisation (WHO), the metals of most immediate concern are Chromium, Zinc, Iron, Mercury and Lead, which have possibilities of entering into the food chain, increase the turbidity of water body and hamper the photosynthesis process and causing alteration in the habitat.

Textile industry in general and textile processing industry in particular plays a big role in emitting the carbon dioxide and other greenhouse gases in atmosphere. Chemicals used in processing, release acid, fumes and gases in the atmosphere, more alarming of which are Nitrous Oxide, Sulphur Trioxide, Hydrogen Sulphide. Green house gases like Carbon Dioxide, Choloro Floro Carbon(CFC), Methane and Nitrous Oxide and so on trap the heat of sun light, leading to global warming, melting of glaciers, increase of sea level and risk of submerging of low lying areas and hence displacement of lakhs of people.
In addition, textile processing uses maximum steam, heat and electrical energy. This energy is produced of burning of wood, coal, gas and other fossil fuel. Release of Chlorine, Carbon dioxide, Sulphur and Nitrous fumes from coal converts into acids and come down on earth as acid rains. Use of high energy could bring in such acid rains as its side effect and in turn result in damage of crops, property and acidification of rivers and damage to aqua system. Though the fundamental principle of Industrial Ecology states that a waste generated from one system is a valuable resource for another system, many a times it does not remain economically viable.

5.4.1 Pollution Control Measures

Ecological considerations are becoming important factors in the marketing of consumer goods including textiles all over the world. Exporters of textiles goods comply with new environmental regulations being introduced in the target markets.

It has been stated in the World Development Report 1992 “economic development and sound environmental management are complementary aspects without adequate environmental protection development will be undermined; without development, environmental protection will fail”. According to Royston in “Pollution Prevention Pays”, industries should not consider pollution control as an overhead towards cost with no returns.

6. www.acidrain.org/ecosystems
Pollution control could be achieved through three stages, which primarily require serious awareness of the problems. The basic tenets of these three stages are (i) ‘use minimum’, (ii) ‘use substitutes’ (toxic materials being substituted by less harmful or non toxic materials to reduce the ill effects on the environment) and (iii) ‘treat the pollutants to make them harmless to the environment”.

The measures taken for pollution control may be classified under the following heads
1. Technological Measures (waste / effluent treatment)
2. Preventive Measures
3. Measures to Create Awareness
4. Measures to Create Commitment

5.4.1.1 **Technological Measures** (waste / effluent treatment)

For any type of chemical industry, water forms an integral part of operations and hence, in addition to solid waste generation and sometimes even air pollution, the wastewater generation is very common and substantial. Depending upon the specific nature of the chemicals dealt within the industry, the characteristics of the wastewater will differ.

Soft water is ideal for wet processes for the achievement of desired results. With the growth and spread of textile wet processing sector all over, it has become difficult to get good quality water and that too in ample quantities. Purity of water is affected by colouring agents, turbidity, alkalinlity, acidity, hardness, chemicals, metals and so on. Apart from developing the machines for low consumption of water, efforts are also necessary to purify and recycle the used water
(effluent) either in the processing itself or for some other simpler uses like washing, gardening, cleaning and so on.

The operations necessary to be carried out for complete treatment of an effluent have been classified into three categories:

Primary treatments, Secondary treatments, and Tertiary treatments. As the nomenclature indicates, the cost and complexities of these treatments increase as we go from preliminary to tertiary treatments.

The primary effluent treatments involve
A. Screening
B. Sedimentation
C. Equalisation
D. Neutralisation, and
E. Coagulation / flocculation and floatation

5.4.1.1.1 Screening

The first and foremost treatment involves removing the undissolved materials accomplished by screening and sedimentation. The larger suspended and floating particles such as fibres, yarn, pieces of fabrics and lint are removed through use of a coarser screen followed by a finer screen. Unnecessary presence of these may either clog the pipes of effluent treatment plant or hinder the further effluent processing treatments.

5.4.1.1.2 Sedimentation

The sedimentation process, although categorized by virtue of its simplicity in primary treatments, may be required to be carried out at various stages of effluent treatment wherein precipitates are generated
and need to be settled down using mostly gravity or sometimes, mechanical accessories to accelerate the settling.

5.4.1.1.3 Equalisation

The treatment called equalization maintains the uniformity of the wastewater characteristics and enables partial neutralization. The textile wet processing involves a variety of textile fibre materials, each one morphologically and chemically different from the other.

5.4.1.1.4 Neutralisation

In the process of neutralization, acid like sulphuric acid is added to the alkaline effluent or lime / caustic soda / soda ash is added to the acidic effluent to bring the pH in desired range.

5.4.1.1.5 Coagulation

Fine suspended colloidal particles in an effluent are difficult to settle down. On addition of certain chemicals, called coagultants, the colloidal particles in an effluent are destabilized and aggregated to form larger particles, which can settle down rapidly making their removal efficient.

5.4.1.2 Preventive Measures

If pollution is not controlled at this stage at least, its hazardous effects will endanger the very survival and rectification may not be possible even at a very high cost. The most important pollution prevention strategies in dyeing operations include, operating at the lowest possible bath ratio improved dye fixation, controlled dispersing of dyes and chemicals, right-first-time approach and right techniques of dyeing and reuse of dye bath.
A solution to the problem of treating coloured effluents of textile dye houses is to use non-cellulose membranes for ultra-filtration of wastewater, raw material conservation, product substitution, process and equipment modification, material handling, scheduling, waste recovery, optimum chemical handling practices and use of natural polymers. Process alternatives are in the form of pigment printing and inkjet printing which have computerized control in printing, eliminates messy colour mix, and reduces wastages of all types.

5.4.1.3 Measures to Create Awareness

With the present national and international awareness of environment, ecology and environmental legislation, ultraviolet and ozone dry treatment for modifying the fabric surface to achieve the same processing benefits as aqueous processing, with shorter dyeing time and lower dyeing temperature are done.  

For the ‘Environmentalist - in - operation’ the fundamentals of each of the processes need to be very clear and to have the best understanding of what, why and how the treatments are undertaken. Continuous efforts are made to improve upon the textile process quality, particularly with the use of alternate materials and processes, use of minimum of the chemicals and eco-friendly materials. A thorough understanding of the processes, list of what has been used in a particular process house, list of type and quantity of each of the chemicals used in different processes are essential in the selection of the wastewater treatment type. Many times, it is possible that instead of recovery and reuse of a chemical from effluent, the

8. www.uvo3.co.uk/?go=Ozone
purified wastewater, but containing a specific chemical can be reused in the same or similar process. This approach becomes more viable economically as well as ecologically.

Growing consumer awareness of green issues, bio degradation, the result of bacterial action, is a word often used, as an indication of a product environmental friendliness. Biotechnology, the new era’s cutting edge technology, has gifted bio polymers having bio-compatibility and bio-degradability to the field of textiles. Similarly, awareness can be created in the use of cotton fabrics instead of synthetic materials. The inherent ‘breath ability’ of cotton as a fibre continues to ensure its preference as a comfort fabric.

The scope of value addition in cotton with various treatments for special effects and finishes, imparting a whole range of visual and physical characteristics, makes cotton a more lucrative and sought-after proposition. Environmental awareness throughout the world has given new impetus to consider alternate colourant to the synthetic and to rescue the total fall of natural dyes, pure cotton cloth as dress materials in place of cloth made from synthetic fibres and natural products. Publicity campaign organized will make the public understand that the product is treated with Ultra-fresh antimicrobial products, so that the comfort and health factor for the end user is enhanced.

5.4.1.4 Measures to Create Commitment

Pollution as a sign of inefficiency in industrial production can be controlled only by a commitment from everybody involved in.
5.4.1.4.1 Statutory Measures to Control Pollution

The Central and State governments have initiated a number of steps to control Environmental Pollution.

(i) Notification of general and source-specific standards for emissions and effluents.

(ii) Regulating the location of industries.

(iii) Regular monitoring for compliance to environmental standards.

(iv) Legal action for non-compliance.

(v) Setting up of clean technology mechanisms in polluting industries.

(vi) Setting up of Common Effluent Treatment Plants (CETPs) in industrial estates.

(vii) Establishing Waste Minimization Circles (WMC) in clusters of small scale industries.

(viii) Implementing recommendations of Charter of Corporate responsibility for Environmental Protection (CREP) in 17 categories of highly polluting industries.

(ix) Implementing an Eco-mark scheme to encourage production / consumption of environment-friendly products.

(x) Setting up National Clean Development Mechanism Authority (CDM) as per Kyoto protocol.

(xi) Promoting economic instruments to internalize the costs of pollution and fiscal incentives for pollution control equipments.

In this context, a long-term approach to pollution prevention can be taken through formalized employee education. Knowledge is essential for pollution prevention and hence the following steps are being undertaken at the employee level to create eco-awareness.
(i) Establishment of corporate level work groups to develop and distribute information concerning pollution prevention engineering, pollution prevention auditing, waste exchanges and innovative pollution prevention ideas.

(ii) Internal training, education through process improvement groups, in house newsletters devoted to pollution prevention topics are another effective way to communicate & educate employees.

(iv) Commitment to consider alternatives before adding a new chemical to a process on the part of production process designer.

(v) Environmental excellence to be achieved at the processing stage by selecting the best raw materials, using best practices during manufacturing and carefully considering the environmental impacts of products during use and disposal.

(vi) Application of cleaner industrial production processes and more rational use of natural resources.

(vii) Transfer and adaptation of environmentally sound technologies, know-how and skills to meet the need and mobilization of resources properly.

(viii) Adherence to voluntary environmental codes for the conduct of industrial investment and protection.

(viii) Integration of environmental responsibility in decision making at all management levels.
To help consumers to know that there will be no hazard in the use of textiles, in 1980s, the **Australian Textile Research Institute (OTI)** in Vienna gave a prescription namely the OTN 100, for the analysis of harmful substances.⁹

“**International Association for Research and Testing in the Field of Textile Ecology**” (OKO - Tex) was established with seventeen textile-testing institutes as members to follow one uniform testing method worldwide for harmful substances and with its first task to the preparation of the common standard “OKO - Tex standard 100” for testing textiles on their ecological properties on humans. For this purpose the “OKO - Tex Association fixed the chemical and fastness criteria for baby wear; textile in contact with the skin, textiles not in contact with the skin and household textiles.”¹⁰

### 5.4.1.4.2 Establishment of Pollution Control Bodies

**National Environmental Engineering Research Institute (NEERI)** has turned its attention to low cost pollution abatement system for small-scale industries, use of biotechnology for wash treatment and hazardous waste management.¹¹ In line with the changing trends, the Government of India has notified **Indian Eco standards** and prohibited manufacture and use of some chemicals. It also established eco-testing labs in major processing clusters of the country with international testing facilities to meet the requirements of the industry.

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⁹. www.oeti.at.html
¹⁰. www.okoTex.coms
¹¹. www.neeri.res.in/-
In order to control the negative impact of industrialisation on environment, the Government of India has initiated various steps for protection, conservation and development of the environment. The **National Environment Policy (NEP) 2006**, which was approved and adopted in May 2006, facilitated realization of sustainable development by mainstreaming environmental concerns in all developmental activities and describing key environmental challenges, currently and prospectively facing the country. Another significant policy development was the **Environment Impact Assessment (EIA)** process and made it more efficient, decentralized and transparent.¹²

A **National Clean Development Mechanism Authority (CDM)** has also been set up for the purpose of protecting and improving the quality of environment in terms of the Kyoto Protocol.¹³

Environment Impact Assessment (EIA) Notification 2006 on September 14, 2006 involved a complete re-engineering of the Environment Impact Assessment process and made it more efficient, decentralized and transparent. A **National Clean Development Mechanism Authority (CDM)** has also been set up for the purpose of protecting and improving the quality of environment.¹⁴ The textile wet processing industries have come into the close scrutiny of pollution compliance. **Auditing and the State Pollution Control Board (SPCB)** has started putting pressure on Textile Processing Units to effect dye-bath segregation and salt removal in their effluent treatment process.

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The Government of India promulgated a number of Acts, Rules, and enacted regulations whenever necessary to protect environment.

A few of them are listed as follows

(i) Water (Prevention & Control of Pollution) Act 1974, Rules 1974

These statutory measures forced the identification of the dyes, which are carcinogenic in nature, to search for the alternative safe dyes and their cost effectiveness. Prohibition by banning the handling of harmful dyes through Gazette notification and creation of awareness in prohibiting it use.

Eco-friendly, environmentally safe, natural products and environmental awareness in textiles have become the key elements for preventing pollution.

5.4.1.4.3 Responsibilities of Indian dyestuff and auxiliary manufacturers

The Indian dyestuff and auxiliary manufacturers have the moral responsibility to preserve environment and protect human lives by

\(^{15}\) Confederation of Indian Industry (C11)
(i) manufacturing safe products
(ii) developing innovative synthesis route to eliminate unintentional impurities.
(iii) bringing more awareness among textile producers for overall Eco-Toxicological requirements.
(iv) developing in-house capabilities for the evaluation of restricted ecological & toxicological parameters.
(v) guiding processors in selection of proper dyestuff.
(vi) efficient waste management.

5.4.1.4.4 Responsibilities of Processors

The textile processors are the key players in the use of dyes and chemicals. In order to protect the environment, they are responsible for selecting the right dyestuff, understanding fully the relevant national requirements and buyers requirements before arriving at process parameters, avoiding use of banned alternatives and flame retardants, squandering, ubiquitous leaking and fittings drippings, overflowing vessels and tubs, reduction of waste to a concentrated form to facilitate disposal and quantity of solid waste generated by the treatment process. The processors are supposed to use relatively less harmful solvents and stain removers, alternates in processing, anti-creasing auxiliaries with correct process parameters, use appropriate cross-linking agents and binders in pigments printing and control process parameters, alternative products which contain fatty alcohol ethoxylates, power clean, a high efficiency internal spraying for boil outs, intermittent machine cleaning to minimize energy, water, chemical usage and time consumption and harmless metallic accessories such as button, rivets, zippers and so on.
5.5 INNOVATIONS TO MAINTAIN ECO-SYSTEM IN TEXTILE PROCESSING

Innovations in wet processing are a continuous process in energy conservation, economy, environmental considerations or developments in associated technologies concerned with (i) health, (ii) hygiene and comfort and (iii) fashion. Health considerations represent the ecology and user, hygiene represents odour control and comfort, fashion deals with social status and adaptability. To make innovations and value addition in textiles effective and lucrative, the following innovations are adding feathers to the cap of textile processing.

5.5.1 Eco-textiles

Eco-textiles are fabrics made from natural and environmental-friendly materials. They are grouped in different forms such as organic cotton, bamboo, corn, soy bean, hemp, milk, tea, pineapple fibre, banana fibre, jute fibre, flax and ramie (used in mummy cloths in Egypt 5000 - 3000 BC). Saffron, turmeric, indigo Heart wood of Jack fruit, red sandal wood sawdust, Hibiscus Rosa sinensis, Kamala leaves, Eucalyptus bark dye.

An eco-friendly natural anti microbial finish from aloe vera, neem and pomegranate for textile application is reported to have value addition. Application of white rot fungi for the bio remediation of hazardous waste sites, bamboo fibre for environmental and skin

17. www.academicjournals.orgs
friendly, Soya bean fibre for blood circulation and **naturally coloured cotton** produced by conventional genetic selection and by direct DNA engineering are gaining momentum in its textile usage. Controlled environment offers crop protection and crop improvement for specific target and ensures quality maintenance.

### 5.5.2 Eco-concepts

In a world where people are becoming increasingly concerned about ecology, there is a growing demand for Green Textiles in the major world markets. Certain chemicals have been red listed, whereas certain azo chromophore based dyestuffs have been banned. There is an ongoing conflict between what the global retailers consider acceptable products in the sourcing countries. The Greening Centers are unstinting in its efforts to ensure a pleasant and pollution free environment for future generations and help both buyers and manufacturers to satisfy the most stringent international eco testing requirements. The idea is to create a uniform social requirement in production facilities worldwide.  

### 5.5.3 Energy Audit

In Indian textile industry, energy has become the largest conversion cost at about 10per cent of sales and almost 5 times the net profit margin the mill can earn under normal trading condition. In order to reduce the overall energy cost, many government and non-government organizations are involved in conducting energy audit in every industrial establishment.

18. www.ecoconcept susa.coms
Moreover, the government has made it a mandatory requirement for all most all industries.

Energy Audit is the starting point of an energy management plan and it is an important process for taking stock of the available system, so that it can highlight various issues for improvement. **Parallel Flow Exhaust System** aids in saving thermal / heat energy (@ 20 to 25per cent) by re-circulating part of heated air in the chambers and minimizing air pollution by reducing the amount of exhaust gases left to the atmosphere. The more efficient fully automatic system, ‘**Flash Tech Evaporator**’ consumes less power and steam to evaporate more effluent, to eliminate huge volume of sludge, recovers 90 per cent of the water and 99 per cent salt with no discharge of treated water.19

### 5.5.4 Eco-labelling

Quality demands dictate textiles to suit geographical, regional and climatic conditions. A transparent, unbiased and accountable method of review and implementation of certain norms and criteria in respect of textile products, based on cradle- to - grave approach be developed analyzing the products entire life cycle production, distribution and utilization and disposal after use. The Government of India also evolved eco-standards for eco labeling of the textile items in consultation with the Indian Textile Trade and Industry.

Helping the end-consumer to identify and ascertain the conformity of the products to certain set ecological and safety parameters, without having to get into the specific technical details is known as Eco-labels.

Apart from promoting the eco-friendliness of the textiles, eco-label products would enhance market acceptability due to the growing concern for ecological impact including production ecology, user ecology and disposal ecology.

5.5.5 Virtual eco-industrial park

This type of park developed by Brownsville, Texas, USA is a network of related regional companies. By working together, companies in a virtual park can create economies of scale, buy goods with a higher recycled content, hire a shared engineering/efficiency expert or compliance auditor, participate in waste exchange at lower prices for secondary raw materials, realize savings in hazardous waste disposal charges and enjoy reduced transportation costs.

5.5.6 Zero-emissions eco-industrial park

Developed by the Port of Cape Charles in Virginia USA, just as virtual eco-industrial parks, the participants reap a certain level of resource efficiency through co-operative buying, waste exchange and co-locating units, that the waste products of one can become another’s raw material.20

5.5.7 Environmental Management System (EMS)

During 1990’s the concept of Environmental Management Systems was developed and focused more on how a company manages the environmental impact of its activities as a whole rather than on the detailed assessment of individual products. Pursuant to this, ISO 14001 has become an effective mechanism for transmitting

environmental issues along the supply chain, as it requires an organization to question its suppliers on their environmental performance and practices.

5.5.8 Green Consumers Concept

Green Consumers concept gained popularity during 1990s. In 1995, a survey conducted in UK identified different types of green consumers, viz., Arm chair greens people concerned about the environment but this concern does not carry through into their life style or purchasing behaviour, Pale greens people concerned about the environment and opt for product marketed a premium for goods and services that have environment impact and Very dark greens people who only buy natural or organic products and protest against motorway extensions, nuclear installations, usage of chemical and so on.21

Even if an individual producer country does not have tough pollution control legislation or labour laws, minimum standards of working conditions and safety, health and environmental requirements may be imposed by the European or North American purchasing organisations. In India, the following are a few standards prescribed.

(i) Standards specified by the Government of India in the Environment (Protection) Rules.

(ii) Minimal National Standards (MINAS) and Emission Regulationsevolved by Central Pollution Control Board.


(iv) Standards evolved by the Pollution Control Boards of various states.

To survive, grow and prosper, the wet processing industry and the technical expertise of the processor should be improved to adapt quickly to the current and future challenges in the textile world.

5.5.9 Environmental Audit

Environmental Audit is a system for integrating the interests of the industry and the environment, so that these could be mutually supportive to become a part of every industry’s internal procedures, to help the industry in fulfilling its responsibilities towards better environment. Environmental Audit activities deal with appraisal of location of the industry with surrounding land uses, water utilization, products manufactured, waste water generation and disposal, gaseous emissions, solid waste/hazardous waste generation, policies of the company vis a vis environmental management. The Confederation of Indian Industries (CII) is making all possible attempts to educate industries and make them recognize that despite its mandatory nature, the environment audit as a strategic tool to improve manufacturing efficiency.

5.5.10 Sludge Management

The textile effluent is intensively coloured; contains both organic and inorganic substances in dissolved, colloidal or suspended form and hence the effluent treatment plant comprises physical, chemical and biological treatment units where each unit generates different type of sludge. The disposal of these wastes has received a considerable attention in recent years to protect the environment. The pernicious effect of primary sludge has necessitated the reuse of the sludge as manure for land application in agricultural production, as brick making material and recycling in subsequent effluent treatment loop.
5.5.11 Bio-auxiliaries

Modern society expects bio-auxiliary as the answer for many worldwide problems like depletion of energy sources, incurable illnesses and pollution, among other problems. Industrial use of biotechnology is bringing about new products and processes aimed at the use of renewable resources, the application of green technologies with low energy consumption and environmentally healthy practices. As textile, fibres are polymers, the majority being of natural origin, it is reasonable to expect there would be many opportunities for application of bio auxiliary, which are bio-degradable, to textile processing.

5.5.12 Environmental Impact Assessment (EIA)

It is one of the more recent branches of environmental engineering where the developmental activities are taken up with the best of intentions whether to take up a project, enables to foresee dangers, take preventive steps right from the beginning and helps in reducing the cost of environmental protection and production.

An environmental impact is any alteration that may be caused in physical environment (temperature, humidity, noise level etc), chemical environment (acidity of water, composition of air, adulteration of food), biological environment (depletion in bird population, damage to plants, shifts in species compositions etc), social environment (creation of sense of well being or social tensions), economic environment (change in per capita, creation or loss of jobs etc), political environment change in voter preference due to the impacts of the projects and so on.
5.5.13 Hi Performance Functional Textiles

The physical structure of the fibre has been tuned to give both responsiveness and structural stability. The research at Indian Institute of Technology (IIT) Delhi has made several successful attempts in developing truly smart textile materials that respond actively to the changes in the environment, shape-changing fibres, yarns and fabrics produced with the help of suitably designed stimuli sensitive co-polymers.22

Conventional textiles are used to cover human body and function as a protective layer for the body from dust, sunlight, wind and other contaminants present in the normal living environment. When the textiles are used for additional function specific to an adverse or extreme climate, job environment to enhance adaptability/productivity of the user. It may be regarded as Smart Textiles and when the additional functionality changes with change in use conditions, that textile may be regarded as Active smart or intelligent textile.

5.5.14 Plasma Technology

Plasma Technology is an alternative to conventional wet chemical process and provides efficient surface treatment opportunities, uses no water, less chemicals and the speed of the process reduces energy consumption still further. The increasing interest in the application of plasma processes on textiles is due both to the necessity of adding value to products and to develop new pollution free technologies.23

22. www.express textile.com,
5.5.15 Wrinkle free processing

Wrinkle free processing has been developed in modern times. People want to spend minimum time in caring for the garments and the trend is for garments that can take care of themselves. Hence, stain proof, wrinkle proof and easy care kind of labels are flooding the market. Ironing the garments consumes time and energy in the form of electricity and human strain and that can be avoided.24

5.5.16 ‘WELLNESS’ Finish with Vitamin E

‘WELLNESS’ finish with vitamin E has been successfully showing the presence of vitamin E on the textiles. It was possible that active substance of vitamin E passes over to the skin when the textile is worn. With the transfer proof of vitamin E from the textile into a skin model, a very important milestone has been set on the journey of introducing product ideas and the next challenge will be to confirm the transfer in real wearing results.25 Similarly applications of Artificial Neural Networks (ANN) in textiles include evaluation of trash and colour grading of cotton, prediction of yarn properties using natural computations, theoretical control and experimented verification of carded web density, fabric defects and so on.26

5.5.17 Bio- mimetics

Bio- mimetics (bio-mimicry-life to imitate) is a fascinating and fast- emerging field of research, using nature’s principles to create products processes and policies that are well adapted to life on earth.

24. www.Textile Library.blog spot.com
5.6 Role of Natural Dyes in Textile Processing

Natural dyes are looked at as an ‘eco-solution’ to the ill effects of synthetic dyes. The concept of ‘eco-friendly textiles’ is gaining momentum in the present era of ecological concern. The discovery of side effects of synthetic dyes as well as some chemicals coupled with the implementation of the environment protection legislation has generated entropy in the system

Natural dyes have been part of human life since time immemorial. Though naturally coloured cotton and natural dyes have existed for thousands of years around the world, they received little attention because of their unsuitability for commercial processing and lack of colour intensity and visual appeal of the products. In recent years, there is a trend to go back to nature and patronise natural product through commercialisation of indigenously developed technology of manufacturing of natural dyes.

Some of the natural dyes like indigo were leguminous in nature and played a valuable role in the enriching of the soil by crop rotation. With the advent of synthetic indigo, natural indigo seeds were no longer collected and the fields lost out a valuable input, by which nitrogen from the atmosphere was fixed in the soil. Use of myrobalan and pomegranate rind in dyeing encouraged the use of bio wastes and cleaned up the environment. Lac was an insect dye derived from the shell of the lac insect, providing gainful employment to hundreds of forest dwellers. More important than the commercial value of the individual natural dye concerned was the empathy between man and nature. This empathy had fostered in mankind a healthy respect for the biosphere, which was broken once the dyes were synthesized in the laboratory.
The use of natural dyes has become extinct except in few places like Kalahasti, Pedanna in Andhra Pradesh, a few places in the tribal belt of Madhya Pradesh and Orissa.

Nevertheless, natural dyes have been environmentally friendly and maintain ecological balance. Wastelands can be utilized to grow dye-yielding plants. Some of the dyeing resource enable clean environment by waste recycling. Natural dyes are non-allergic, non-toxic, and safe for human health. Similarly, natural dyes when used in isolation have limitation of poor fastness and dullness of shade.

However, the use of natural dyes along with metallic mordant would produce brightness and fastness in colour. Though it is not always eco-friendly, the problems created by metallic mordents are of lower order and easily manageable.

The Industrial and Technical Consultancy Organisation of Tamil Nadu (ITCOT) made a study on natural dyes which indicated that Indian Natural Dye Industry stood a good chance of growth both in domestic and international markets due to the ban on the use of azo based dyes in international market. Obviously, natural dyes offer the advantage of eco-friendly and user-friendly. Despite this, unscrupulous deforestation may cause environmental imbalances. Natural dyestuffs, made from natural materials mainly vegetables, bark of trees fruits and animal matter are limited in supply. In order to supply natural dyes to satisfy global demand, large area of agricultural land is required.

27. www.itcot.com
Over exploitation of species, variation in the quality of raw materials, poor washing, light fastness, variation in colour characteristics, chances of contamination during storage, problems in fixation of colour are posing problems in wide usage of natural dyes. Therefore, bio-resources should be optimally utilized to protect environment.

5.6.1 Standardization and Commercialization of Natural Dyes

Interest on colouration of textiles with dyes of natural origin, particularly vegetable origin, has been revived due to its known advantages, are now being systematically and scientifically standardized for application procedure and for characterization. The following were the attempts made towards it. During late 1997, Technology Information, Forecasting and Assessment Council (TIFAC) a wing of Department of Science & Technology, DST Government of India arranged a Technology-Business-Meet jointly with Indian Institute of Technology (IIT) Delhi, the commercialization of indigenously developed technology of manufacturing of Natural Dyes and Standardization eco-friendly natural dyes were initiated and the stages of improvement were the following.28

(i) standardization of natural dyes and the conversion of natural dyes extracts into a powdered form.
(ii) only water as such or at different pH and temperature would be used for the extraction of the colouring matter from the raw materials.
(iii) high level of quality control of the dyes Dye qualities such as solubility, strength, shade and staining on other fibres were severely controlled for each production lot, so that there may be no need to make correction with changing lot.

parameters such as pH, time and temperature of extraction were initially worked out at IIT Delhi, at a great cost for getting the maximum standardized colouring matter.

Attempts were made for further research and commercialization of natural dyes made a submissive start at M/S Alphs Industries, Ghaziabad in U.P. Accordingly, the natural dye powder manufacturing facility was the scale up of the pilot plant with many additional features such as materials handling equipment, large storage silos, raw material grinding and sieving and extraction facility: high-speed continuous centrifuges, vacuum concentrators, spray drying were set up. The raw materials were purchased in bulk quantity and the plant was run to test its capacity and quality of the product. Very elaborate shade cards were prepared along with the publicity material. Since water has natural salts in varying quantity, these salts interact with the dye and product dye-metal complexes, having different hues. For the first time, it was realized that the dyeing with natural dyes must be carried out with standardized water quality for universal reproducibility. The shade variations are kept to minimum and the tolerance limits are set with the help of the computer colour matching system. In order to build the confidence of the user and to familiarize him, an arrangement for after-sales service has to be made to tackle the dyer’s problems during use.

However, the use of natural dyes posed a few problems. It does not qualify to be environment friendly because some of the mordants of chromium, copper and so on are carcinogenic. Avoiding the use of such hazardous chemicals and using benign chemicals like aluminum
and iron is the need of the hour. These chemicals also help in the production of some pleasing colours without harming the eco-cycle. The rebirth of natural dyes as an alternative to the hazardous synthetic dyes as recently received a worldwide attention. There is virtually a worldwide hunt for eco-friendly dyes as they are non-hazardous and safe. Recently, the eco-friendly features of natural dyes, like its pleasing tones of blue, yellow, brown, green, crimson, scarlet, rust red, black, chocolate, beige, sage, puce, moss green, fawn and other shades on silk and cotton have gained attention.

Relentless perseverance to convert to natural dye has now enhanced their product range and the value the customer enjoys. The furnishing fabrics made from the natural-dye and yarns were manufactured and exhibited in an exhibition in USA as part of the promotional activity. Indian plant wealth has a great potential to meet out a substantial portion for the requirement of natural dyes.

5.7 ECO-FRIENDLY MEASURES IN THE TCTP MILLS LTD

The Tamil Nadu Cooperative Textile Processing Mills Ltd. from the very inception, processed the uniform cloths required by various government departments like Social Welfare, Adi Dravida, Backward Class and Most Backward class and so on. The clothes are desized, scoured, washed, and bleached and coloured, where in a variety of dyes & chemicals are used batch wise. During these wet processing activities, large quantity of water is used as a solvent for processing chemicals and as a washing rinsing medium in addition to steam.
5.7.1 Installation of ETP

Until early 1980s, effluent water was discharged from the TCTP MILLS in the nearby water bodies during which effluent treatment rules were not very stringent. The mills started using VAT dyes during 1985-86, which were reportedly costlier and less polluting. Similarly, sodium chloride (salt) has not been added in the processing activities and hence pollution was reported to be comparatively lesser in the TCTP Mills than that of knitting units in Tirupur. The Tamil Nadu Pollution Control Board directed the mills to establish full-fledged Effluent Treatment plant during 1985-86. As a first step, an Air Blower was installed and during the process, sludge was settled and water was treated and let off. The entire quantity of effluents collected from both dye bath and wash water was not separated during that time. During 2001-02, separate tanks were constructed for dye bath as well as wash water. This step was taken as to decolour the water in the Dye bath because there was hue and cry among the farmers who lived aside of river banks of Cauvery, Noyyal and Kalingarayan Canal. The water flowing in these rivers was in multi colour due to pollution. Therefore, it was mandatory to install a foolproof Effluent Treatment plant. Thus, the mills was bound to take all possible steps to update the effluent treatment system from time and again.

Figure 5.2 explains the activities of the Effluent Treatment plant installed in the mills.
Figure 5.2

Effluent Treatment Plant of TCTP Mills
5.7.1.1 Various Components of Effluent Treatment / Plant

5.7.1.1.1 Equalization Tank

Equalization tank is a storage chamber of all the processed wash water. The wash water being collected from various processing activities equalises all liquid wastes except dye bath water.

5.7.1.1.2 Flash Mixer and Primary Clarifloculator

The flash mixer facilitates the formation of flocks in the Clarifloculator. Poly Aluminum Chloride and Poly Electrolyte are used as agents. In Clarifloculator, chemical flocculation and clarification of effluent take place. This would result in removal of suspended solids, organics (BOD and COD), colour and reduce turbidity. Effluent then enters into Aeration tank. Clarifloculator underflow sludge and then is pumped into thickener to increase sludge concentration.

5.7.1.1.3 Thickener

Having removed the suspended solids the underflow sludge is pumped into Thickener tank.

5.7.1.1.4 Filter Press

In the presence of chemical dosing (LIME), Thickener underflow sludge water (colloidal form) compressing process takes place to make sludge in cake form.

5.7.1.1.5 Sludge Drying Beds

The sludge from thickener and biological sludge in excess is pumped into sludge drying bed for quick drying. Wherever necessary, sunlight drying is done to save energy.
The sludge after drying is collected in gunny bags, sealed and stored in a safe place for disposal.

5.7.1.1.6 Aeration Tank

Here the effluent water has undergone extended aeration by activated sludge process to reduce the load of BOD and COD up to 75 per cent to 85 per cent by microbiological oxidation. Required amount of MLSS is maintained by recycling Biomass from secondary clarifier.

5.7.1.1.7 Secondary Clarifier

In secondary clarifier, overflow water goes to storage tank. Excess biological sludge from secondary clarifier is pumped in to sludge drying beds.

5.7.1.1.8 Dual Media Filters (DMF)

Here treated water passes through the dual media filter under mechanical pressure to remove the suspended solids, silts, colour and odour, then goes to the ultrafiltration feed tank.

5.7.2 Setting up of Reverse Osmosis System and Reject Management System

In the year 2003, the Orathupalayam Farmers Association in Tirupur filed a case in the Honourable High court of Judicature, Madras, to order for compensation for the barren land, which was fertile once, due to the polluted water stored at the Orathupalayam Dam in Tirupur district. The High Court ordered the dyeing and processing units located in and around Tirupur to pay immediate compensation to the farmers and directed the dyeing units to install Reverse Osmosis and Reject Management Systems to ensure zero discharge of water and insisted to
recycle water, failing which to face closure of the units. It was also ordered to move 5 kilometres radius away from the river basin and new units should not be set up henceforth.

Tamil Nadu is probably the only state in the country where River Protection Authority has been constituted, which petitioned to the High Court against processors ruining the rivers. The High court has also directed the processing units to shift to another location and follow zero discharge norms. Reverse osmosis is a federation that removes many types of large molecules and ions from solutions by applying pressure to the solution when it is on one side of a selective membrane. The result is that the solute is retained on the pressurized side of the membrane and the pure solvent is allowed to pass to the other side. In the normal osmosis process, the solvent naturally moves from an area of low solute concentration, through a membrane, to an area of high solute concentration. The movement of a pure solvent to equalize solute concentrations on each side of a membrane generates a pressure and this is the ‘osmotic pressure’. Applying an external pressure to reverse the natural flow of pure solvent, is reverse osmosis.

30 wikipedia.org/wiki/reverse-osmosis
Figure: 5.3
R.O and R.M.S Plant
The TCTP Mills’ Broad of Management discussed the subject of installing RO system in the existing mills premises and gave a formal approval. The mills floated All India Tender under the provision of the Tamil Nadu Transparency in Tender Act 1998 and Rules 2000. The Indian Institute of Technology Madras (IITM), Chennai was identified as technical experts. A few Technical Consultancy Organisations participated in the tender and it was identified that the technical feasibility was not fulfilled. However, it was mandatory to install Reverse Osmosis and Reject Management System because eight Common Effluent Treatment Plants (CETP) of Tirupur and Perundurai were forced to set up the RO plants as per the direction of the High Court. Mean time, the mills was directed by the Board to purchase land in SIPCOT Industrial Growth Centre located in Perundurai about 20 kilometres away from Erode. The mills took steps to obtain allotment for 9.62 acres of land. As per the feasibility study of relocating the factory to Perundurai SIPCOT land and also installing a new ETP, RO and RMS systems there it was ordered to proceed further. In course of time, that plan was dropped and it was decided to set up the Reverse Osmosis and Reject Management Systems in the existing mills premises.

The Action Plan for setting up of RO and RMS was chalked out and in the month of July 2007, it was ordered by the Pollution Control Board to pay penalty at the rate of 6 paise per litre for the entire quantity of discharged water and the mills paid the penalty and was granted permission to run the factory continuously. Thus, the mills paid penalty from July 2007 to January 2009. The TCTP Mills finally installed the RO and RMS by floating nationwide competitive bid as per the Act and Rules.
M.S Phermeonics Ltd, Vadodara, Gujarat was awarded the contract and installed the same in January 2009, at a cost of Rs 1.5 crores, fully financed by the mills own funds. Figure 5.3 elucidates various activities carried out in Reverse Osmosis and Reject Management System.

5.7.2.1 Ultra Filtration

Ultra filtration is a process of treatment to reduce the turbidity and suspended solids in the pretreated water.

5.7.2.2 Reverse Osmosis

In Reverse Osmosis, membranes play a vital role. Under high pressure, the water treated in Ultra Filtration process, passes through the semi-spermeable membrane to remove the colour and all minerals. In the RO process, chemicals such as Hydrochloric Acid, Anti-salines are used.

5.7.2.3 Multiple Effect Evaporator

Here under vaccum, the RO final reject water passes through a vessel and vapour separator to generate condensed water.

5.7.2.4 Solar Pond

The Multiple Effect Evaporator’s final reject water goes to solar pond for natural evaporation treatment. In other words, the water is dried in solar pond in sunlight.

5.7.2.5 Common Permeate Water

The permeate water received from three stages of Reverse Osmosis I, II and III is stored in a separate tank. This permeate water in a purified form which is pumped to factory and is recycled for the processing and domestic activities.
During the installation of the RO and RMS, the mills faced a number of problems like payment of penalty to TNPCB and problems like delay in getting government orders for uniform cloth and so on during 2008 - 2009. However, the problems were mitigated to some extent.

**Figure 5.4**

**VARIOUS ACTIVITIES OF REVERSE OSMOSIS AND REJECT MANAGEMENT SYSTEM**

![Diagram of RO and RMS system]
Figure 5.5
Multiple Effect Evaporation Plant
extent in course of time. An amount of Rs.89.34 lakhs was paid by the mills and the TN Pollution Control Board insisted on payment of further penalty of Rs.111.46 lakhs for the consented quantity of 500 kilo litres of water per day.

The mills faced a closure in December 2010 for the delay in installation of RO and RMS. The management of the mills approached the High Court and filed the Writ petition and obtained interim stay order on closure order issued by the TN Pollution Control Board. The stay order was revoked in February 2011, the mills resumed functioning and promised in the High Court to pay penalty of Rs.111.46 lakhs in near future, and later it was paid.

In addition to the existing five Electro Magnetic Flow Metres the mill installed four additional Electro Magnetic Flow meters in 2010 and seven more Electro Magnetic Flow Meters in April 2011 and the mill connected all its Electro Magnetic Flow Meters with Tamil Nadu Pollution Control Board Head Office in ‘On-line’. Having complied with all the requirements of the Pollution Control Board, the mills formulated a strategy of being eco-friendly. In this process, comprehensive environmental audit was completed under the active guidance of the Operations Research Wing of the Indian Statistical Institute (ISI), Coimbatore to get ISO 14001 Certification.

Thus, the mills has had a novel responsibility of playing a role of a model employer as the mills in an apex cooperative institution established by the Government of Tamil Nadu. The management of the mills took every step to adhere to the pollution control norms and to run the mills to project itself as model in protecting environment and being eco-friendly.
5.8 CONCLUSION

Industrialisation generates economic growth, but it is associated with side effects of health hazards of pollution. It is necessary to take care of such pollution by introducing clean technology, regulatory measures and awareness creation. Eco requirements will continue to dominate the trade and the processor needs to understand in detail the changes that need to be done to satisfy these requirements. Society, Economy and Environment, the three important components of real sustainable development, balancing all the three simultaneously with the existing level of technology is a herculean task.

It is noteworthy to mention that the TCTP mills has undertaken all possible steps to comply with pollution control norms by installing Effluent Treatment Plant and subsequently established RO and RMS as per the conditions stipulated by the Government and the Pollution Control Board to safeguard the environment.