

**ECO-FRIENDLY SUBSTITUTE USED ON
POLYESTER-VISCOSE FABRIC IN TEXTILE WET
PROCESSING UNITS OF BHILWARA CITY**

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MISS HEENA JAITHLIA

THESIS

MASTER OF SCIENCE (HOME SCIENCE)

IN

(Textiles and Apparel Designing)



2016

**DEPARTMENT OF TEXTILES AND APPAREL DESIGNING,
COLLEGE OF HOME SCIENCE, UDAIPUR
MAHARANA PRATAP UNIVERSITY OF AGRICULTURE
& TECHNOLOGY, UDAIPUR (RAJASTHAN)**

**MAHARANA PRATAP UNIVERSITY OF AGRICULTURE
AND TECHNOLOGY,
COLLEGE OF HOME SCIENCE, UDAIPUR**

CERTIFICATE – I

Dated

This is to certify that **Miss Heena Jaithlia** had successfully completed the Comprehensive Examination held on..... as required under the regulation for **Master's Degree.**

Dr. Meenu Srivastava
Professor and Head
Department of Textiles and Apparel Designing,
College of Home Science
MPUAT, Udaipur.

MAHARANA PRATAP UNIVERSITY OF AGRICULTURE AND TECHNOLOGY
COLLEGE OF HOME SCIENCE, UDAIPUR

CERTIFICATE - II

Dated

..... This is to certify that this thesis entitled **“Eco-friendly substitute used on polyester-viscose fabric in textile wet processing units of Bhilwara city”** submitted for the degree of **Master of Science** in the subject of Textiles and Apparel Designing of the **Maharana Pratap University of Agriculture and Technology, Udaipur** embodies bonafide research work carried out by **Miss Heena Jaithlia** under my guidance and supervision and that no part of this thesis has been submitted for any other degree. The assistance and help received during the course of investigation have been fully acknowledged. The draft of the thesis was also approved by the advisory committee on.....

Dr.Meenu Srivastava

Dr. Rupal Babel

Professor & Head
Department of Textiles and Apparel
Designing
College of Home Science
MPUAT, Udaipur.

Major Advisor

Dr. Arti Sankhla

Professor & Dean
College of Home Science,
MPUAT, Udaipur.

**MAHARANA PRATAP UNIVERSITY OF AGRICULTURE AND
TECHNOLOGY,
COLLEGE OF HOME SCIENCE, UDAIPUR
CERTIFICATE - III**

Dated :

This is to certify that this thesis entitled “**Eco-friendly substitute used on polyester-viscose fabric in textile wet processing units of Bhilwara city**” submitted by **Miss Heena Jaithlia** to **Maharana Pratap University of Agriculture & Technology, Udaipur** in partial fulfilment of the requirements for the degree of **Master of Science in Home Science** in the subject of **Textiles and Apparel Designing** after recommendation by the external examiner was defended by the candidate before the following members of the examination committee. The performance of the candidate in the oral examination on this thesis has been found satisfactory. We therefore, recommend that the thesis be approved.

Dr. Meenu Srivastava

Professor and Head
Department Textiles and Apparel Designing,
MPUAT, Udaipur

Dr. Rupal Babel
Major Advisor

Dr. Meenu Srivastav
Member

Dr. Arti Sankhla

Professor & Dean
College of Home Science, Udaipur

Dr. Gayatri Tiwari
Member

Dr. Dhriti Solanki
(DRI Nominee)

Approved
Director Resident Instructions
Maharana Pratap University of Agriculture and Technology,
Udaipur

**MAHARANA PRATAP UNIVERSITY OF AGRICULTURE AND
TECHNOLOGY**

COLLEGE OF HOME SCIENCE, UDAIPUR

CERTIFICATE - IV

Dated :

This is to certify that **Miss Heena Jaithlia** student of **Department of Textiles and Apparel Designing**, College of Home Science, Udaipur has made all corrections/modifications in the thesis entitled “**Eco-friendly substitute used on polyester-viscose fabric in textile wet processing units of Bhilwara city**” which were suggested by the external examiner and the advisory committee in the oral examination held on _____. The final copies of the thesis duly bound and corrected were submitted on _____ are enclosed herewith for approval.

Dr. Rupal Babel

Major Advisor

Enclosed one original and two copies of bound thesis, forwarded to the Director Resident Instructions, Maharana Pratap University of Agriculture and Technology, Udaipur through the Dean, College of Home Science, Udaipur.

Dr. Meenu Srivastava

Professor and Head

Department of Textiles and Apparel Designing
MPUAT, Udaipur

Dr. Arti Sankhla

Professor & Dean

College of Home Science, MPUAT, Udaipur.



***Department of Textiles and Apparel
Designing***
COLLEGE OF HOME SCIENCE, UDAIPUR
**MAHARANA PRATAP UNIVERSITY OF AGRICULTURE
AND TECHNOLOGY, UDAIPUR**

CERTIFICATE – V

Dated :

This is to certify that **Miss Heena Jaithlia** (M.Sc. Scholar) has worked under me on **“Eco-friendly substitute used on polyester-viscose fabric in textile wet processing units of Bhilwara city”**

1. I have monitored her research work.
2. I and the scholar were in contact with the committee members and the research work was reviewed regularly.
3. The advisory committee members have gone through M.Sc. thesis critically and made the corrections as per requirement.

Dr. Rupal Babel
Major Advisor

**MAHARANA PRATAP UNIVERSITY OF AGRICULTURE AND
TECHNOLOGY**

COLLEGE OF HOME SCIENCE, UDAIPUR

DEPARTMENT OF TEXTILES AND APPAREL DESIGNING

M.Sc. Thesis

Topic: Eco-friendly substitute used on polyester-viscose fabric in textile wet processing units of Bhilwara city.

ABSTRACT

Textile industry is largest employer in the unorganized and organized sector. Textiles are among the basic needs of human being. This sector has wide spectrum of industries ranging from small-scale units that use traditional manufacturing process, to large integrated mills using modern machineries and equipment. Textile raw materials, dyes & chemicals, textile processes all should be based on 3R (reduce-recycle-reuse) concept. The processing of textiles should be cost effective and environment-friendly. Synthetic fabrics such as polyesters are - Easy care and more durable. These fibers need to be washed at lower temperature saving a lot of energy throughout their life cycle. Textile processing industry requires huge volume of water, energy & various chemicals for dyeing, printing and finishing stage. Textile industry, backbone of fashion garments, is large variation in demand of type, pattern & color of fabric resulting into significant fluctuation in waste generation. Textile processing produce much waste steam, including liquid, gaseous and solid wastes, some of which may be hazardous. Wet processing creates the highest volume of waste water. Textile finishing represents the most variable area in the production process. A wide and ever-growing range of finishes are now available that either improves the properties, handle or texture of the fabric.

The present research was planned to study the “Eco-friendly substitute used on polyester-viscose fabric in textile wet processing units of Bhilwara city.” To achieve the objectives researcher was proposed the research plan in which, 10 textile wet processing units of Bhilwara were selected for studying their profile, method of processing, different sub units of TPU (Textile Processing Units), explore the dyes

and auxiliaries used in dyeing, printing and finishing process, eco-friendly substitute used, pollution control measures, reuse of disposed material and waste effluent.

The recycling process starts with sorting collected textiles according to their condition and the types of fibers used. Unbearable textiles are sold to the 'flocking' industry for shredding and re-spinning. These textiles are first resorted according to their type and colour. The colour sorting means no re-dyeing is needed to save energy and avoids pollutants. Then textile materials are shredded or pulled into fibers and depending on the end use of the yarn, other fibers may be incorporated. The blended mixture is carded to clean and mix the fibers. The yard is re-spun ready for later weaving or knitting. Depending on the final application, fibers sometimes do not need to be spun into yarns; they can simply be compressed to create new textile fillings. In the case of polyester-based materials, recycling starts by cutting the garments into small pieces. The shredded fabric is then granulated and turned into polyester chips, which are melted and spun into new filament fibers used to make new polyester fabrics.

An alternative to minimize the problems related to the treatment of textile effluents would be the development of more effective dye that could be fixed fiber with higher efficiency decreasing losses on tailings waters and reducing the amount of dye required in the dyeing process, reducing certainly improve the cost and quality of the effluent.

Thus, the study emphasize that eco friendly fabric is created from resources that are environmental friendly and sustainable, and efficient management of obtaining green clothing requires considering all stages, starting from designing for the environment, obtaining raw materials, producing garments, distributing them to the channels, stores and also considering their reverse logistics and waste. . Green clothing provides consumers with healthier and more eco- friendly apparel choices. Environmental friendly, a term used to refer to goods or services, laws, guidelines and policies claiming to inflict minimal or no harm on the environment.

Major Advisor

Research Scholar

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INTRODUCTION

The textile industry has a glorious history in India. Indian textiles are known for the excellence of the craftsmanship, skill and their unique, design texture and color combination. Textile industries play a vital role in the Nation's economy taking a share of 20% of the country's industrial output and contributing nearly one- third to the total foreign exchange earnings of around Rs.3,500 crore from export of yarn, fabrics and readymade garments.

Textile industry is largest employer in the unorganized and organized sector. Textiles are among the basic needs of human being. The textile industries therefore have great economic significance by virtue of its contribution to overall industrial output and employment generation. This sector has wide spectrum of industries ranging from small-scale units that use traditional manufacturing process, to large integrated mills using modern machineries and equipment. There are 10,000 Effluent Treatment Plant (ETP) in our country. Eco-friendly or green project concept. Textile raw materials, dyes & chemicals, textile processes all should be based on 3R (reduce-recycle-reuse) concept. The processing of textiles should be cost effective and environment-friendly. Innovative techniques and various measures of **textile cleaner production” (CP)** which ensures textile processing **“eco-friendly”, “cost effective” and “sustainable business”**. Synthetic fabrics such as polyesters are - Easy care and more durable. These are more energy production, but these fibers need to be washed at lower temperature saving a lot of energy throughout their life cycle. Textile processing industry requires huge volume of water, energy & various chemicals for dyeing, printing and finishing stage. Textile industry, backbone of fashion garments, is large variation in demand of type, pattern & color of fabric resulting into significant fluctuation in waste generation. Textile processing generates much waste steam, including liquid gaseous and solid wastes, some of which may be hazardous. Wet processing creates the highest volume of waste water. Textile finishing represents the most variable area in the production process. A wide and ever-growing range of finishes are now available that either improves the properties, handle or texture of the fabric.

Pollution from small and medium size industries is a major problem in India. Nearly half of waste generated by the most polluting industries in India comes from the small and medium size industries. Water act of 1974 and its subsequent amendment in 1988 compel these industries to treat their wastewater to meet the stringent effluent discharge norms set by central pollution control boards and secondary pollution control boards. However size of these industries such that establishing independent ETP is unaffordable because of the fixed cost. In 1984, Ministry of environment and forest first mooted the idea of CETP (Common Effluent Treatment Plant) for cluster of small scale industries since then public authorities such as CPCB and SPCBs are actively promoting this idea for the small scale industries to join hands and treat their effluent jointly. World Bank has also promoted idea of ETP as the cost effective abatement measure for the pollution originating from small and medium scale industries in India and has given significant aid for the development of ETPs.

Globalization results in both pressure and drivers for all countries and enterprises in the world that are trying to improve their environmental performances. Global pollution and increased awareness are prompting consumers to seek healthier living choices. 'Green' principles and strategies have become vital for companies as public awareness of their environmental impacts has increased. Today consumers are increasingly health conscious and actively support greener lifestyles. Green clothing (also known as natural clothing, eco friendly) provides consumers with healthier and more environmentally friendly apparel choices. Environmentally friendly (also eco-friendly, nature friendly, and green) are terms used to refer to goods and services, laws, guidelines and policies claiming to inflict minimal or no harm on the environment.

Eco friendly fabric is created from resources that are environmentally friendly and sustainable. Consideration is given to the product's total life span as well as its impact on the planet, in other words, the carbon footprint. Eco friendly fabric is created from resources that are environmentally friendly and sustainable, and efficient management of obtaining green clothing requires considering all stages, starting from designing for the environment, obtaining raw materials, producing garments, distributing them to the channels, stores and also considering their reverse logistics and waste.

Textile industry involves wide range of raw materials, machineries and processes to engineer the required shape and properties of the final product. Waste stream generated in this industry is essentially based on water-based effluent generated in the various activities of wet processing of textiles. The main cause of generation of this effluent is the use of huge volume of water either in the actual chemical processing or during re-processing in preparatory, dyeing, printing and finishing. In fact, in a practical estimate, it has been found that 45% material in preparatory processing, 33% in dyeing and 22% are re-processed in finishing.

The process of textile production involves the use of further toxic chemicals which are often bonded to the fabric fibers by use of heat. Many of these chemicals leave residues that can never be washed out. They are used for fabric treatments such as bleaching, straightening, sizing, shrink resistance, anti-static and wrinkle reduction, stain and odor resistance, fireproofing and moth-proofing, disinfectants, mildew prevention and dyes.

Moreover a finite source water is used at every step of the textile process, becoming full of chemicals, which in turn pollutes the environment via the effluent's heat, through its increased pH, and because it is saturated with dyes, deformers, bleaches, detergents, optical brighteners, equalizers and many other chemicals used during the process. We breathe chemicals that evaporate into the air or are absorbed through our skin from traditionally produced fabrics that contain residuals of chemicals used during their manufacture.

Textile industries transform fibers into yarn; convert the yarn into fabrics or related products, and dye and finish these materials at various stages of production. In processing of textiles, the industry uses a number of dyes, chemicals, auxiliary chemicals and sizing materials. As a result, contaminated wastewater is generated which can cause environmental problems unless properly treated before its disposal. The wastewater treatment is mostly by primary and secondary processes. However, these conventional treatment systems are not very effective in removal of pollutants such as dissolved solids, colour, trace metals etc. The advance treatment methods, while reducing these pollutants also give scope for recovery and recycling of water and chemicals.

Textile is the important industry of Rajasthan, representing over 20 percent of investment made in the state. It contributes over 7.5 percent of India's production of cotton and blended yarns and over 5 percent of fabric (60 million sq meters). Rajasthan has leading position in spinning of polyester viscose yarn & synthetic suiting (at Bhilwara) and processing, printing & dyeing of low cost, low weight fabric (at Pali, Balotra, Sanganer and Bagru). Besides, Jaipur is also a well-known center for manufacturing garments primarily for exports. Some knitting units are in process of setting up their ventures at Neemrana. Abundant availability of raw material, availability of trained labor and a network of backward and forward linkages make Rajasthan an attractive location for textile industry. Bhilwara emerged as one of the India's largest manufacturer of suiting, fabrics and yarn. Rajasthan has leading position in spinning of polyester viscose yarn & synthetic suiting and processing, printing & dyeing of low cost, low weight fabric (at Pali, Balotra, Sanganer and Bagru). Besides, Jaipur is also a well-known center for manufacturing garments primarily for exports. Sanganer town, district Jaipur is famous worldwide for its dyeing and printing industries.

(<http://www.rajasthantour44.com/business/textile.html>)

The industrial of Bhilwara situated in Mewar Region of Rajasthan, is famous hub of textiles in India. The textile industry of Bhilwara district widely popular for exporting textile products like synthetic yarn, woolen commodities, cotton yarn and fabrics. The export sector which comprise the mills of Bhilwara fetch a sum of Rs.1300 crores per year with textile being the main industry in the district. The area has more than 400 manufacturing units, making it a major textile centre specializing in synthetic fabrics for trousers.

A well functioning weaving sector is another feather in the cap of Bhilwara's prospering textile industries. The weaving cluster in district occupies 440 units. Rajasthan has 22,000 power looms and out of which 17,000 can be found in the district of Bhilwara comprising 77% of the state's total capacity. Over 70 crore meters of the different blends of polyester fabrics such as polyester-wool, polyester-viscose-modal, polyester-viscose-elastane being produced in the district.

Textile processing industry is one of the major environmental polluters as the effluent from these industries contains a heavy load of chemicals including dyes used during textile processing. There are two main ways to limit the environmental impact of textile processing. One is to construct sufficiently large and highly effective effluent treatment plants, and the other way is to make use of dyes and chemicals that are environment friendly.

Natural dyes, when used by themselves have many limitations of fastness and brilliancy of shade. However, when used along with metallic mordants they produce bright and fast colours. Therefore, instead of using unsustainable technology for producing colours one can use mild chemistry to achieve almost similar results. The rich biodiversity of our country has provided us plenty of raw materials, yet sustainable linkage must be developed between cultivation, collection and their use. Natural dyes can produce special aesthetic qualities, which, combined with the ethical significance of a product that is environmentally friendly, gives added value to textile production as craftwork and as an industry.

Polyester is a synthetic material which appropriately determines the colours or shades of color of the resulting textile fabric and thus the fabric ultimate values to the consumer and the market place. Polyester fabric mainly used in apparels, home furnishings, ropes and nets, threads, tire cord, auto upholstery etc.

The 21st-century where Textile dyes constitutes an important segment of the whole business of specialty chemicals. Dyes that are used by the textile industry are now mostly synthetic. They are mostly derived from two sources namely, coal tar and petroleum-based intermediates. These dyes are marketed as powders, granules, pastes or liquid dispersions. The concentration of active ingredients typically ranges from 20 to 80 percent. The textile dye segment is characterized by new dyes. These new dyes are regularly developed for meeting the demands of new technology, new kinds of fabrics, detergents, advances in dyeing machineries, along with overcoming the serious environmental concerns posed by some existing dyes.

With the fast changing world of product profile of the textile industry, from high- cost cotton textiles to the durable and versatile synthetic fibers, the pattern of consumption

of these dyes is also going through rapid changes. The major consumption of water and disposing large volumes of effluent to the environment. The textile industry utilizes abundant water in dyeing and finishing process.

The use of non-toxic and eco-friendly natural dyes on textiles has become a matter of significant importance because of the increased environmental awareness in order to avoid some hazardous synthetic dyes. However, worldwide the use of natural dyes for the colouration of textiles has mainly been confined to craftsman, small scale dyers and printers as well as small scale exporters and producers dealing with high valued eco-friendly textile production and sales. Recently, a number of commercial dyers and small textile export houses have started looking at the possibilities of using natural dyes for regular basis dyeing and printing of textiles to overcome environmental pollution caused by the synthetic dyes.

Natural dyes produce very uncommon, soothing and soft shades as compared to synthetic dyes. On the other hand, synthetic dyes are widely available at an economical price and produce a wide variety of colours; these dyes however produce skin allergy, toxic wastes and other harmfulness to human body. The search and development of new methods to promote the treatment of effluents from the textile industry with a maximum of efficiency of the process of decolonization and / or removal of these compounds present in the medium can trigger further damage human health and the environment is fundamental importance. The understanding of the composition of waste generated is extremely significant to develop these methods of treatment due to the high complexity by virtue of huge number of compounds which are added at different stages of the dyeing fabrics.

Environmental problems with used dye baths are related to the wide variety of different components added to the dye bath, often in relatively high concentrations. In the future, many of textile factories will face the requirement of reusing a significant part of all incoming freshwater because traditionally used methods are insufficient for obtaining the required water quality.

There are important benefits of recovering and recycling textiles, both environmental and economical. The first advantage is reducing the need for landfill space. Certain

synthetic fiber products do not decompose, while natural fiber such as wool does decompose but produces methane, which contributes to global warming. The second advantage is reducing pressure on virgin resources. This includes materials traditionally used in textiles, such as cotton or wool, as well as oil and other chemicals employed to produce synthetic fibers. Reducing pollution as well as water and energy consumption and reducing the demand for dyes and fixing agents are other advantages. More than a million tons of textiles are thrown away each year, most of which by households rather than industry. Today many recycling centers, charities and collection projects accept textile goods. Clothing, shoes, blankets, curtains and other items made from fabric can be reused if they are in good condition, or converted into new products if they are damaged or worn. Approximately 50% of all textiles collected are reused and 50% are recycled.

The recycling process starts with sorting collected textiles according to their condition and the types of fibers used. Unbearable textiles are sold to the 'flocking' industry for shredding and re-spinning. These textiles are first resorted according to their type and colour. The colour sorting means no re-dyeing is needed to save energy and avoids pollutants. Then textile materials are shredded or pulled into fibers and depending on the end use of the yarn, other fibers may be incorporated. The blended mixture is carded to clean and mix the fibers. The yard is re-spun ready for later weaving or knitting. Depending on the final application, fibers sometimes do not need to be spun into yarns; they can simply be compressed to create new textile fillings. In the case of polyester-based materials, recycling starts by cutting the garments into small pieces. The shredded fabric is then granulated and turned into polyester chips, which are melted and spun into new filament fibers used to make new polyester fabrics.

However, due to dwindling supply and increasing demand of water in the textile industries, a better alternative is to attempt to further elevate the water quality of wastewater effluent from a secondary wastewater treatment plant to a higher standard for reuse.

Therefore, the investment in the search for methodologies to more effective treatment of these effluents can be much smaller than that spent in tertiary treatment to remove

these products in low level of concentrations and in the presence of much other interference. This requires action that the cost / benefit are reviewed and the development of new techniques for wastewater treatment capable of effective removal of these dyes is intensified and made economically viable.

An alternative to minimize the problems related to the treatment of textile effluents would be the development of more effective dye that can be fixed fiber with higher efficiency decreasing losses on tailings waters and reducing the amount of dye required in the dyeing process, reducing certainly improve the cost and quality of the effluent.

For successful commercial use of natural dyes, the appropriate and standardized dyeing techniques need to be adopted without scarifying required quality of dyed textiles materials. Therefore, to obtain newer shades with acceptable colour fastness behaviour and reproducible colour yield, appropriate scientific techniques or producers need to be derived from scientific studies on dyeing methods, dyeing process variable, dyeing kinetics and compatibility of selective natural dyes. A need has also been felt to reinvestigate and rebuild the traditional processes of natural dyeing to control each treatment and pre-dyeing process (preparation, mordanting) and dyeing process variables for producing uncommon shades with balanced colour fastness and eco-performing textiles.

The textile industries in India are using harmful chemicals and other substances for enhancing aesthetic apparel for improving certain desirable characteristics. These toxic chemicals are being used in several textile process is such as desizing, socuring, bleaching, dyeing, printing and finishing about more than 800 chemical substances are used, which is known or suspected to be harmful to human health and environment.

Categorization of waste generated in Textile industry:

Textile waste is broadly classified into four categories-

1. Hard to treat wastes- This category of waste includes those that are persistent, resist treatment or interfere with the operation of waste treatment facilities. Non biodegradable organic or inorganic materials are the cheap sources of

wastes, which contain surfactants, toxic organic compound, pesticide, and phosphates. Since these types of textile wastes are difficult to treat, the identification and eliminations of their sources are the best possible ways to tackle the problem.

2. Hazardous or toxic wastes- These wastes are a subgroup of hard to treat wastes. But, owing to their substantial impact on the environment, they are treated as a separate class. In textile hazardous or toxic wastes include metals, chlorinated solvents, non biodegradable or volatile organic materials.
3. High volume wastes- Large volume of wastes is sometimes a problem for textile processing units. Most common large volume wastes include:
 - High volume of waste water
 - Waste water from preparation and continuous dyeing process and alkaline wastes from preparatory processes.
 - Bath dye waste containing large amount of salt, acid and alkali.

These wastes some can be reduced /recycled/reused by the process and equipments modifications.

4. Dispersible wastes- The following operations in textile industry generate highly disposable waste-
 - Waste stream of continuous operation
 - Print paste
 - Lint (preparatory, dyeing and washing operations)
 - Foam from coating operations
 - Still bottoms from solvent recovery
 - Batch dumps of unused processing

Effluent treatment plants are the most widely accepted approaches towards achieving environmental safety. But unfortunately, no single treatment method is suitable or universally adopted for any kind of effluent treatment. Therefore the treatment waste

stream is done by various methods, which include physical, chemical and biological treatment depending upon the pollution load.

Justification of the study-

The work “Environment” today has become almost inseparable from the term “Environmental friendly” and so on, thus there is requirement to protect the environment. This research work is expected to educate and make one aware to the problem related to the pollution caused by the textile processing and its environmental impact. Textile processing is characterized not only by the large volume of water required for the various unit operations but also by variety of chemicals used by various processes. Apart of consuming large quantity of water, textile industry also discharges a variety of effluents.

Disposal of industrial waste is responsible for soil and water pollution. Before disposal they need to be treated for certain acceptable tolerance limits since pollution control laws are strictly followed all over the world and captured worldwide attention. The textile industry discharges a variety of chemicals, dyes, acids, alkalis and other toxic compounds.

For successful commercial use of natural dyes, the appropriate and standardized dyeing techniques need to be adopted without scarifying required quality of dyed textiles materials. Therefore, to obtain newer shades with acceptable colour fastness behavior and reproducible colour yield, appropriate scientific techniques or producers need to be derived from scientific studies on dyeing methods, dyeing process variable, dyeing kinetics and compatibility of selective natural dyes. A need has also been felt to reinvestigate and rebuild the traditional processes of natural dyeing to control each treatment and pre-dyeing process (preparation, mordanting) and dyeing process variables for producing uncommon shades with balanced colour fastness and eco-performing textiles.

Pollution from small and medium size industries is a major problem in India. Nearly half of the waste generated by the most polluting industries in India comes from the small and medium size industries. Water act of 1974 and its subsequent amendment in 1988 compel these industries to treat their wastewater to meet the stringent effluent

discharge norms set by central pollution control boards and secondary pollution control boards. However size of these industries such that establishing independent ETP (Effluent Treatment Plant) is unaffordable because of the fixed cost. In 1984, Ministry of environment and Ministry of forest mooted the idea of CETP (Common Effluent Treatment Plant) for cluster of small scale industries since then public authorities such as CPCB (Central Pollution Control Board) and SPCB (State Pollution Control Board) are actively promoting this idea for the small scale industries to join hands and treat their effluent jointly. World Bank has also promoted idea of ETP as the cost effective measure for the pollution originating from small and medium scale industries in India and has given significant aid for the development of ETP's.

Eco friendly fabric is created from resources that are environmentally friendly and sustainable, and efficient management of obtaining green clothing requires considering all stages, starting from designing for the environment, obtaining raw materials, producing garments, distributing them to the channels, stores and also considering their reverse logistics and waste.

Global pollution and increased awareness are prompting consumers to seek healthier living choices. 'Green' principles and strategies have become vital for companies as public awareness of their environmental impacts has increased. Today consumers are increasingly health conscious and actively support greener lifestyles. Green clothing (also known as natural clothing, eco friendly) provides consumers with healthier and more environmentally friendly apparel choices. Environmentally friendly (also eco-friendly, nature friendly, and green) are terms used to refer to goods and services, laws, guidelines and policies claiming to inflict minimal or no harm on the environment.

OBJECTIVES

1. To study the profile of wet processing units of textile industries of Bhilwara.
2. To explore the dyes and auxiliaries used in dyeing, printing and finishing process on polyester-viscose fabric.
3. To identify the eco-friendly substitute used for polyester-viscose fabric in textile wet processing units.

OPERATIONAL DEFINATION-

- **Textile processing units:** - Those units which are engaged in various textile processing like pretreatment, dyeing and finishing of yarn & fabrics.
- **Eco-friendly:** - Eco-friendly literally means earth-friendly or not harmful to the environment. This term most commonly refers to products that contribute to the green living practices that help to conserve resources like water and energy.

IMPLICATIONS

- The research will be helpful to policy makers & government to aware about the wet processing units of polyester-viscose fabric.
- The present study will serve as a guideline to researchers, students, entrepreneurs, etc. to know about the dyes & auxiliaries used in dying, printing & finishing process on polyester -viscose fabric.
- The study will be helpful to increase the knowledge of peoples about the eco-friendly substitute.

REVIEW OF LITERATURE

Patra (2000) described that after global consciousness about use of eco-friendly dye due to the hazardous and carcinogenic effect of many synthetic dyes, awareness has been developed on selection of dyes that may be used for textiles. The latest development of this score is that the European union has proposed to ban 300 textile dyes.

Jayagpragasam (2000) in his paper on “Environmental pollution of plant growth and development” discussed the untreated industrial effluents let in to the surrounding considerably affect the soil in which plant grow, the soil pH salinity are altered. The soil texture, quality and availability of nutrients are affected; finally the soil become uncultivable. Initially the plant die to high concentrations of salts and heavy metals and ultimately the plants do not grow in the land.

Bhattacharya and layer (2000) reported that the polyester fabric and its blends for different composition have been dyed with three commercial disperse dyes of different molecular weight and reactive dyes at various depth of shades by using ultrasound. Such dyes was also compare with conventionally dyed sample in term of their colour value, i.e. value and other fastness properties.

Singh (2001) studied that the Indian blackberry bark dye can be use on polyester in combination with different synthetic mordents to produce shades of cafean-lait. All the mordents namely alum, potassium dichromate and ferrous sulphate help in increasing the colour strength of the dye on polyester on treatment with mordents a marked increase in the case of lightened perspiration fastness and a decrease in the case of wet rubbing fastness.

Rahman (2001) reported that chronic exposure to fumes, chemical substance and dust of workplace represented the main factors for development of chronic obstructive pulmonary disease (COPD) and asthma.

Dievall (2003) reported that the textiles created with very fine fibers are more pleasant to the touch and provide better thermal comfort. Thus micro fibers (polyethylene) has extended the range of uses for PET, but these new fibers required the modification on of some certain process.

Esteves et.al (2004) states that textile material like polyester blends are almost always pre-brightened when manufactured. This is because the printing and colours are brightened when manufactured. This is because the printing and colours will be brighter and more attractive if applied to bright fabric. In most cases the percentage of optical brightness causes decrease in light and fastness of dyed fabric. However, in colored textiles, sometime a difference in one hue is detected already in a first domestic wash, even in case of solid colors.

Al-Kdasi, A. et al (2004) reported that main pollution in textile wastewater came from dyeing and finishing processes. These processes require the input of a wide range of chemicals and dyestuffs, which generally are organic compounds of complex structure. Because all of them are not contained in the final product, became waste and caused disposal problems. Major pollutants in textile wastewaters are high suspended solids, chemical oxygen demand, heat, colour, acidity, and other soluble substances.

Roscow and Wilson (2005) reported that the high risk factors for workplace stress were over work load, lack of recognition from co-workers and supervisor poor relation with supervisors, a low level of participation in decision and insufficient communication of information.

Alanya, S. et al. (2005) states that textile industry is a very diverse sector in terms of raw materials, processes, products and equipment and has very complicated industrial chain. Although there is a large variety of processes and technologies within the textile industry, this sector can be categorized into dry and wet processes. Dry processing includes yarn manufacturing, fabric weaving and knitting while wet processing includes preparation, dyeing and finishing. The textile industry has always been regarded as water intensive sector. The main environmental concern is, therefore, about the amount of water discharged and the chemical load it carries.

Yusuff, et al. (2005) studied the effluents from five major textile industries in Kaduna (Nigeria), characterized for a proposed central effluent textile processing. Seven of the measured parameters exceeded the limit set by the Federal Ministry of Environment. Colour intensity exceeded it in all the samples (Mills1-5) by about 350

folds on the average while COD, TSS, NH₃, BOD₅, and S₂ were by 24, 13, 8, 7 and 3 folds respectively. TDS was detected in all samples with limit exceeded only in Mill2. Nitrate, oil and grease were detected in Mill 1 and 2 and within the limit. Al, Mn, and Zn were detected in 80% and within the limit while Fe was detected in 60%. Cu was detected in 80% with limit exceeded about 3 folds on the average. The study was focused on the pollution in placations of these effluents from textile operations in the city; because of the risk of human exposure to them.

Manzoor et al. (2006) conducted a study on “Multivariate analysis of trace metals in textile effluents in relation to soil and groundwater”, in which samples were collected from three textile industries located in Hattar Industrial Estate, Pakistan. Metals were estimated by flame atomic absorption spectrophotometry. The result showed elevated levels of Cr, Pb, Ni, Co, Fe, Ca, Na, K and Zn in these media, following the order: soil > effluents > water. Principle component analysis (PCA) of the data showed that the textile effluents were contaminating the soil wherein Cr and Pb were dominant toxic metals having concentrations of 5.96 mg/Kg and 4.46 mg/ Kg, respectively. Other toxic metals such as Co, Cd, Zn, Ni, Mn and Fe, were found to have common origin in the textile effluents. The correlation study along with linear regression and PCA supported the fact that various evaluated metal concentrations emerged from the textile industrial effluents ultimately leading to contamination of the soil and groundwater in their proximity.

Nayak et. al. (2007) studied that in polyester-viscose blended fabric which the increase in polyester content, the extensibility and the tensile energy of the fabric decreases and the tensile resiliency of the fabric increases. The coefficient of friction increases while the geometrical roughness decreases with increase in polyester content. The THV (total hand value) decreases with the increase in polyester content. The fabric with higher viscose content give better hand, higher air permeability and higher moisture vapour transfer but lower thermal insulation.

Jaiswal et.al. (2007) reported that textile industry is one of the major growth industries for export purpose and which required large number of workers. Respiratory problem is one of the major health to the textile workers. It lead to some

systemic symptoms in exposed workers, along with this they suffer from number of other physical problem like hearing loss or noise problem.

Garg and Kaushik (2007) evaluated the suitability of textile mill wastewater (treated and untreated) at different concentration (0, 6.25, 12.5, 25, 50, 75, and 100%) for irrigation purposes. Effect of textile mill waste water on germination, delay index, physiological growth parameters and plant pigments of two cultivars of sorghum was studied. The textile effluent did not show any inhibitory effect on seed generation at lower concentration (6.25%). The other reported plant parameters also followed the similar trend. Seeds germinated in 100% effluent but did not survive for longer period. It has also been concluded that effect of the textile effluent is cultivar specific and due care should be taken before using the textile mill wastewater for irrigation purpose.

Vankar, P.S. (2007) reported that a number of commercial dyers and small textile export houses have started looking at the possibilities of using natural dyes for regular basis dyeing and printing of textiles to overcome environmental pollution caused by the synthetic dyes. Natural dyes produce very uncommon, soothing and soft shades as compared to synthetic dyes. On the other hand, synthetic dyes are widely available at an economical price and produce a wide variety of colours; these dyes however produce skin allergy, toxic wastes and other harmfulness to human body.

Dos Santos, A.B.et al. (2007) studied that the textile industry consumes a substantial amount of water in its manufacturing processes used mainly in the dyeing and finishing operations of the plants. The wastewater from textile plants is classified as the most polluting of all the industrial sectors, considering the volume generated as well as the effluent composition. In addition, the increased demand for textile products and the proportional increase in their production, and the use of synthetic dyes have together contributed to dye wastewater becoming one of the substantial sources of severe pollution problems in current times. Textile wastewaters are characterized by extreme fluctuations in many parameters such as chemical oxygen demand (COD), biochemical oxygen demand (BOD), pH, color and salinity. The composition of the wastewater will depend on the different organic-based compounds, chemicals and dyes used in the dry and wet-processing steps.

Sivaramkrishna (2008) discussed in his article “Effluent treatment a review” that, due to the nature of various chemical processing of textile, large volumes of waste water with numerous pollutants are discharged. Since these streams of water affect the aquatic ecosystem in number of ways such as depleting the dissolved oxygen content or settlement of suspended substances in anaerobic condition, a special attention needs to be paid.

CPCB (2008) reported that water is most essential but scarce resource in our country. Presently the quality & the availability of the fresh water resources is the most pressing of the many environmental challenges on the national horizon. The stress on water resources is from multiple sources and the impacts can take diverse forms. Geometric increase in population coupled with rapid urbanization, industrialization and agricultural development has resulted in high impact on quality and quantity of water in our country. The situation warrants immediate redressal through radically improved water resource and water quality management strategies.

Lokeshappa, B. et .al. (2008) studied that the wastewaters discharged from wet processing textile mills are harmful to the environment. On an average about one million liters of effluent is discharged per day by an average sized textile mill having a daily production of 8000 kg. The industrial owners should implement cleaner technology in the processing stage, so that the waste will be minimized in the initial stage itself.

Ali, S. et al. (2009) reported that textile processing unit is one of the major environmental pollutes as the effluent from these industries contains a heavy load of chemical including dyes used in different textile processing. There are two main ways to limit the environmental impact of textile processing. One is the construct sufficiently large and highly effective effluent treatment plant and the other way to make use of dyes and chemicals that are environmental friendly.

Saikh, M.A. (2009) reported that the textile Industry is in no way different than other chemical industries, which causes pollution of one or the other type. The textile industry consumes large amount of water in its varied processing operations. In the mechanical processes of spinning and weaving, water consumed is very small as

compared to textile wet processing operations, where water is used extensively. Almost all dyes, specialty chemicals, and finishing chemicals are applied to textile substrates from water baths. In addition, most fabric preparation steps, including desizing, scouring, bleaching, and mercerizing use aqueous systems. According to USEPA a unit producing 20,000 lb / day of fabric consume 36000 liters of water.

Samanta et al. (2009) reported that the use of non-toxic and eco-friendly natural dyes on textiles has become a matter of significant importance because of the increased environmental awareness in order to avoid some hazardous synthetic dyes. However, worldwide the use of natural dyes for the colouration of textiles has mainly been confined to craftsman, small scale dyers and printers as well as small scale exporters and producers dealing with high valued eco-friendly textile production and sales.

Agarwal, P. (2009) studied that the advent of widely available and cheaper synthetic dyes in 1856 having moderate to excellent colour fastness properties, the use of natural dyes having poor to moderate wash and light fastness has declined to a great extent. However, recently there has been revival of the growing interest on the application of natural dyes on natural fibers due to worldwide environmental consciousness. Although this ancient art of dyeing with natural dyeing with natural dyes withstood the ravages of time, a rapid decline in natural dyeing continued due to the wide available of synthetic dyes at an economical price. However, even after a century, the use of natural dyes never erodes completely and they are still being used. Thus, natural dyeing of different textiles and leathers has been continued mainly in the decentralized sector for specialty products along with the use of synthetic dyes in the large scale sector for general textiles owing to the specific advantages and limitations of both natural dyes and synthetic dyes.

Couto, S.R.et al. (2009) reported that the textile industry, up to 200,000 tons of these dyes are lost to effluents every year during the dyeing and finishing operations, due to the inefficiency of the dyeing process. Unfortunately, most of these dyes escape conventional wastewater treatment processes and persist in the environment as a result of their high stability to light, temperature, water, detergents, chemicals, soap and other parameters such as bleach and perspiration. In addition, anti-microbial agents resistant to biological degradation are frequently used in the manufacture of

textiles, particularly for natural fibers such as cotton. The synthetic origin and complex aromatic structure of these agents make them more recalcitrant to biodegradation. However, environmental legislation obliges industries to eliminate color from their dye-containing effluents, before disposal into water bodies.

Mozia, S. et al. (2010) evaluated that the environmental problems with used dye baths are related to the wide variety of different components added to the dye bath, often in relatively high concentrations. In the future, many of textile factories will face the requirement of reusing a significant part of all incoming freshwater because traditionally used methods are insufficient for obtaining the required water quality. However, due to dwindling supply and increasing demand of water in the textile industries, a better alternative is to attempt to further elevate the water quality of wastewater effluent from a secondary wastewater treatment plant to a higher standard for reuse. Thus far very little attention has been paid to this aspect. Therefore, the investment in the search for methodologies to more effective treatment of these effluents can be much smaller than that spent in tertiary treatment to remove these products in low level of concentrations and in the presence of much other interference. This requires action that the cost / benefit are reviewed and the development of new techniques for wastewater treatment capable of effective removal of these dyes is intensified and made economically viable.

NIIR Board, (2010) evaluated that the textile industry is listed one among the industries that consume large quantities of water. As the fresh water becomes scarce, and its treatment costs are escalating, the two possible means to solve the crisis are (i) to cut down the consumption of fresh water at possible stages of processing, and (ii) reuse of waste water in place of fresh water in certain operations. The latter way is gaining importance due to the twin advantages incurred-reduction in water consumption and lower quantities of effluents generated. With top management backing, reuse of waste water could result in large reductions of water consumption.

Fukushima, M. et al. (2010) studied carried out using a source of hydroxyl radicals with oxidizing agents, the photo Fenton system developed to promote the degradation of aniline stands out. This method has shown promise for the mineralization of aromatic amines, obtaining a reduction of approximately 85%. However, high

performance liquid chromatography (HPLC) identified a number of intermediate species formed during the degradation of the aniline, such as p-aminophenol, p-hydroquinone, maleic and fumaric acids and NH_4 .

Bhattacharyya, N. (2010) studied that plants have been used for the extraction of a majority of natural dyes. Various plant parts including roots, leaves, twigs, stems, heartwood, bark, wood shavings, flowers, fruits, rinds, hulls, husks, and the like serve as natural dye sources. The famous natural blue dye, indigo is obtained from the leaves of the plant *indigofera tinctoria*. Some plant-derived dyes have other applications also, for example, as food ingredients and medicines in traditional medicine systems and hence a commercial supply chain of these dyes is in place. Some of the natural dyes were well known in the past for their dyeing properties and have remained in use even now, albeit on a small scale. A renewed interest in natural dyes has increased their commercial availability.

Rajkumar, A.S.et al. (2011) studied that if their impact on the environment and health of people is considered, their cost increases by almost INR 410 per kg of dye. It is common knowledge that dyeing operations in developing countries are mostly carried out in small-scale industries that discharge highly polluted effluent in nearby water bodies or land with no or little treatment resulting in heavy contamination of surface and groundwater in areas having a large concentration of dyeing units. This contaminated water was unfit for human or animal use and people in the surrounding area had to fetch water from long distances and at huge costs causing them immense hardship. This water was not even fit for irrigating crops, resulting in fertile agricultural land turning barren and farmers being deprived of their livelihoods.

Ogunlajal , O.et al. (2011) studied that the water pollution is of grave consequence because both terrestrial and aquatic life may be poisoned; it may cause disease due to the presence of some hazardous substance, may distort the water quality, add odours and significantly, hinders economic activities. If textile waste water, not properly treated is released into the environment, it can introduce metals and organ chlorine compounds which can bio-accumulate in fishes in receiving streams. These fishes can have harmful effect on human when consumed. Dye residue and degraded starch render the water unfit for drinking because they reduce its quality by imposing colour

and odour on water. Hot effluent also affects dissolved oxygen (DO), which in turn affects the aquatic environment of living organisms in such streams.

Eswaramoorthi, S. (2011) studied that the trade effluent is any effluent (liquid waste) that is discharged from any premises where a trade or industry is carried out. A dye contaminated effluent, then, is one which contains residual dye, here a dye is defined as a soluble substance suitable for staining or colouring, which has an affinity to the substrate that it is being applied to. The treatment of textile effluents is of interest due to their toxic and esthetical impacts on receiving waters. While much research has been performed to develop effective treatment technologies for wastewaters containing azo dyes and other toxic materials no single solution has been satisfactory for remediating the broad diversity of textile wastes.

Khatri et al. (2011) studied that the wet textile processes assisted by ultrasound are of great interest to the textile industry for this reason and showed that the dyeing of polyester fiber using ultrasonic energy resulted in an increased dye uptake and enhanced dyeing rate. Another way to use ultrasonic energy is that, improving dye productivity and washing fastness, and reducing both energy costs and water consumption.

Padhi, R. (2012) reported that the manufactures preferred the synthetic dyes because of easy dyeing process, variation of shades, color fastness properties as compare to natural dyes. But, the dyes cause some serious health hazards like allergic, carcinogenicity, and skin diseases through they are widely and commercially popular. They pose also treat towards its eco-friendliness, as most if the dye contain azo groups of aromatic amines that may be harmful to human health and environment.

Ben Mansour, H. (2012) studied that the textile industry consumes a substantial amount of water in its manufacturing processes used mainly in the dyeing and finishing operations of the plants. The wastewater from textile plants is classified as the most polluting of all the industrial sectors, considering the volume generated as well as the effluent composition. Textile wastewaters are characterized by extreme fluctuations in many parameters such as chemical oxygen demand (COD), biochemical oxygen demand (BOD), pH, color and salinity. The composition of the

wastewater will depend on the different organic-based compounds, chemicals and dyes used in the dry and wet-processing steps. Recalcitrant organic, colored, toxicant, surfactant and chlorinated compounds and salts are the main pollutants in textile effluents.

Sulak, M.T. et al. (2012) emphasized the broad variety of technical and industrial applications, which includes “classical” utilizations like dyeing of textiles and other consumer goods as well as rather new usages such as laser dyes and dyes for organic light emitting diodes (OLDEs), liquid crystal (LC) displays, optical data storage and fluorescent labeling, has produced a great deal of research in this filed. The main driving force is the constant demand for improved dyeing efficiency or photochemical/ photo physical properties, while also focusing on eco-friendly procedures reduced toxicity, and decreased production costs.

Ali, A.et al. (2012) studied that textile materials and garment are susceptible to microbial attack, as these provide large surface area and absorb moisture required for microbial growth. Natural fibers have protein(keratin) and cellulose, etc., which provide basic requirements such as moisture, oxygen, nutrients and temperature for bacterial growth and multiplication. This often results in objectionable odour dermal infection, product deterioration allergic responses and often related diseases. The control of microorganisms (e.g. bacteria, mildews molds, yeasts and viruses) on textile fabrics extends to diverse areas such as hospitals, the environment and everyday households.

Basak, S.et al. (2012) have reported improvements in both UV protection and antibacterial activity for polyamide 6 fabrics after treatment with natural dyes. Fabrics dyed with some natural dyes have been reported by the wearers to be free of odor perhaps due to the antibacterial or bacteriostatic properties of natural dye materials. Users of natural dyed fabrics have also found such fabrics to be mosquito repellent and/or moth repellent as perhaps the plant material from which these dyes were derived might also have contained natural repellent substances. In addition, recently, cellulosic textiles treated with natural plant extract have been found to exhibit flame-retardant properties.

Perkins, W.S. (2012) estimated that over 10,000 different dyes and pigments are used industrially and over 7×10^5 tons of synthetic dyes are annually produced worldwide. Textile materials can be dyed using batch, continuous or semi-continuous processes. The kind of process used depends on many characteristics including type of material as such fiber, yarn, fabric, fabric construction and garment, as also the generic type of fiber, size of dye lots and quality requirements in the dyed fabric. Among these processes, the batch process is the most common method used to dye textile materials.

Ibrahim et al. (2013) states that the improvements in both UV protection and antibacterial activity for polyamide 6 fabrics after treatment with natural dyes. Fabrics dyed with some natural dyes have been reported by the wearers to be free of odor perhaps due to the antibacterial properties of natural dye materials.

Sengupta S. et al. (2013) studied that the synthetic fibers are most often petroleum based, but recycled fibers and those sourced from natural substances are on the rise. Ingeo, a fabric by nature works derived from fermented corn starches, can be spun into fibers for apparel and home textiles, and also used for bioplastics.

Sami A.M. (2013) states that a verity of applicative products has been developed from different existing products and also different processing changes occurred in textiles such as dyeing, chemical processing, etc. Advances in biotechnology and enzymology have bought a new lines of research and have accelerated the development of enzymatic applications in Textiles wet processing in the near future. Enzyme technology can be used to develop usable, more environmental friendly, economically competitive processes.

Almahy, H.A. et al. (2013) estimated that the natural dyes can be classified into three categories: natural dyes obtained from plants, E.g. indigo, those obtained from animals, E.g. cochineal and those obtained from minerals E.g. ocher. Natural dyes are mostly non-substantive and must be applied on the textiles with the help of mordents, usually a metallic salt, having affinity for both the colouring matter and the fiber.

Meena, K. (2014) reported that the modern automated textile plants consume large amount of energy. Textile finishing consumes large amount of water and energy and often produces harmful effluent. The expansion of textile production and consumption

has contributed to increasing pollution, water shortages, fossil fuel and raw material depletion, and climate change. There is no question that current state of the worldwide textile industry is unsustainable. The increasing pollution load has forced the textile sector to think of environmentally safe processes, finishes and product for pushing sustainable development globally.

Mehandiratta, (2014) reported that the eco-labels for green apparels are-

- Mobins loop
- Eco-mark
- Fair wear foundation
- Global Organic Textile
- Standard
- European Union Eco-label
- Good Weave
- United Parcel Service (UPS) Carbon Neutral
- Carpet and Rug Industries (CRI) Green Label

METHODOLOGY

In all kinds of research certain approach to resolve the problems is taken in to account. The approach should be rational and scientific. It must be systemized in the context of objectives to be achieved. This chapter furnishes methodological details of present investigation.

The present investigation was carried out to find the “ **Eco friendly substitute used on polyester-viscose fabric in textile wet processing unit of Bhilwara city.**” The study design refers to the logical manner in which units of study are assessed and analyzed for the purpose of drawing generalization. In this investigation, a description of the study design can be laid as follows:

- 1) Locale of the study
- 2) Selection of the sample
- 3) Development of research tool
- 4) Data collection
- 5) Analysis of data
- 6) Existing facilities

1. **LOCALE OF THE STUDY**

The present study is a survey study and was conducted in Bhilwara district of Rajasthan. The study was conducted on wet processing units of textile industries of Bhilwara city. These textile industries provide substantial contribution to the economy in the form of income and employment generation.

2. **SELECTION OF THE SAMPLE**

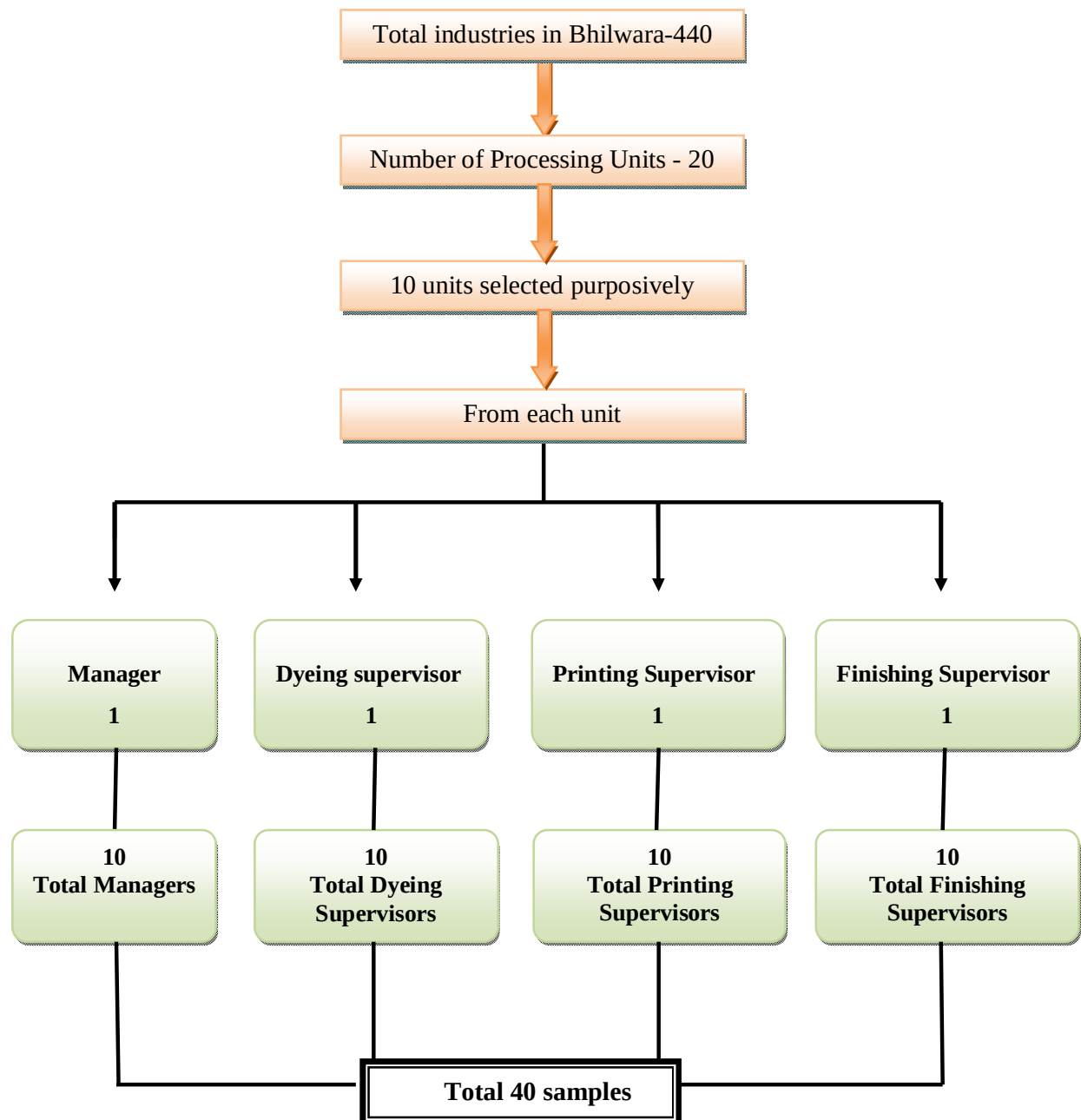
The sample selection was done as per the objectives of the study.

Selection of Textile wet processing unit.

Bhilwara is textile industrial place and there are many industries in Bhilwara city. A list of all the registered industries was procured during preliminary survey from office

of DIC Bhilwara. It was found that there are 440 textile industries and 17,000 power looms in the Bhilwara district and out of these there are 20 wet processing units in Bhilwara. Now from the list of 20 wet processing units, 10 units were selected purposively who were willing to co-operate researcher.

Sample selection process-



3. DEVELOPMENT OF RESEARCH TOOL AND ITS DESCRIPTION-

Survey work-

The researcher will develop the tool regarding information required-

Section I- For studying the profile of textile wet processing unit (TPU).

Section II- For studying the eco-friendly substitute used in textile wet processing unit.

4. PROCEDURE OF DATA COLLECTION-

Section I- For studying the profile of Textile wet processing unit.

A pre structured interview schedule was developed to gain information from the manager of TPU. The developed schedule had questions regarding-

- Background information, location, area covered, total number of workers, working hours, total year income, production per year etc.
- Information regarding different subunits in TPU.

Section II- For studying the eco-friendly substitute used in textile wet processing unit.

The structured interview schedule was developed to collect the information from the dyeing, printing and finishing supervisors of each unit regarding the eco-friendly substitute used in wet processing units. The schedule was developed with questions regarding-

- Method of processing.
- Eco-friendly chemical/ dyes used.
- Effluent management practices.
- Pollution control measures.
- Reuse of disposed material and waste effluent.

5. ANALYSIS OF DATA-

After collecting the data, the same was coded, according to preplanned format. The data were statistically analyzed through frequencies and percentages.

Coding – After categorization, coding were done as per the determine code characteristics for response through coding sheet.

Tabulation – The coded data was decoded by transforming it from code sheet to comprehensive tables and analyzed for suitable statistical treatment in light of objectives of the study.

Statistical method used-

- I. Frequency** – The qualitative data were quantified by calculating and expressed in frequency.
- II. Percentage distribution** – Data were tabulated according to the frequency and converted into percentage.

$$\text{Percentage of Score} = \frac{\text{Obtained Score}}{\text{Total Score}} \times 100$$

RESULTS AND DISCUSSION

This chapter contains the outcome of the major goals of the study i.e. the result of the study. The present investigation to find out the “**Eco-friendly substitute used on polyester-viscose fabric in textile wet processing units of Bhilwara city**”. The results of the study have been systematically illustrated by the use of tables and graphs at par with the objectives. The discussion has been made under the following broad heads:

Section I- For studying the profile of textile wet processing units (TPU).

Section II- For studying the dyes and auxiliaries used in dyeing, printing and finishing process on polyester-viscose fabric.

Section III- For studying the eco-friendly substitute used in textile wet processing unit.

SECTION-I

PROFILE OF TEXTILE WET PROCESSING UNITS:

Present structure of textile processing units of Bhilwara:

The first industrial area in Bhilwara, established in 1961. Bhilwara is located at 25.35°N 74.63°E. It has an average elevation of 421 metres (1381 feet). It falls between the districts of Ajmer (in north) and Chittorgarh and Udaipur (in south). Major rivers flowing through the district are Banas, Bedach, Kothari, Khari, Mansi, Menali, Chandrabhaga and Nagdi. At present textile wet processing units in Bhilwara are located in various industrial complexes. It was found that there are 440 textile industries and out of these there are 20 wet processing units. There are four developed industrial areas in city. Table1 and Fig.1 gives distribution of industrial units area wise.

Table 1: Area wise distribution of Textile wet processing units in Bhilwara.

S.No.	Name of Area	Frequency (f)	Percentage (%)
1.	Chittor Road industrial area	12	60
2.	RICCO industrial area	2	10
3.	Pur Road industrial area	3	15
4.	Mandal Road industrial area	3	15

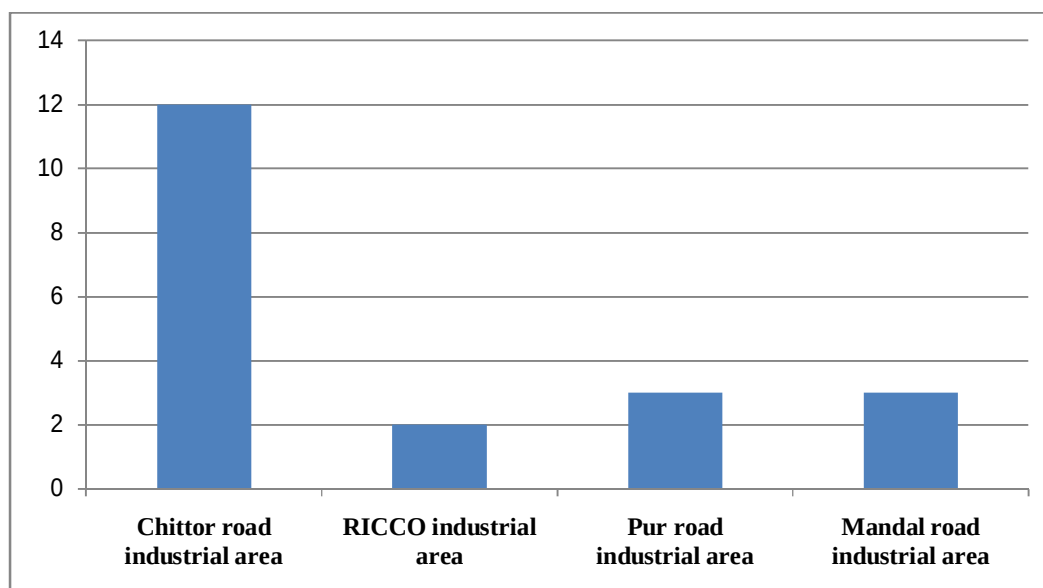


Fig.1: Area wise distribution of Textile wet processing units.

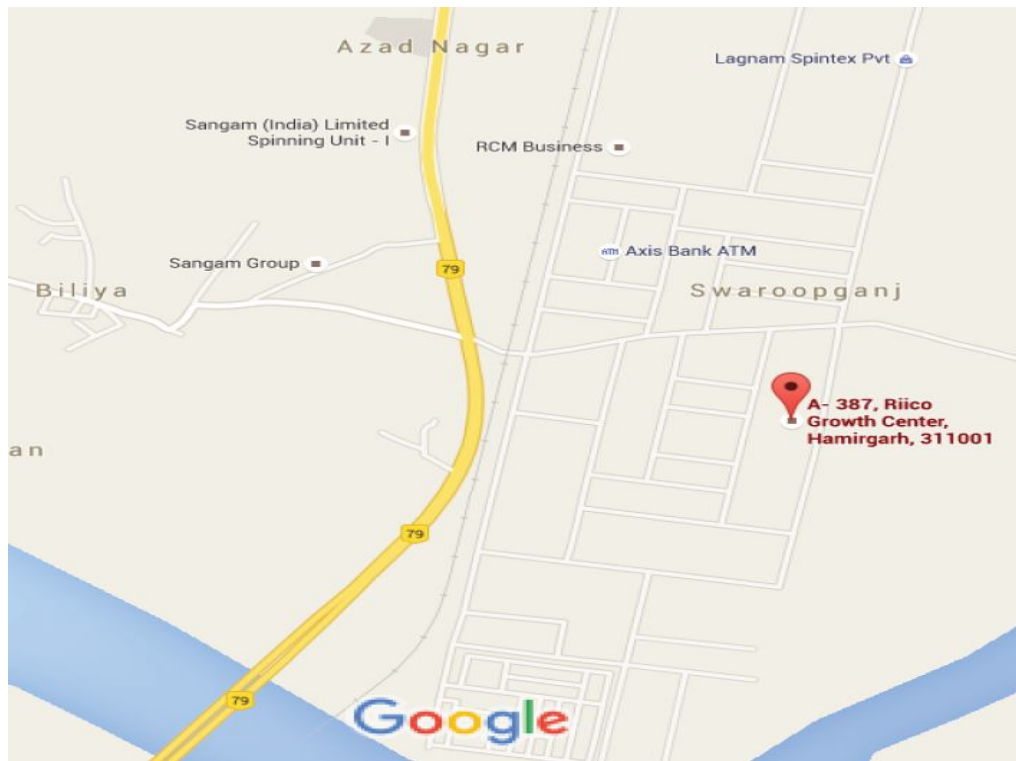
Profile of Textile wet processing units:

This section reveals the general information regarding location, size, area covered, total capital investment, production per year, total capital investment, production per year, yearly turn over etc.

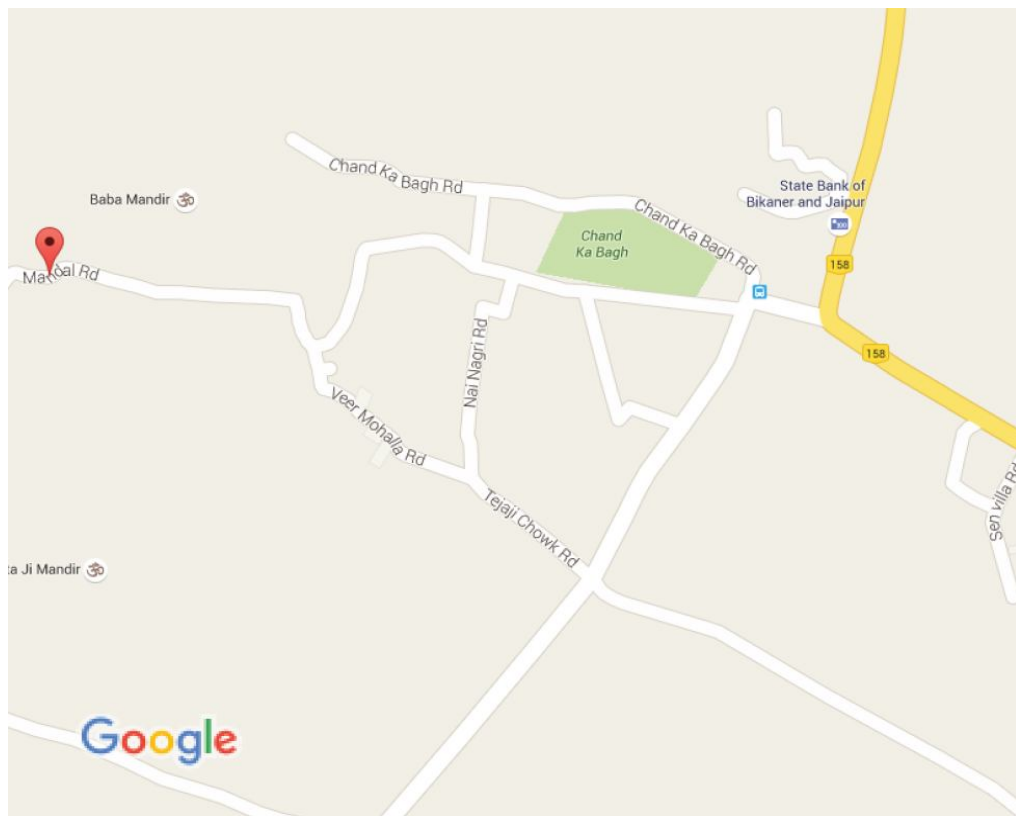
Map 1: Location of Bhilwara



Map 2 : Location of Riico Area



Map 3 : Location of Mandal Road, Industrial Area



Location and size:

The researcher selected 10 Textile wet processing unit of Bhilwara from different areas for conducting survey work. The data in Table2 and Fig. 2 clearly shows that 60 percent of textile wet processing units were selected from Chittor road industrial area due to the higher concentration of textile wet processing units in that area. Rests of the units were selected from industrial area Mandal road and RICCO area.

Table 2: Frequency and percentage distribution of Textile wet processing units by its location **N=10**

S.No.	Location area	Industries Name	Frequency (f)	Percentage (%)
1.	Chittor Road Industrial Area	▪ Janki ▪ BSL ▪ Sangum ▪ Chairman ▪ Sona ▪ Puja	6	60
2.	RICCO Industrial Area	▪ Ronak ▪ Sarvodaya	2	20
3.	Mandal Road Industrial Area	▪ Kanchan ▪ Suzuki	2	20

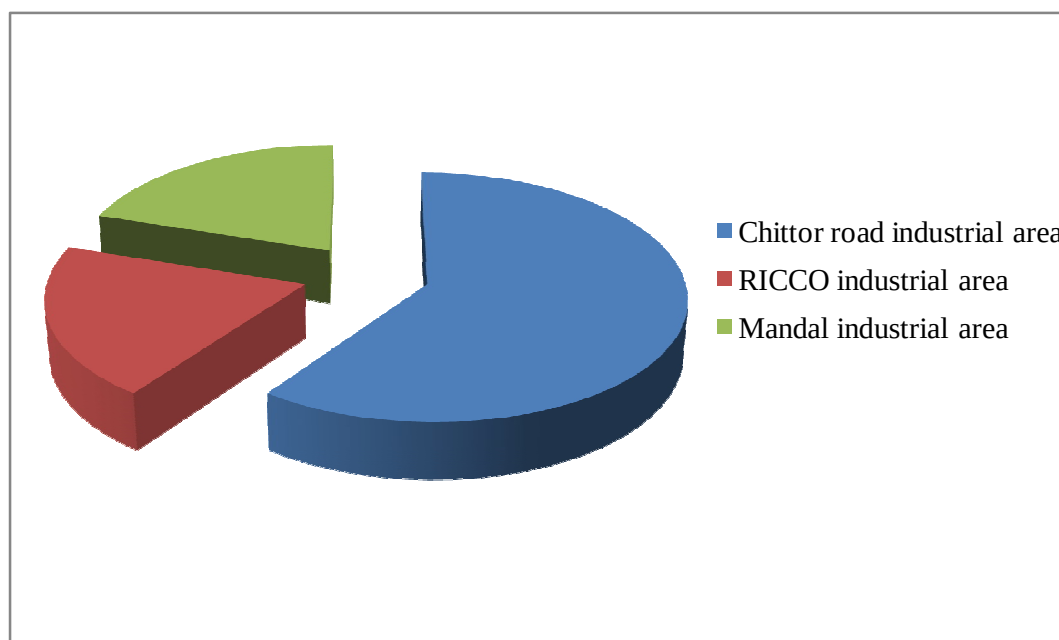


Fig.2: Frequency and percentage distribution of Textile wet processing units by its location

Regarding the size of the Textile wet processing units, all the units selected as sample comes under large scale industries based on their capital investments.

Year of Establishment:

The data about year of establishment of selected Textile wet processing units have been presented in table 3 and Fig. 3. It is found that majority (40%) of textile wet processing units were established between year 1980-1990 followed by 30 percent sample units in year 1990-2000. Rests of the 30 percent selected as sample were established in year 1960-1980 and 2000-2010.

Table 3: Frequency and percentage distribution of Textile wet processing units by its establishment N=10

S.No.	Year of Establishment	Frequency (f)	Percentage (%)
1.	1960-1970	1	10
2.	1970-1980	1	10
3.	1980-1990	4	40
4.	1990-2000	3	30
5.	2000-2010	1	10

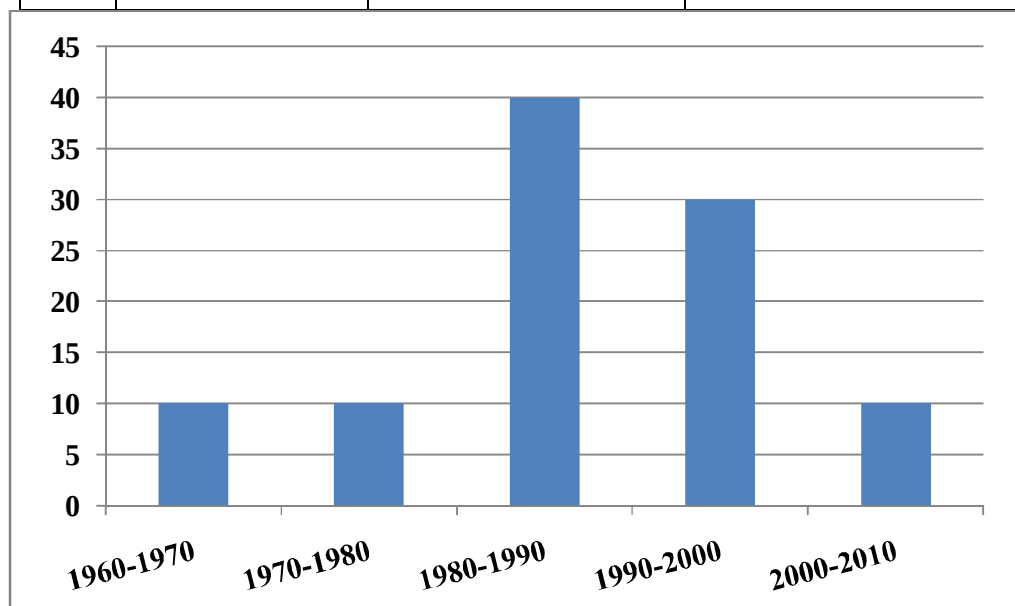


Fig. 3: Frequency and percentage distribution of Textile wet processing units by its establishment

Total capital investment:

Money invested in a business venture with an expectation of income and recovered through earning by the business over several years. Capital investment may also refer

to a firm acquisition of capital assets or fixed assets such as land, machinery or buildings rather than used to cover the business day today operating expenses. Table 4 and Fig.4 shows that 70% Textile wet processing units had invested money upto 100 crore, remaining 30% units invested between 100-400 crore.

Table 4: Frequency and Percentage distribution of Textile wet processing units by its capital investment **N=10**

S.No.	Total Capital Investment (in crore)	Frequency (f)	Percentage (%)
1.	0-100	7	70
2.	100-200	1	10
3.	200-300	1	10
4.	300-400	1	10

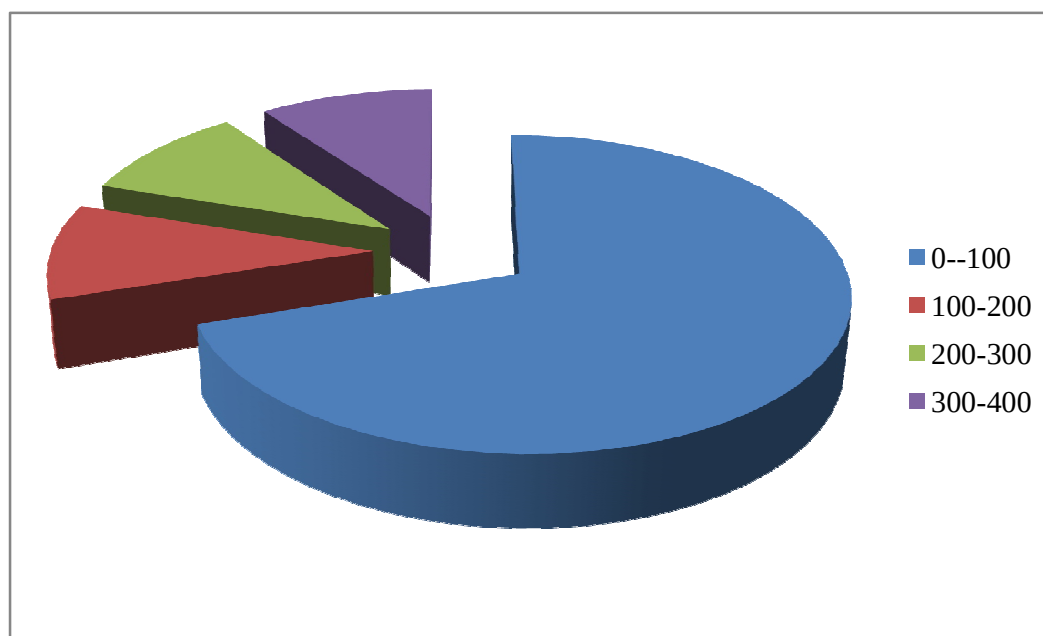


Fig.4: Frequency and distribution of Textile wet processing units by its capital investment

Production per year:

Production involves the processes and methods employed to transformed tangible inputs and intangible inputs into goods and services. Productions of any goods depend upon the relationship between demand and supply and the industrial environment of

the area. Table5 and Fig.5 shows the frequency and percentage distribution of the Textile wet processing units by production per year.

Table 5: Frequency and percentage distribution of textile wet processing units by its production per year **N=10**

S.No.	Production per year (in 100 lac meter)	Frequency (f)	Percentage (%)
1.	0-3	2	20
2.	3-6	4	40
3.	6-9	3	30
4.	9-12	1	10

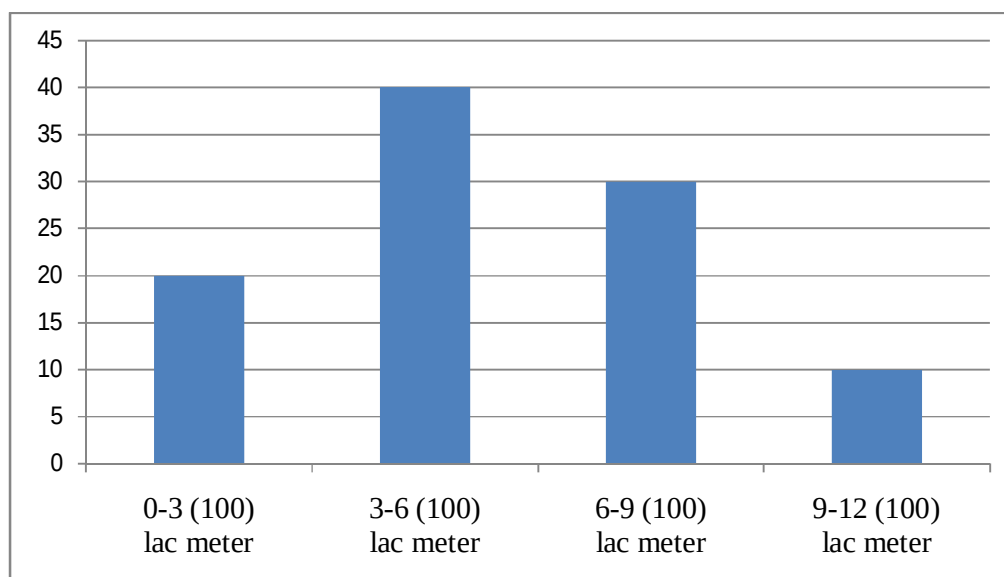


Fig. 5: Frequency and percentage distribution of textile wet processing units by its Production per year

Table 5 indicates that 40% of textile wet processing units has production per year in between 3 to 6 (100) lac meter; that means average production of approximately 3 to 6 crore for dyeing, printing and finishing per year. In the year generally 360 days are counted for production.

Yearly turn over:

Table-6 depicts the distribution of selected samples units by its yearly turnover.

Table 6: Frequency and percentage distribution of textile wet processing units by its Yearly turn over **N=10**

S.No.	Yearly turn over (in crore)	Frequency (f)	Percentage (%)
1.	0-40	4	40
2.	40-80	2	20
3.	80-120	4	40

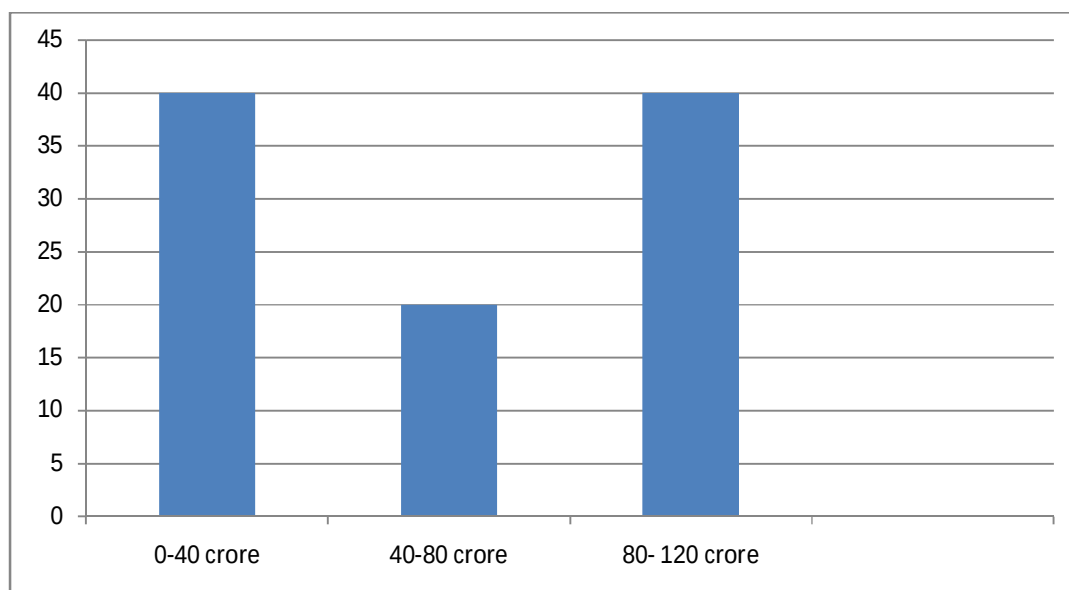


Fig.6: Frequency and Percentage distribution of textile wet processing units by its yearly turn over

Requirement of water:

Water requirement per day in textile processing units depend on the size of the unit and production capacity. Approximately 5 to 6 liter of water on an average is needed up to the final product of one meter cloth.

Table 7: Frequency and percentage distribution of textile wet processing units by its Requirement of water **N=10**

S.No.	Water required/day	Frequency (f)	Percentage (%)
1.	5-8 lac liter	2	20
2.	8-11 lac liter	1	10
3.	11-14 lac liter	4	40
4.	14 lac and above	3	30

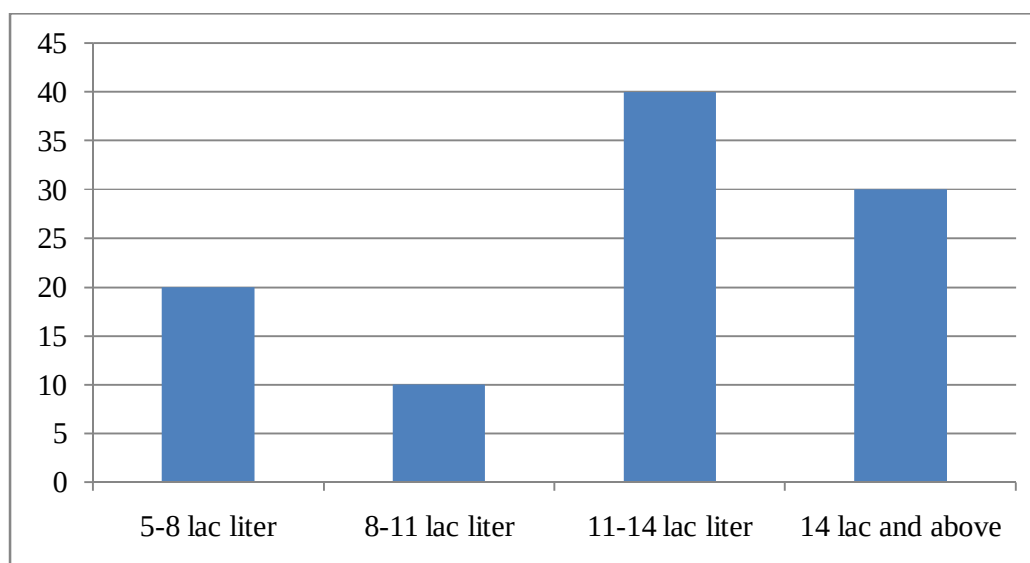


Fig. 7: Frequency and percentage distribution of textile wet processing units by its requirement of water

SUBUNITS OF TEXTILE WET PROCESSING UNITS

Each textile wet processing unit had different sub units. These subunits performed different function required for the fabric to be functioned. First four processes are called preparatory processes which prepare the fabric for dyeing and printing. Table-8 shows different subunits and their functions during textile processing.

Table 8: Subunits and Their Functions in Textile wet processing units.

S.No.	Subunits	Functions
1.	Desizing Unit	Removal of Starch
2.	Scouring Unit	Removal of insoluble or soluble impurities
3.	Bleaching Unit	Removal of colouring matter
4.	Mercerizing Unit	Improve strength, luster and absorption of fabric
5.	Dyeing Unit	Colouring of the fabric
6.	Printing Unit	Printing the fabric
7.	Finishing Unit	Finishing the fabric
8.	Folding and packaging Unit	Fold and package the final product

WET PROCESSING IN TEXTILES

Waste processing refers to operations that require the use of a large quantity of water. These include textile process such as desizing, scouring, mercerizing, bleaching, dyeing, printing and finishing. Due to the nature of various chemical processing of textile, large volume of waste water with numerous pollutants is discharged.

Desizing:

The size is needed to be removed from the fabric because they interfere with subsequent processing steps. Three methods frequently used in textile processing are acid desizing, enzyme desizing and oxidative desizing. In enzymatic desizing grey cloth is treated with aqueous solutions of enzymes and wetting agents for removal sizing materials which are unwanted for subsequent processes. Good desizing is the first and most important step to achieve good washing results.

Desizing operations represent large contribution to pollution load. The BOD is highest in desizing. These constitutes from 30% to 50% of the total BOD of a process house.

Scouring is typically performed in a alkaline solution and high temperature environment. The removal of natural impurities is based upon saponification at high Ph. These make the fabric more absorptive without undergoing any chemical and

physical changes. Scouring waste water contributes a large portion but less than 50% of BOD loads in waste stream from preparation process.

Bleaching:

Almost all cellulosic fabrics are bleached to remove natural coloured matter. After scouring cotton becomes more hydrophilic in nature. However the original colour stays unchanged due to presence of coloured matter that cannot be completely removed by washing and alkaline extraction. When the material has to be dyed in dark colours. It can be directly dyed without bleaching also.

Mercerizing:

Mercerization is the treatment of pure cotton fabric or yarn with a strong caustic soda solution (usually 280-300 gpl) to improve strength, luster and smoothness but a large volume of dilute caustic soda solution is generated in the process which causes water pollution.

Dyeing:

Dyeing is a method which imparts beauty to the textile by applying various colour and their shades on fabric. Findings of the study revealed that all the textile wet processing units used synthetic dyes for polyester blends.

Dyeing can be done in the bath or continuous mode. Continuous dyeing is carried out by passing the fabric through a dye bath of sufficient length. The dye is then fixed on the fabric by steaming. Subsequently, the fabric is washed to remove excessive dye.

Several auxiliary chemicals are added to the bath during the dyeing process. The mixtures are often developed to solve problem specific to the process. Some specialty chemicals are developed to counteract or enhance the effect of other chemicals. In other cases, the specialty chemical cause side effects that is detrimental to the overall process. Basic chemical and auxiliaries used in dyeing process are alkali, salt, reducing and oxidization agents etc.

Printing:

Printing, like dyeing is a process for applying colour to a substrate. However, instead of colouring the whole substrate as in dyeing colour is applied only to defined areas on the fabric to obtain the desired pattern in printing process. These involves different techniques and different machineries with respect to dyeing, but the physical and

chemical process that take place between the dye and the fiber are analogous to dyeing.

Finishing:

Under finishing also, different type of treatment process are carried such as softening, durable press etc.

- **Softening-** Softener gives a soft feel to the fabric. They are also used with starch and other additives to give softness and body to the fabric. Different type of softness like cationic, reactive and emulsion are available. Except silicone softeners, all other are temporary and get washed off after two or three washes. Silicone also gives wash repellency, which is fast through washing and dry cleaning. It is compatible with other finishing agents. It can be easily applied on the cloth. Air porosity is not alerted in fabric treated with silicones.
- **Durable press finishes-** Cellulosic fibers like viscose don't have natural bridges or cross-links between them. When deformed under stress (washing or wrinkling), the cellulose chains do not return to their original position, therefore durable press finishes are given to the viscose fabrics to impact improve dyeing properties and dimensional stability. Cross-linking agents are used to produce wash and wear the durable press properties of the fabrics which can be washed and dried to a smooth state. They exhibit excellent crease recovery. For preparing resin finishing for fabric the textile is impregnated with a solution of resin containing a catalyst dried and cured at high temperature Example: Urea formaldehyde resin, dimethyldihydroxy ethylene urea etc.

Problem associated with durable press finish:

- 1) Most of the durable press finishes contain formaldehyde as a cross linking agent. Formaldehyde is a toxic substance when present in gaseous as well as dissolved form.
- 2) Formaldehyde is believed to be carcinogenic causing lung cancer.
- 3) It is a server eye irritant, dissolved in eye fluid resulting in inflammation.



Fig.8: Desizing



Fig.9: Bleaching



Fig.10: Mercerizing



Fig.11: Dyeing



Fig.12: Printing



Fig.13: Finishing

Different subunits of textiles wet processing units

SECTION- II

Dyes and auxiliaries used in dyeing, printing and finishing process on polyester-viscose fabric:

The researcher made effort to find out the type of dyes used for dyeing and printing. The respondents used synthetic dyes for dyeing and printing purpose but also eco-friendly dyes, for fabric coloration as per the export order procured.

Synthetic dyes and chemicals

With the change of technique and revolution of industries, different kinds of synthetic dyes and chemicals are being used in various processes of dyeing and printing.

Dyes which are mainly used in study area are selected according to the nature of fabric. In the study area, mainly polyester-viscose fabrics are used for dyeing and printing. Selection of dye depends on the requirement of colours and shades of the fabric.

Disperse dye is applied on most of the synthetic fabric. For polyester, it is only for colouring. Procion and pigments dyes are used for printing of cotton fabric and disperse dye for polyester printing. Besides these dyes, various textile auxiliaries are also used to perform various functions etc. as shown in table- 9.

Table 9: Auxiliaries used in textile wet processing

Description	Composition	Function	Processing step
Salts	Sodium Chloride Sodium Sulphate	Neutralise Zeta Potential of the fiber, retarder	Dyeing
Acids	Acetic acid Sulphuric acid	pH control	Preparation Dyeing, Finishing
Bases	Sodium hydroxide Sodium carbonate	pH control	Preparation Dyeing, Finishing
Buffers	Phosphate	pH control	Preparation Dyeing, Finishing

Sequestering Agents Chelates	EDTA	Complex hardness retarder	Preparation Dyeing
Surface Active agents	Anionic, Cationic and non- ionic	Softener, Disperse dyes, Regular dye application, wetting agents, Emulsifier	Preparation Dyeing finishing
Oxidizing Agents	Hydrogen Peroxide Sodium nitrate	Insolublise dyes	Dyeing Preparation
Reducing Agents	Sodium hydrosulphitre sodium sulphide	Solublise dyes Remove unreacted dyes	Dyeing
Carriers	Phenyl Phenols Chlorinated benzens	Enhance Absorption	Dyeing

Disperse dyes

Approximately dyes are used in textile wet processing units. Some of dyes are as follows-

Colour Index	Colour Name	Colour
Disperse Blue 27	Blue GLF	Blue
Disperse Blue 35	Navy Blue BT 200%	Navy Blue
No Cl	Black SKO 150%	Black
Disperse Orange 44	Orange 2GF	Orange
Disperse Red 50	Red2GN	Red
No Cl	Brilliant Pink FFB Powder	Brilliant Pink
Disperse Yellow 54	YellowL5G200%	Yellow

Eco-friendly Dyes/ chemicals:

Dyeing is a method which imparts beauty to the textile by applying various colours and their shades on the fabric. Findings of the study revealed that the entire textile wet processing units used eco-friendly dyes for polyester-viscose fabric. These dyes are used for fabric colouration as per the export order.

Dyeing can be done in the batch or continuous mode. Continuous dyeing is carried out by passing the fabric through a dye bath of sufficient length. The dye is then fixed on the fabric by steaming. Subsequently, the fabric is washed to remove excess dye. Each textile wet processing units in the study area has 50 to 80 employees per department and the eco-friendly dyes come from Mumbai and Delhi. Each unit has approximately 70-75 eco-friendly chemical/dyes and per unit the average quantity of substitute used is 1 ton per day. The shades which are available in eco-friendly dyes are sufficient and these dyes are more expensive from synthetic dyes. The fixing agent which is used to make the shade permanent on the fabric is CBDYEFIXHP.

Eco-friendly dyes

Eco-friendly dyes are used in textile wet processing units. Some of the eco-friendly dyes are as follows-

Colour Name	Colour
R.B. YELLOW 3RX	Yellow
R.B. RED 4 BX	Red
R.B. RED DXL3B	Blue
R.B. NAVY BLUE	Navy Blue
R.B. BLACK XLW	Black
EVERZOL BLUEED	Royal Blue
EVERZOL RED LX	Red

Textile auxiliaries used on polyester-viscose fabric in textile wet processing units

DESIZ 1065: Desizing agent for synthetic sizes used for removing sizing material from the fabric.

BRIGHTON EXNAF: Wetting, Scouring, Swelling and Stain Removing Agent used for removing natural and artificial impurities.

DET PWD: Detergent with emulsifying properties used for washing the fabric and removing impurities.

MER 1010: Mercerizing and Wetting Agent used for luster, strength and more absorbent to the fabric.

Dyeing Auxiliaries

STAB 1092 CONC: Hydrogen peroxide stabilizer

ECO ACID: Eco friendly acetic acid replacement

N 2065: Organic acid based core alkali neutralizer

CATIONIZER: Per treatment chemical for pigment dyes

VAPRON LPY 2037: Leveling agent for dispersed dyes used for fix the dyes on the fabric.

VAPRON RL 2030: Leveling agent for reactive dyes used for fix the dyes on the fabric.

VAPRON LEV 500: Leveling agent for acid dyes used for fix the dyes on the fabric.

VAPRON PS 2061 CONC: Washing off agent for reactive dyes

CBDYEFIXHP: Dye fixer used for fix the dye on the fabric.

Finishing Auxiliaries

Finishing agents used for the fabric to give softness, luster etc.

LUBRISHINE SPL

BELFASIN WSP

MAGNASOFT JSS

JAKAZOL TURQ

JAKAZOL BRILL

JAKAZOL RED EP

JAKAZOL DK BLU

JAKOFIX BLACK

JAKAZOL NAVYCF

Printing Auxiliaries

POYBEST BRS: Cotton Bum out chemical

POLYESTER BURNOUT: Polyester Bum out chemical

POLYBEST HT: Loop accelerator for dispersed dyes

POLYBEST CDC: Color enhancer for polyester discharge printing

In all the industries same dyes and auxiliaries are used but the quantity of dyes and auxiliaries are different. The quantity of dyes and auxiliaries used in each textile wet processing unit depends on the amount of production of fabric.

Different synthetic fabrics like nylon, polyester etc. are dyed with various source natural dyes/colourants like onion skin extract, babool bark extract, henna etc. through exhaust, HT-HP (high temperature and high pressure) and padding methods (cold-pad-batch) with or without mordanting. Mordanting facilitates to get wide range of shades from the same source of natural dye as per requirement by variation of mordant chemicals as well as mordanting techniques. In case of dyeing synthetic fabrics, dyeing is carried out at acidic pH and HT-HP dyeing technique results an overall best dyeing performance in terms of colour strength and fastness properties provided the natural colourants are stable at that high temperature employed for dyeing. Also energy consumption is higher in case of HT-HP dyeing method than exhaust method as well as cold-pad-batch method of dyeing. HT-HP method is used for dyeing polyester fabrics with pomegranate rind, catechu, nova red and turmeric. Uncountable dyes and chemicals are used and both type of water (hot and cold) is also used in all textile wet processing units. Fabric quality and shade was changed than

dyeing temperature and program was also changed. All the quality parameters and quality standard are maintained as per norms.

Colour fastness properties of natural dyes

Colour fastness is the resistance of a material to change in any of its colour characteristics or extent of transfer of its colourants to adjacent white materials in touch or both for different environmental and use conditions or treatments like washing, dry cleaning etc or exposure to different agency heat, light etc. Fading means changes in the colour with or without loss of depth of shade for exposure to particular environment/agency/treatments either by lightening or darkening of the shades. Bleeding is the transfer of colour to a secondary material in contact accompanying white fabric material of similar/dissimilar nature. The colour fastness is usually rated either by loss of depth of colour/ colour change in original sample or it is often expressed by staining scale meaning that the accompanying material gets tinted/stained by the colour of the original fabric, when the accompanying white fabrics of similar/dissimilar nature are either in touch/ made to touch by some means of test procedure/protocol.

Light fastness

An extensive work has been carried out to improve the light fastness properties of natural dyed textiles. After-treatments for improving the wash fastness and light fastness of mordant dyes on cotton; some of these treatments might be applicable to selective/specific natural dyes /colours in museum textile are often different from their original. The fastness ratings are similar to those found earlier in day light fading. A large proportion of natural dyes are, of course, mordant dyes. There is strong influence on nature, type and concentrations of mordants on wash and light fastness grades. The influences of different mordants are found to play important role in fading of 18 yellow natural dyes. The corresponding colors changes after exposure to xenon arc lamp are also assessed in each case. Turmeric, fustic and marigold dyes faded significantly more than any of the other yellow dyes. However, use of tin and alum mordants resulted in significantly more fading than the same for use of chrome,

iron, or copper mordant. Thus the type of mordant are found to be more important than the dye itself in determining the light fastness of natural colored textiles. Some dyes undergo marked changes in hue on washing, shown to be attributed to even small amounts of alkali in washing mixtures, high-lighting the necessity of knowing the pH of alkaline solutions used for cleaning of textiles dyed with natural dyes.

Rub fastness

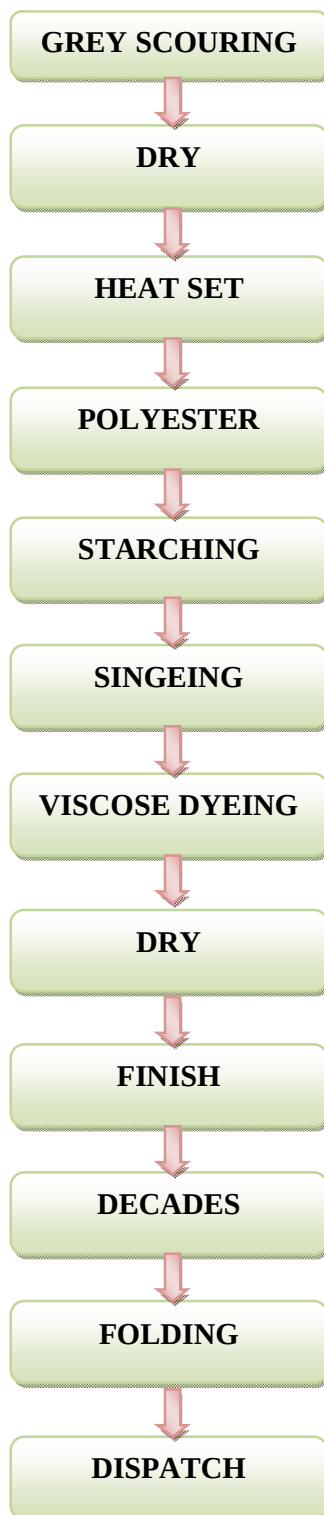
Rub fastness of most of the natural dyes have been found to be moderate to good and does not require any after treatment. Jackfruit wood, manjistha, red sandal wood, babool, mariegold etc. have good rub fastness. Cutch and ratanjot shows moderate to good dry rub fastness.

SECTION –III

THE ECO-FRIENDLY SUSTITUTE USED IN TEXTILE WET PROCESSING UNITS

Method of processing the polyester-viscose fabric.

FLOW DIAGRAM FOR POLYESTER-VISCOSE FABRIC



Effluent management practices:

Functioning of ETP (Effluent treatment plant)

ETP is the concept of treating effluents by means of a collective effort mainly for a cluster of large scale industrial units. The main objective of ETP is to reduce the treatment cost while protecting the environment.

In Bhilwara, every unit has been installed to treat the enormous textile effluent discharges from various cotton and synthetic textile wet processing units. The industrial areas according to the capacity of ETP for treatment of textile effluents is present in table 9.

Table 10 : Capacity of ETP for treatment of textile influents

S.No.	Area	Capacity (kld)
1.	Chittor Road industrial area	15-20
2.	RICCO industrial area	5-10
3.	Mandal Road industrial area	10-15

Persual of table 8 shows that the ETP of Chittor road industrial area and its treating capacity per unit was 15 to 20 kilo liter per day. Textile wet processing unit discharge of textile effluents also increased and to treat these effluents. RICCO industrial area capacity of ETP per unit was 5 to 10 kld and Mandal road industrial area capacity of ETP per unit was 10 to 15 kld.

The textile effluents of different parameters (pH, COD, BOD etc.) from different textile processing units. Wet processing of textile involves unit operation such as desizing, mercersing, scouring, bleaching, dyeing, printing and finishing. Different auxiliaries are used either in solid or in liquid form to the textile product to obtain the desired effect. Cotton textiles cannot dyed and printed evenly without removing its natural and added impurities which inhabit the proper penetration of dyes and chemicals. Thus, treatment with various chemical such as enzymes, alkalis, acids,

salts surfactants solvents, oxidizing and reducing agent etc. are necessary prior to dyeing and printing. In the process of dyeing, auxiliary chemicals, sodium chloride and other bio salts are added to exhaust the dye from the liquor to substrate at appropriate temperature and pH. Even after dyeing and printing unfixed dyestuff and complex organic products arising out of the reaction with textile substrate and dyes are to be adequately removed from the surface of the fabrics to achieve the proper fastness requirements. So waste stream from the textile wet processing industry which is to be fed into the ETP essentially comprised of the above ingredients which are used in preparatory processes, dyeing, printing and finishing process.

The effluent treatment method broadly classified into three main categories:

- i. Physical treatment- neutralization, coagulation-flocculation, chemical precipitation of metals, and phosphorous, sulphide and ammonia stripping, disinfection, active carbon adsorption, ionic exchange, reverse osmosis, ultra filtration, electro dialysis.
- ii. Chemical treatment- screening, sand removal, de-oiling, pre-aeration, equalization and homogenization, flotation, sedimentation, filtration.
- iii. Biological treatment- active sludge oxidation, rot percolator oxidation, lagoon, anaerobic digestion, nitrification /denitrification.

There are four stages, preliminary, primary and secondary and tertiary treatments to treat the textile effluents. The preliminary treatment processes are equalization and neutralization. The primary stage involves screening, sedimentation floatation and flocculation. Secondary stage are used to reduce organic load facilitate physical chemical separation and biological oxidation. Tertiary stages are important because they serve as polishing of effluent treatment. Per unit treated the textile effluent disposed per day was 3 to 5 tone.

There are many ways of combining the operations and processes in an ETP:

- A properly designed biological treatment plant, which typically includes screening, equalization, pH control, aeration, and settling, can efficiently satisfy BOD, pH, TSS, oil and grease requirements. However the compounds in industrial effluent may be toxic to the microorganisms so pretreatment may be necessary. Most dyes are complex chemicals and are difficult for microbes to degrade so there is usually very little colour removal.
- Another option is a physico-chemical treatment plant, which typically includes screening, equalization, pH control, chemical storage tanks, mixing unit, flocculation unit, settling unit and sludge dewatering. This type of treatment will remove much of the colour depending on the processes used. It can be difficult to reduce BOD and COD to meet effluent standards and it is not possible to remove TDS.
- Most often, physico-chemical treatment will be combined with biological treatment. The typical components of such a plant are screening, equalization, and pH control, chemical storage, mixing, flocculation, primary settling, aeration, and secondary settling. The physico-chemical treatment always comes before the biological treatment units. Using a combination of treatments will generally reduce pollutant levels to below the discharge standards 4-8.
- Another form of biological treatment is the reed bed, which can be used with a settling tank, or in combination with other treatment processes. It presents a natural method of treating effluent which is often lower in capital, operation and maintenance costs. Reed beds can contribute to a reduction in colour, a decrease in COD, an increase dissolved oxygen and a reduction in heavy metals, but function best with some form of pretreatment.

As discussed, there are many options for the design of an ETP. The type of plant and the various components of the plant will depend on the characteristics of the effluent. In evaluating an ETP design in an application for an ECC, it is necessary to determine

whether the components of the ETP are sized correctly for the flow and to assess whether the effluent is likely to meet the requirements of the discharge standards.

Need of ETP-

Water is basic necessity of life used for many purposes one of which is industrial use. Industries generally take water from rivers or lakes but they have to pay heavy taxes for that. So its necessary for them to recycle that to reduce cost and also conserve it. Main function of this ETP is to clean GCP effluent and recycle it for further use.

The basic thrust of the technology is to convert entire quantity of effluent to zero level by separating water and salt using evaporation and separation technology. The concept and the treatment is based on the removal of the entire COD/BOD and the condensate coming out to meet the fresh water quality requirement in the process.

Pollution control measures:

Water and air was used for pollution control. The reason behind the pollution discharging large amount of waste water through various processes caused water pollution. Smoke which emits out from the chimney caused air pollution. Flat bed screen printing machines in textile wet processing units caused noise pollution and cloth scraps, containers, drums, bags which contains chemicals caused solid waste pollution. In order to control pollution and reduce its effect on environment, one should consider following measures.

1. Prevention of pollution generation.
2. Treatment of polluted streams close to the source of pollution (start of pipe approach).
3. Treatment of the final effluent (end of pipe approach).

As a very general rule, the pollution prevention actions can normally succeed in all companies, while the start of pipe approach is mostly indicated in medium or big enterprises and the simplicity of the end of pipe approach makes it suitable also in small and medium enterprises. Pollution prevention techniques have proved to be an effective means to improving process efficiency and to increasing company profits and at the same time to minimizing environmental impact. In each case of implementation of these techniques, the specific conditions must be carefully

considered and every option and change must be examined, to understand how it could affect air, land and water pollutant releases. Examples of practical applications of pollution prevention techniques:

Quality control for raw materials- Textile companies can reduce waste emissions by working with suppliers to find out less polluting raw materials. Prescreening raw materials is a useful practice to determine interactions among processes, substrates, and other chemicals and possibly reduce waste production.

Chemical substitution- Since textile finishing is so chemically intensive, special attention should be dedicated to the selection of textile process chemicals. Opportunities for chemical substitution vary substantially among mills according to the differences in environmental conditions, process conditions, product, and raw materials. The possible actions include the replacement of chemicals as desizing agents, dyes, and auxiliaries with less-polluting ones and/or replacement of chemical treatment in some processes with mechanical or other non-chemical treatments.

Process Modification- Optimization of the processes can be obtained by modifying some operations. Examples of possible modifications are:

- ❖ Substitution of dyeing machines using low liquor ratio, i.e. equipment able to substantially reduce bath ratio and allow considerable savings of energy, water, dyes and chemicals.
- ❖ Optimization of process conditions, such as temperature and time.
- ❖ Combining operations (for instance, combining scouring and bleaching) to save energy and water.

Textile processing industry is characterized by its fairly high specific water consumption and its large amounts of wastewater discharges. The process water or wastewater situation is characterized by very different conditions of split flows from the different processing steps. Split flows which show an extremely intense colouring or a high organic contamination are residual dye baths or desizing wastewater.

Split flows which show a comparatively slightly pollution are the big amounts of rinsing waters from different processing steps.

Skimmer Belt

The skimmer makes use of the differences in specific gravity and surface tension between oil and water. These physical characteristics allow a moving collector in the shape of a belt, operating on a motor and pulley system, to attract oil and other hydrocarbon liquids from the surface of the fluid. After traveling over the head pulley, the belt passes through tandem wiper blades where oil is scraped off both sides of the belt, and discharged. The tail pulley has flanges which allow it to roll freely on the inside of the belt without becoming dislodged. It requires no bearings and does not need to be fastened to the tank.

Aeration Tank

These are the large holding tanks. Biological treatment removes organic matter from waste water. For effective treatment of waste water, oxygen required for growth of micro organisms as also mixing in the aeration tank, floating types of mechanical aerators have been provided. The detention period in aeration tank is 3-4 hrs. During this time a healthy flocculent sludge is formed with brings about oxidation of the dissolved organism matter. BOD removal to the extent of 99% could be achieved with efficient operation.

Flash Mixer

Effluent with pH 8-9 is transferred to chemical dosing house for chemical dosing, where coagulants are added to the effluents. This are-

Lime- To raise the pH up to 8-9

Ferrous Sulphate- To remove colour

Polyelectrolyte- To settle the suspended matter

According to above the portions the chemical were added and mixed with the effluents. In the flash mixer agitator mixers the effluent with the chemical dosed which develops flocculates. The inlet water consists of 60% water and 40% solids. The effluents are passed through the centrifuge for thickening and solidification

centrifuge action, the solids and liquids are then separated with polyelectrolyte (cationic type) dosing. The sludge thickener centre fudge reduces the water content in the effluent wastes to 40% water and 60% solids. The effluent is then reprocessed and sludge is collected at the bottom.

Biological Oxidation Tank

Biological treatment is an important and integral part of any wastewater treatment plant that treats wastewater from either municipality or industry having soluble organic impurities or a mix of the two types of wastewater sources. The obvious economic advantage, both in terms of capital investment and operating costs, of biological treatment over other treatment processes like chemical oxidation; thermal oxidation etc. has cemented its place in any integrated wastewater treatment plant. The process by which bacteria and other types of microorganisms consume dissolved oxygen and organic substances in waste water, using the energy released to convert organic carbon into carbon dioxide and cellular material.

Waste Effluent Compressor (Filter Press)

Sludge from the sludge tank will be pumped to the Waste Effluent Compressor equipments for dewatering purpose. According to performance guarantee the cake moisture should not be more than 20%. For this purpose different types of filters are used namely- gravity settlers, gravity belt filters, centrifuges, vacuum or pressure belt filters and filter press. But among these filter press is most efficient and economical. Other filtration systems offer high pressure filtration, but only the filter press has both high pressure capability and efficient filter cake removal. The filter elements are constructed of lightweight polypropylene. They are extremely corrosion resistant and virtually eliminate plate breakage. After exceeding the required level of recycling, sludge passed through waste effluent compressor where it is compressed and remaining water in waste effluent is left out.

Dry Bed

Sludge is applied on the sand bed and is allowed to dry by evaporation and drainage of excess water over a period of several weeks or 7-8 days in open area depending on climatic conditions. Bacterial decomposition of the sludge takes place during the drying process while moisture content is sufficiently high. During the rainy season the process may take a longer time to complete and sizing the area of the drying beds

should take this into account. Then the disposed material is filled in bags and sent to the cement plant and Rajasthan State Minerals and Mines (RSMM) in Udaipur.

Force Evaporation

Waste water which involves easy-soluble reactive dyes, especially non degradable dyes is very difficult to decolour efficiently by normal process such as coagulation process and biological treatment. The highly chromaticity water which can't be further used is evaporated. Release to environment with the check of final load of effluent in it.



Fig.14: Effluent Treatment Plant



Fig. 15: Skimmer belt- separations of oil and chemicals from waste water



Fig16: Aeration Tank



Fig. 17: Flash Mixer

PAC (polyelectrolyte, lime, ferrous sulphate)



Fig. 18: Pure water after passing through different stages of RO



Fig. 19: Biological Oxidation Tank



Fig. 20: Water after biological treatment



Fig. 21: RO Plant



Fig. 22: Sludge Tank



Fig. 23: Waste effluent compressor



Fig. 24: Dry Bed



Fig. 25: Force evaporation

SUMMARY AND CONCLUSION

Bhilwara is textile industrial place and there are many industries in Bhilwara city. It is famous hub of textiles in India. The textile industry or Bhilwara district widely popular for exporting textile products like synthetic yarn, woolen commodities, cotton yarn and fabrics. The effluent discharges from these textile wet processing units causes environmental pollution. Textile effluent discharge from various TPU of Bhilwara. Before disposal they need to be treated for certain acceptable tolerance limits since pollution control laws are strictly followed all over the world and captured worldwide attention. Further to be in tune with the government restriction installation of effluent treatment plant (ETP) to construct sufficiently large and highly effective and to make the use of dyes and chemicals that are environment friendly. The objective of the study were-

1. To study the profile of wet processing units of textile industries of Bhilwara.
2. To explore the dyes and auxiliaries used in dyeing, printing and finishing process on polyester-viscose fabric.
3. To identify the eco-friendly substitute used for polyester-viscose fabric in textile wet processing units.

Methods of investigation:

The first industrial area in Bhilwara, established in 1961. Bhilwara is located at 25.35°N 74.63°E. It has an average elevation of 421 metres (1381 feet). It falls between the districts of Ajmer (in north) and Chittorgarh and Udaipur (in south). Major rivers flowing through the district are [Banas](#), Bedach, Kothari, Khari, Mansi, Menali, Chandrabhaga and Nagdi. At present textile wet processing units in Bhilwara are located in various industrial complexes.

Bhilwara is textile industrial place and there are many industries in Bhilwara city. A list of all the registered industries was procured during preliminary survey from office of DIC Bhilwara. It was found that there are 440 textile industries and 17,000 power looms in the Bhilwara district and out of these there are 20 wet processing units in

Bhilwara. Now from the list of 20 wet processing units, 10 units were selected purposively selected. Each textile wet processing unit had different sub units. These subunits performed different function required for the fabric to be functioned.

The textile effluents of different parameters (pH, COD, BOD etc.) from different textile processing units. Wet processing of textile involves unit operation such as desizing, mercersing, scouring, bleaching, dyeing, printing and finishing. Different auxiliaries are used either in solid or in liquid form to the textile product to obtain the desired effect. Cotton textiles cannot dyed and printed evenly without removing its natural and added impurities which inhabit the proper penetration of dyes and chemicals. Thus, treatment with various chemical such as enzymes, alkalis, acids, salts surfactants solvents, oxidizing and reducing agent etc. are necessary prior to dyeing and printing. In the process of dyeing, auxiliary chemicals, sodium chloride and other bio salts are added to exhaust the dye from the liquor to substrate at appropriate temperature and pH. Even after dyeing and printing unfixed dyestuff and complex organic products arising out of the reaction with textile substrate and dyes are to be adequately removed from the surface of the fabrics to achieve the proper fastness requirements. So waste stream from the textile wet processing industry which is to be fed into the ETP essentially comprised of the above ingredients which are used in preparatory processes, dyeing, printing and finishing process.

Best on the findings of the study, use of eco-friendly chemicals and dyes in various processes and product across the entire value chain. Pollution control measures and reuse of disposed material and waste effluents. Textile processes all should be based on 3R (reduce-recycle-reuse) concept. The processing of textile should be cost effective and environment-friendly. Eco- friendly fabric is created from resources that are environmentally friendly and sustainable. The data were statistically analyzed through frequency and percentage.

MAJOR FINDINGS:

Profile of Textile Wet Processing Units

It was found that there are 440 textile industries and 17,000 power looms in the Bhilwara district and out of these there are 20 wet processing units in Bhilwara and 10 were purposively selected 60 percent of textile wet processing units were selected from Chittor road industrial area due to the higher concentration of textile wet processing units in that area. Rests of the units were selected from industrial area Mandal road and RICCO area.

Textile wet processing units were established between year 1980-1990 followed by 30 percent sample units in year 1990-2000. Rests of the 30 percent selected as sample were established in year 1960-1980 and 2000-2010.

Total capital investment

Capital investment may also refer to a firm acquisition of capital assets or fixed assets such as land, machinery or buildings rather than used to cover the business day today operating expenses. 70% Textile wet processing units had invested money upto 100 crore, remaining 30% units invested between 100-400 crore.

Production per year

Production involves the processes and methods employed to transform tangible inputs and intangible inputs into goods and services. Productions of any goods depend upon the relationship between demand and supply and the industrial environment of the area, 40% of textile wet processing units has production per year in between 3 to 6 (100) lac meter; that means average production of approximately 3 to 6 crore for dyeing, printing and finishing per year. In the year generally 360 days are counted for production.

Requirement of water:

Water requirement per day in textile processing units depend on the size of the unit and production capacity. Approximately 5 to 6 liter of water on an average is needed up to the final product of one meter cloth.

Wet Processing in Textiles

Waste processing refers to operations that require the use of a large quantity of water. These include textile process such as desizing, scouring, mercerizing, bleaching, dyeing, printing and finishing. Due to the nature of various chemical processing of textile, large volume of waste water with numerous pollutants are discharged.

The eco-friendly substitute used in textile wet processing units**Eco-friendly chemical/dyes:**

The dye is fixed on the fabric by steaming. Subsequently, the fabric is washed to remove excess dye. Each textile wet processing units in the study area comprised of 50 to 80 employees per department and the eco-friendly dyes were obtained from Mumbai and Delhi. Each unit has approximately 70-75 eco-friendly chemical/dyes and per unit the average quantity of substitute used is 1 ton per day. The shades which are available in eco-friendly dyes are sufficient and these dyes are more expensive from synthetic dyes. The fixing agent which is used to make the shade permanent on the fabric is CBDYEFIXHP.

Effluent management practices:**Functioning of ETP (Effluent treatment plant)**

ETP is the concept of treating effluents by means of a collective effort mainly for a cluster of large scale industrial units. The main objective of ETP is to reduce the treatment cost while protecting the environment.

In Bhilwara, every unit has been installed to treat the enormous textile effluent discharges from various cotton and synthetic textile wet processing units. ETP of

Chittor road industrial area and its treating capacity per unit was 15 to 20 kilo liter per day. Textile wet processing unit discharge of textile effluents also increased and to treat these effluents. RICCO industrial area capacity of ETP per unit was 5 to 10 kld and Mandal road industrial area capacity of ETP per unit was 10 to 15 kld. Per unit treated the textile effluent disposed per day was 3 to 5 tone.

Pollution control measures:

Water and air was used for pollution control. The reason behind the pollution discharging large amount of waste water through various processes caused water pollution. Smoke which emits out from the chimney caused air pollution. Flat bed screen printing machines in textile wet processing units caused noise pollution and cloth scraps, containers, drums, bags which contains chemicals caused solid waste pollution.

Reuse of disposed material and waste effluents:

Waste effluent and disposed material is collected in sludge tank. Then the wet disposed material and waste effluent is passed through a machine where it is compressed and remaining water in waste effluent is left out. Remaining material is kept under sunlight for 7-8 days in open areas. Then the disposed material is filled in bags and sent to cement plant. At last water which can't be further used is evaporated. Every textile wet processing units treated waste water and reuse the disposed material and waste effluent was send to cement plant and Rajasthan State Minerals and Mines (RSMM) in Udaipur.

Conclusion

Hence, it can be concluded that textiles wet processing units of Bhilwara is of large scale industries. Eco-friendly dyeing is a method which imparts beauty to the textile by applying various colours and their shades on the fabric. ETP is the concept of treating effluents by means of a collective effort mainly for a cluster of large scale industrial units. The main objective of ETP is to reduce the treatment cost while protecting the environment. In Bhilwara, every unit has been installed to treat the

enormous textile effluent discharges from various cotton and synthetic textile wet processing units. Water and air was used for pollution control. The reason behind the pollution discharging large amount of waste water through various processes caused water pollution. Smoke which emits out from the chimney caused air pollution. Flat bed screen printing machines in textile wet processing units caused noise pollution and cloth scraps, containers, drums, bags which contains chemicals caused solid waste pollution. Waste effluent and disposed material is collected in sludge tank. Then the wet disposed material and waste effluent is passed through a machine where it is compressed and remaining water is left out. Remaining material is kept under sunlight for 7-8 days in open areas. Then the disposed material is filled in bags and sent to cement plant. At last water which can't be further used is evaporated.

The present study is an effort to describe the eco friendly fabric created from resources that are environmentally friendly and sustainable, and efficient management of obtaining green clothing requires considering all stages, starting from designing for the environment, obtaining raw materials, producing garments, distributing them to the channels, stores and also considering their reverse logistics and waste.

RECOMMENDATION

1. Development of specific strategies with in industry work sector that address the complex interplay between machine, tolls, behavioral and environmental factor causing injuries at work place.
2. Evaluation of quality of dying services provided in industrial area.
3. Research is needed to examine to impact of processing unit and eco-friendly substitute of industrial worker.
4. Research in industry workers dying control technology and personal protective devices can have wide spread direct impact on the safety and health of workers.
5. Research should be related to the dying processing unit and used eco-friendly substitute in textile industry and development of educational packages.

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APPENDIX

Assessment of eco-friendly substitute used on polyester-viscose fabric in textile wet processing unit of Bhilwara city.

1. Name -
2. Post -
3. Phone number -

Section A-

Information regarding different subunits in TPU-

4. Name of textile wet processing unit-
5. Locale of the unit-
6. Size of the unit-
 - a) Small scale
 - b) Medium scale
 - c) Large scale
7. Year of establishment-
 - a) 1960-1970
 - b) 1970-1980
 - c) 1980-1990
 - d) 1990-2000
 - e) 2000-2010
8. Total capital investment- (in crore)
 - a) 0-100
 - b) 100-200
 - c) 200-300
 - d) 300-400

9. Production per year- (in 100 lac meter)
- a) 0-3
 - b) 3-6
 - c) 6-9
 - d) 9-12
10. Yearly turn over- (in crore)
- a) 0-40
 - b) 40-80
 - c) 80-120
11. Total working hours-
- a) Round the clock in 3 to 4 shifts
 - b) 2 shifts
 - c) 1 shifts
12. Type of labour-
- a) Skilled
 - b) Semiskilled
 - c) Unskilled
13. Do you give preference of trained workers in different subunits-
- a) Yes
 - b) No
14. Do you provide any training to develop skills in operating the equipments to untrained or semi skilled workers?
15. Do you sell your products at domestic level? Yes/No
16. Do you process export orders. Yes/No.
17. If yes, mention the places of exporting.

18. Industry ownership-

- a) Private limited company
- b) Sole-proprietorship
- c) Partnership

19. What are the facilities provided by management-

- a) Free medical checkup – Yes/ No
- b) Canteen –Yes/No
- c) Drinking water-Yes/No
- d) Bonus on festivals
- e) Safety equipments
- f) Health education (awareness generation program)

If yes, what is the way of giving health education?

- a) By lecture
- b) By booklet
- c) By pamphlet
- g) Duration of health education program organized by-
 - a) Monthly
 - b) Half yearly
 - c) Yearly

20. First aid facility- Yes/ No.

Section B

Information regarding the method of textile wet processing unit

21. How many method you use in your unit?
22. How many chemical and dyes you use-
23. How much cloth do you produce/process per day?
24. How much water you use in your unit per day –
 - a) 5-8 lac liter
 - b) 8-11 lac liter
 - c) 11-14 lac liter
 - d) 14 lac and above
25. Which type of water you use in your unit? Cold/ Warm
26. Is changes takes place to quality and shade of your fabric if dyeing temperature and program are changes? Yes/ No.
27. Quality parameters
 - 1) Do you have testing lab for quality control. Yes/ No.
 - 2) What are the quality parameters you maintain in your unit?
 - a) Test quality of grey cloth
 - b) Test quality of chemical and dyes
 - c) Test fastness properties
 - d) Test final sample
 - e) Test waste water.
28. Do you follow any quality standards in your unit? Yes/ No.
29. Colour and chemicals used in textile wet process are-
 - a) Natural
 - b) Synthetic
 - c) Eco-friendly
 - d) All of these

Section C

Information regarding the eco-friendly chemical/ dyes used

- 30. Number of employs per department-
- 31. From where you get eco-friendly dyes?
- 32. How mach quantity of substitute is used in your unit per month?(tons)
- 33. Are eco-friendly dyes more expensive to chemical dyes? Yes/ No
- 34. How many eco-friendly dyes are used in the unit?
- 35. Which method do you used to dye the fabric by eco-friendly substitute?
- 36. Which fixing agent you used to make the shade permanent on your fabric?
- 37. Which dyes effect more rapidly?
 - a) Natural dyes
 - b) Synthetic dyes
 - c) Any other
- 38. Shades available in eco-friendly dyes are sufficient for you or not.

Section D

Information regarding effluent management practices

- 39. What is the capacity of ETP?
 - a) 5-10 kld
 - b) 10-15 kld
 - c) 15-20 kld
- 40. Functioning of ETP in detail?
- 41. Characteristic of effluents commonly being treated-
- 42. Different types of effluents which can be treated-
- 43. Amount of treated textile effluent disposed per day-
- 44. Do you think the capacity of ETP is sufficient to treat the waste water?
- 45. At present how many, units are connected.

Section E

Information regarding pollution control measures-

- 46. Which type of method used for pollution control –
- 47. Do you have any treatment plant in your unit? Yes/ No
- 48. Do you think the treated effluent can be safely disposed in soil or water- Yes/ No
- 49. Whether pollution control board regularly check the unit- Yes/ No
- 50. Do you know about clean technologies to minimize the pollution? Yes/ No
- 51. What are the reasons behind pollution?

Section F

Information regarding reuse of disposed material and waste effluent-

- 52. How many textile units can be connected to work at optimum level?
- 53. What is the use of treated waste water-
 - a) Fully disposed in river/land
 - b) Recycled
 - c) Any other
- 54. What is the method of reusing treated textile effluent?