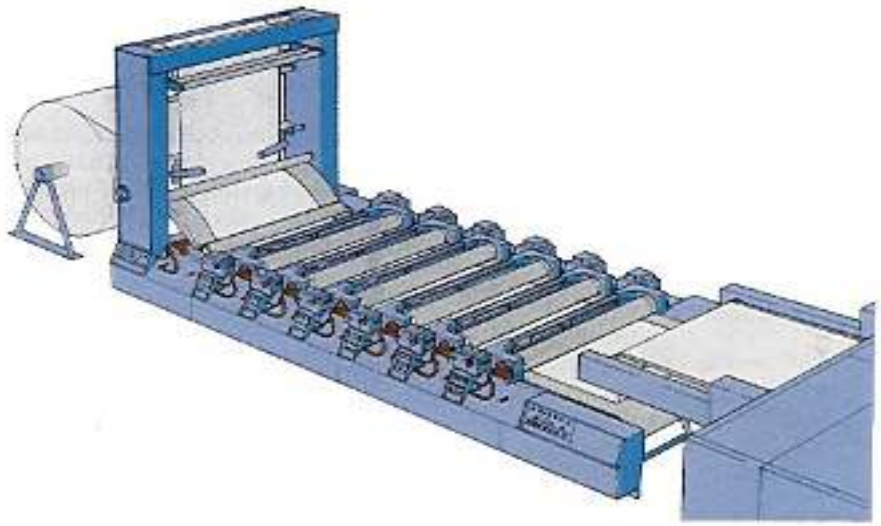
TEXTILE PROCESSING TECHNOLOGY

LEVEL I

Based on February, 2021, Curriculum Version 1



Module Title: - Performing Printing Operations

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Table of Contents

Acknowledgment

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Acronym

PPE	Personal Protective Equipment
SOP	Standard Operating Procedures
WHS	Work Health and Safety
OH&S	Occupational health and safety
NIOSH	National Institute for Occupational Safety and Health
NFPA	The National Fire Protection Association's
KPIs	key performance indicators
UGDC	United Gas Delivery Company
TTLM	Teaching, Training and Learning Materials
LAP	Learner Activity Performance

Introduction to this modules

In the wet processing industry, Textile printing is one method of coloration the textile substrates. However, the wet processing industry required skilled printing machine operators. This module enhances trainees to knowledge, attitudes, and skills to operate different printing machines and equipment to produce printed textiles and garments. This module is designed to meet the industry requirement under the Textile processing technology occupational standard, particularly for the unit of competency: **Performing Printing Operations.**

This module covers the units:

- Job requirements
- Printing processes
- Set up and load machine
- Operate and monitor printing machine
- Printing operations

Learning Objective of the Module

- Determine job requirements
- Understand Printing processes
- Set up and load machine
- Operate and monitor printing machine
- Complete printing operations

Module Instruction

For effective use this modules trainees are expected to follow the following module instruction:

1. Read the information written in each unit
2. Accomplish the Self-checks at the end of each unit
3. Perform Operation Sheets which were provided at the end of units
4. Do the “LAP test” giver at the end of each unit and
5. Read the identified reference book for Examples and exercise

Unit one: Job requirements

This unit is developed to provide you the necessary information regarding the following content coverage and topics:

- Standard operating procedures (SOP)
- Work health and safety
- Personal protective equipment (PPE)
- Job requirements

Identifying job requirements This unit will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Standard operating procedures (SOPs)
- Comply with work health and safety (WHS) requirements
- Use appropriate personal protective equipment
- Identify job requirements

1.1. Standard operating procedures

Definition of printing

Textile printing is the process of applying color to fabric in definite patterns or designs. It is related to dyeing but, in dyeing proper the whole fabric is uniformly covered with one color whereas in printing one or more color are applied to it in certain parts only, and in sharply defined patterns.

Standard operating procedures for tools and equipment are not only about following safety protocols. The safe operating procedures should be designed to minimise or eliminate hazards, such as injury or death to the user. Using hand and power tools in any work setting is dangerous, so it's essential for everyone who does use them to follow safe practices.

1.1.1. Standard Operating Procedures for Tools

Standard operating procedures for equipment will help you identify and implement safety procedures to protect employees from the hazards of hand and portable power tools and document compliance with regulatory requirements. Procedures are as follows:

- Responsibilities imposed by health and safety legislation require a person conducting a business or undertaking, such as an industry owner carrying out high-risk work, to prepare standard operating procedures that identify hazards and control risks with the operation of tools and equipment.
- With well documented standard operating procedures the performance of tasks at your business becomes much easier because all employees are running according to the same plan. This, in turn, leads to better consistency and productivity.

It is important to keep safety and health in mind when working with tools and equipment. The WHS team has created safe operating procedures to help you do that.

- This gives workers the necessary insight into the risks involved in using tools and staying safe when undertaking a task.

1.1.2. Elements of Standard Operating Procedures (SOP)

Elements of Standard Operating Procedures include:

- Work health and safety consultation with workers for input on hazards, risks and solutions.
- Pre-start inspection of tools used in a work task to ensure tool and equipment safety.
- Methods by which to identify faulty, defective or non-compliant plant and equipment.
- The requirement to not alter or modify plant and equipment.
- Incompatible components or parts fitted to or used in connection with a tool.
- The method by which to safely operate the tool to eliminate the risk of injury or death.
- Environmental hazards in the workplace having the potential to be a hazard.
- Work at height hazards and control measures when operating a tool to undertake a work task.
- Hazardous manual tasks requiring the safe handling of tools and equipment
- Residual hazards resulting from the operation of tools requiring PPE as a control measure.
- Training provided to workers to explain safety measures in the use of tools and equipment.
- Good housekeeping practices in the workplace assists with slips, trips and falls prevention.
- Monitor and review control measures to ensure the health and safety of workers.

1.2. Work health and safety

Work health and safety (WHS): Sometimes called occupational health and safety (OH&S) involves the management of risks to the health and safety of everyone in workplace. This includes the health and safety of anyone who does work for workers as well as customers, visitors and suppliers.

Workplace safety is an important part of any job and requires that everyone in the company adhere to the safety guidelines and policies in place. Carefully following appropriate safety

guidelines can go a long way toward preventing workplace injuries. Here are some ways you can work to stay safe on the job.

- Be Aware
- Use Equipment Properly
- Take Breaks regularly
- Locate Emergency Exits
- Report Safety Concern
- Practice Effective Housekeeping
- Make use of mechanical Aids
- Reduce Work place stress
- Use Appropriate safety Equipment

Benefits of Work health and safety

Creating a safe work environment is a legal requirement. It's also critical to the long term success of task/work:

- Help you keep your staff
- Improve staff productivity
- Reduce injury and illness in the workplace
- Reduce the costs of injury and workers' compensation.

1.2.1. Hazard identification and control

Hazard: A condition, object, activity or event with the potential of causing injuries to personnel, damage to equipment or structures, loss of material, or reduction of ability to perform a prescribed function. It can be considered as a dormant potential for harm which is present in one form or another within the aviation system or its environment.

- ✓ **Physical Hazard in Textile Industry:** The textile industry consists of a number of units engaged in spinning, weaving, dyeing, printing, finishing and a number of other processes that are required to convert fiber into a finished fabric or garment.

Fig 1.0-1 Physical hazards in textile industry

- ✓ **Electrical Hazards in Textile Industry:** Electrical hazard can be defined as a dangerous condition where a worker could make electrical contact with energized equipment or a conductor, and from which the person may sustain an injury from shock, there is potential for the worker to receive an arc flash burn, thermal burn, or blast injury.

Fig 1.2 Electrical Hazards in Textile Industry

- ✓ Fire and Explosion Hazards: The textile industry produces various products out of different natural and artificial fibers. It does not only belong to the oldest, but also to the most important segments of industry. However, the production of cloth holds many risks of fire.

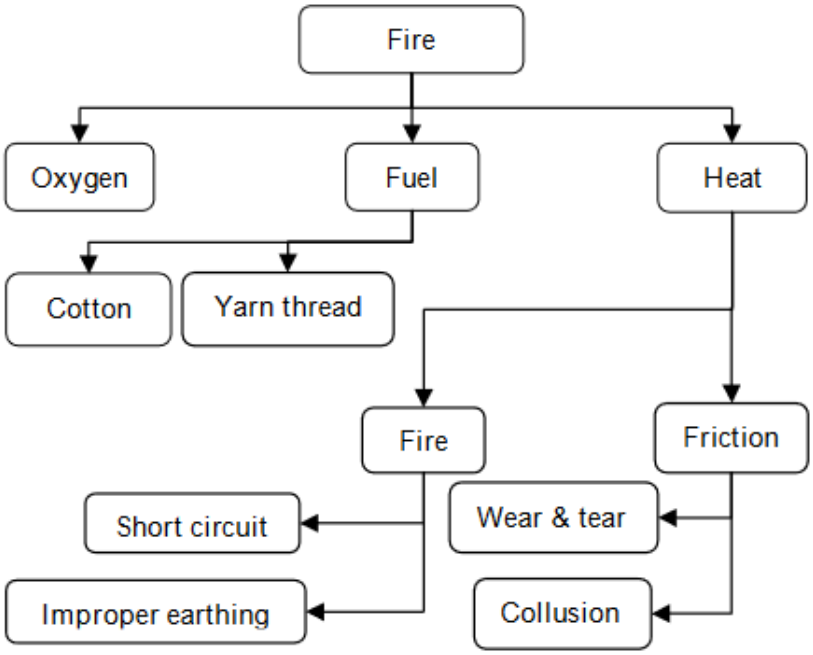

Fig 1.3. Fire and Explosion Hazards

- ✓ **Safety, Health and Welfare of Women's:** Occupational safety and health should be managed in a gender exposure of sensitive way, being aware that there may be differences in the exposure of women to risk compared to men.

This potential for harm may be in the form of a natural hazard such as terrain, or a technical hazard such as wrong runway markings. 'Bow-tie' also refers to the methodology used to build such diagram.

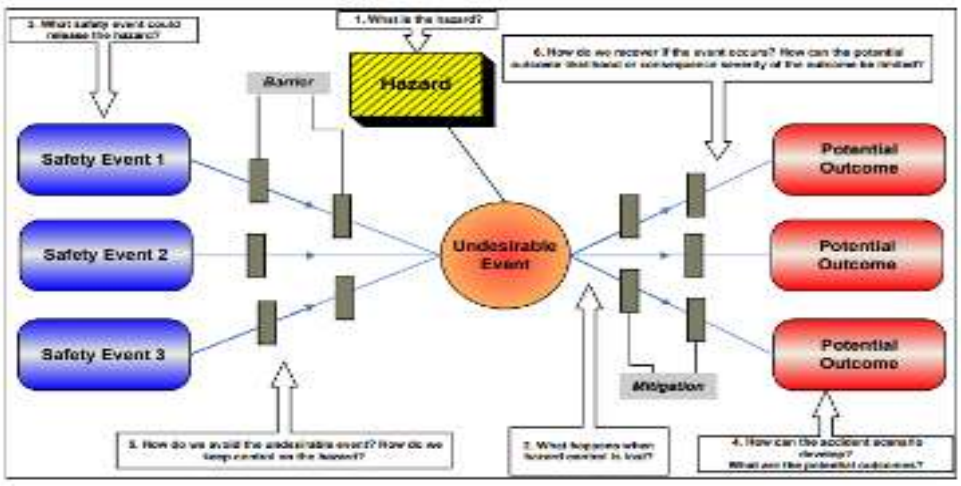

Fig 1.4 'Bow-Tie' Diagram illustrating definition of terms

There are three basic management control strategies to eliminate or reduce exposure to hazards:

Practices: Some of these practices are very general in their applicability. They include housekeeping activities such as:

- Using personal protective equipment (PPE).
- Placing warning signs that inform and restrict access
- Removing tripping, blocking, and slipping hazards
- Removing accumulated toxic dust on surfaces
- Wetting down surfaces to keep toxic dust out of the air

Procedures: These procedures apply to specific jobs in the workplace.

- Permit-required confined space entry procedures
- Lockout/Tag out procedures
- Fork-lift safety inspection procedures

Schedules: Measures aimed at reducing employee exposure to hazard by changing work schedules. Such measures include:

- Lengthened rest breaks
- Additional relief workers
- Exercise breaks to vary body motions
- Rotation of workers through different jobs

1.2.2. Risk assessment and implementation

The textile industry is among the oldest in the world. It's also among the most global sectors because most companies serve the international apparel and textile market. But the dynamic global landscape has changed consumer preferences, driven cost volatility, and brought new risks in the landscape.

Risk reducing measures include frequency reducing and consequence reducing activities, and their combinations. The measures may be of a technical, operational, and/or organizational nature. Choosing the types of measures is normally based on a broad evaluation, where risk aspects are considered. Layout arrangements are suitable for the operations and minimize the exposure of personnel to accidental loads.

A hierarchical approach to risk reduction is designed to:

a) Eliminate and minimize hazards by design (inherently safer design),
b) Prevent (reduction of likelihood),
c) Detect (transmission of information to control point),
d) Control (limitation of scale, intensity and duration),
e) Mitigate consequences (protection from effects), and
f) Emergency response plans (spill, well control, blow out, drive off/drift off, etc.)

1.2.3. Risk reduction measures

Risk: the combination of the predicted frequency and severity of the consequences of hazard(s) taking into account all of the potential outcomes.

Risk assessment is one of the functions in a Safety Management System and an important element of safety risk assessment is the identification of hazards. The risks can be identified via direct observation in the field of the overall loading and unloading activities undertaken by workers.

Stages of risk assessment are:

1) Decomposition of the type of work, type of activities in the order based on the process of loading and unloading process.
2) Identification of potential hazards, potential hazards can be done by conducting direct observations at the port, observations made for all activities undertaken at the port.
3) Assessment of severity conducted risk assessment process with attention to important aspects of severity.
4) Categories: catastrophic, critical, marginal, and negligible. Severity is measured by the impact of an accident.
5) Frequency assessment, at this stage the process of the frequency of the occurrence of accidents or the possibility of emergence of hazard by using hazard exposure classification.

- **Remedial Measures**

Table 1.1. Remedial Measures

FIRE HAZARDS				
1	Welding operation	• Welding sparks	• Spark ignition is very dangerous.	• Restrict unauthorized person to do welding
2	Electrical short circuit happens	• Improper earthing and • Insulations	• If no trip occurs its get sparks and get fire.	• ACB (Air circuit breaker), MCB (motor circuit breaker).
3	Smoking	• Easily ignitable materials	• Easily gets fire	• Safety signs & workers must aware of not using any ignition product
4	Flammable dyestuffs	• Dyes	• It may be easily ignited	• To store the dye stuffs in safe place. • To maintain properly.

		CHEMICAL HAZARDS		
1	Bleaching	• Chlorine powders	• Exposed to dangerous levels of chlorine, a skin and eye irritant • Dangerous pulmonary Tissue irritant causing delayed lung oedema.	• Suitable PPE, including eye protective equipment • Use personal protective equipment
2	Corrosion	• Alkalis and acids	• Expose the workers to • the risk of burns and scalds	• Protective clothing should be cleaned at regular intervals

1.3. Personal protective equipment (PPE)

A Personal Protective Equipment (PPE) is clothing or equipment designed to reduce employee exposure to chemical, biological, and physical hazards when on a worksite. It is used to protect employee's hazard and illness/injuries and to reduce the risks to acceptable levels.

Table 1.2. Personal Protective Equipment

No	Materials	Description
1		**Body safety cloth (Tuta): -** This cloth is a type of cloth which covers all the body part except the head and the fingers**.** It is used to protect the body from dirty.
2		**Eye protecting device: -** It is used to protect the eye from different damages.
3		**Safety shoe:-** it is used to protect foots from hazard chemicals damaging.
4		**Hand glove:** Which is made of leather or strong flexible plastic rubber, it used to cover fingers to protect from sharpen materials**, greases, and oils.** **Mouse cape:-** it is used to protect mouth from any dirty

1.3.1. Importance of Personal Protective Equipment

According to the hierarchy of controls by the National Institute for Occupational Safety and Health (NIOSH), PPE is recommended to be the last level of defence to prevent occupational injuries, illnesses, and fatalities, but some businesses combined it with other control measures to ensure a safe and healthy environment for their workers. Here are some benefits of using PPEs:

- Prevent unnecessary injury in the workplace;
- Protect employees from excessive chemical exposure;
- Help businesses comply with regulatory requirements(e.g., The Personal Protective Equipment at Work Regulations 1992 that's recently been extended to limb workers); and
- Improve employee productivity and efficiency.

1.4. Job requirements

Job requirements are the skills, experiences and qualities an employer deems necessary for a candidate to be considered for a role. Job requirements also called prerequisites or qualifications are an important part of any job description and cannot be overlooked by either the employer or prospective employee. Job requirements should include all the technical or "hard" skills needed to carry out job responsibilities, as well as any "soft" or interpersonal skills that are valuable to the role.

Printing Master (Textile); organize, direct and supervise printing of cloth in various designs ensuring quality, output and smooth running of printing department. Arrange for supply of necessary chemicals and dyes. Check mixing of colors in required proportions for printing purpose. Examine printed sample to check its quality and carries out chemical tests to ensure its fastness. Ensure regular supply or required quantity of cloth for printing in their department.

Get printing rollers with required engraving of pattern fitted in printing machines. Supervises work of Printers, Textile to ensure quality output. Maintains record of job orders completed, and batches of colors used. May check operations of printing machines to ensure optimum output and may make arrangements for repair of defects in machines or replacements of parts

Self-check 1.1	Written Test

Directions: Answer all the questions listed below.

Give short answer for the following questions

1. What are the elements of standard operating procedures?
2. What is Personal Protective Equipment?
3. What is Job requirements?
4. Write some benefits of personal protective Equipment.

Unit Two: Printing processes

This unit is developed to provide you the necessary information regarding the following content coverage and topics:

- Printing processes and technologies
- Interaction of Chemicals and auxiliaries
- Properties and functions of pigments, dyes & auxiliaries

This unit will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Understand printing processes technologies
- Interaction of Chemicals, auxiliaries, pigments and dyes
- Properties & functions of pigments, dyes, Chemical & auxiliaries

2.1. Printing processes and technologies

Introduction

Textile printing is applying color to fabric in patterns or designs. Once a textile is printed, the color is bonded with the fiber to resist washing and friction. Printing process, like dyeing, is a process for applying color to a substrate. However, instead of coloring the whole substrate (cloth, carpet or yarn) as in dyeing, print color is applied only to defined areas to obtain the desired pattern. This involves different techniques and different machineries with respect to dyeing, but the physical and chemical processes that take place between the dye and the fiber are analogous to dyeing.

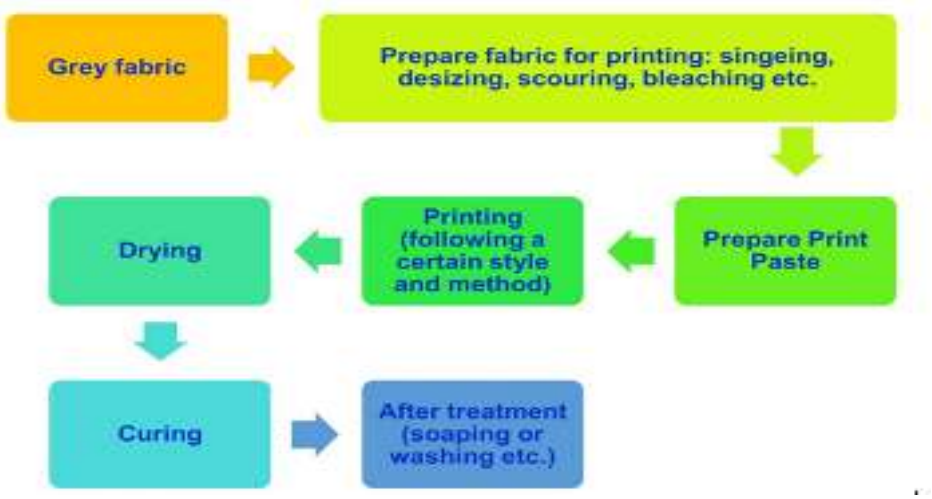

Figure 2.1. General Printing process flow-chart

A typical printing process involves the following steps:

Color paste preparation: When printing textiles, the dye or pigment is not in aqueous liquor, instead, it is usually finely dispersed in a printing paste, in high concentration.

Printing: The dye or pigment paste is applied to the substrate using different techniques, which are discussed below.

Fixation: Immediately after printing, the fabric is dried and then the prints are fixed mainly with steam or hot air (for pigments). Note that intermediate drying is not carried out when printing carpets (too much energy would be needed for removing the highly viscous liquor).

After-treatment: This final operation consists in washing and drying the fabric (it is not necessary when printing with pigments or with other particular techniques such as transfer printing process).

Continuous Process Flowchart for Digital Textile Printing

Fig 2.2. Process Flowchart for Digital Textile Printing

Traditional textile printing techniques may be broadly categorized into three styles:

- Direct printing, in which colorants containing dyes, thickeners, and the mordant or substances necessary for fixing the color on the cloth are printed in the desired pattern.

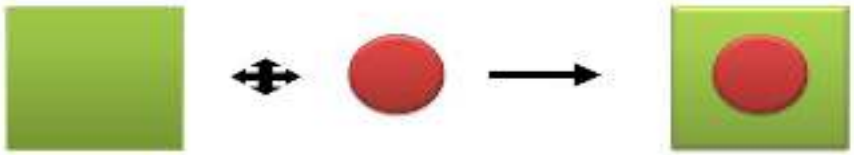

Fig 2.3. Discharge Printing

- Resist dyeing, in which a wax or other substance is printed onto fabric which is subsequently dyed. The waxed areas do not accept the dye, leaving uncolored patterns against the colored ground.

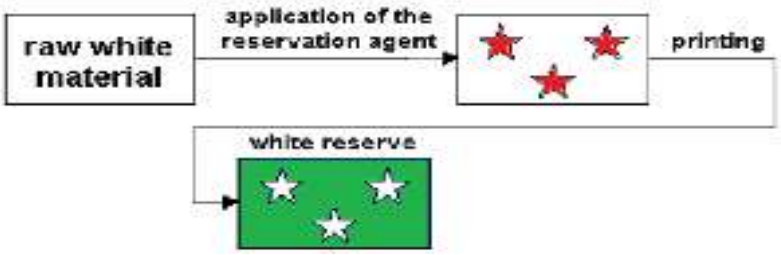

Fig 2.4.Resist printing

- Discharge printing, in which a bleaching agent is printed onto previously dyed fabrics to remove some or all of the color.

Digital Textile Printing Technology

Ink jet printing is also known as digital printing. It has become the major printing technology in the desktop/network printing markets. The advent of digital color printing has opened up many new application areas for ink jet including wide-format graphic arts and increasingly industrial applications such as textiles, which, until recently, were the exclusive domain of the traditional analogue printing technologies.

Digital textile printing has revolutionized the way businesses create their printed materials. It is fast, effective, and provides an alternative to the more traditional method of textile printing.

- **Quality:** When it comes to quality, nothing surpasses digital textile printing. Images are essentially flawless, alignment and registration issues are non-existent, and color is vibrant. Digital printers can also use the entire length of a printable item.
- **Speed:** Digital printing's ability to switch over to a new label almost instantly is another perk of using digital textile printing. Because there's no lost time setting up plates and printing machinery, your order is likely to reach its intended destination days, if not weeks earlier.
- **Short run printing advantage:** Digital textile printing efficiently produces designs at run lengths as low as one yard of fabric without the need for screen changes.
- **Lower water and power consumption:** Digital textile printing eliminates the substantial amount of water and electrical energy one requires for rotary screen preparation, printing and cleanup.
- **Less chemical waste:** Digital textile printing results in significantly less ink usage and waste relative to screen-printing. Taking into account the additional chemistry and chemical waste from screen production, printing digitally offers a greener advantage for printing.
- **Large repeat sizes:** Digital textile printers can print large designs (e.g. cartoon characters on sheets and blankets) on roll fabric without the usual rotary screen-printing limitation in pattern repeat size.

- **Reduced production space requirements:** By not having to prepare and store customer screens for future use, the production footprint for digital textile printing is a fraction of the size one requires for a rotary screen print facility.
- **Less printed inventory needed:** Digital textile printing permits the option to print a design at will. This means that manufacturers with an integrated digital printing system in their production chain can keep a stock of unprinted textiles on hand to print as required.
- **Sampling and production done on same printer:** By being able to print samples (strike-offs) on the same printer one uses for production, digital textile print shops can present their customers with proof samples of designs that will exactly match the final printed material.
- **Print flexibility:** Printing houses utilizing both digital and screen technologies can choose to print a small quantity of designs with different color combinations (color ways) first with their digital textile printing solutions for test the market. They can later opt to print higher volumes of the most desired color designs using rotary screen technology.
- **Variety of creative design choices for printing:** Digital textile printing provides the option to print photographic/continuous tone images, spot color pattern designs or a combination of both. This expands the creative printing alternatives for fashion and interior designers.
- **Low capital investment:** The relatively low capital investment to setup a digital textile print shop, especially compared to rotary screen-printing production, makes it possible to start small and expand as business grows.

There are five significant types of textile printing- **block, roller, screen, and heat transfer and inkjet methods.** In all the ways except the heat transfer method, the dye or pigment is applied to the fabric surface through a print paste medium. The heat transfer method transfers the color from the design printed on paper using the vapor phase into the fibers. However, the ink jet printing process is a comparatively recent innovation and is referred to as a 'non-impact' method. The printing technique also depends on the factors like quantity to be printed, type of textile, type of impression and the end use of the printed product.

- In-cylinder or roller printing the fabric is carried on a rotating central cylinder and pressed by a series of rollers each bearing one color. The design is engraved on the copper rollers by hand or machine pressure or etched by pantograph or photoengraving methods; the color paste is applied to the rollers through feed rollers rotating in a color box, the color being scraped off the smooth portion of the rollers with knives.

Fig 2.5. Cylinder or roller printing

- **Screen printing**: This is a hand method especially suitable for large patterns with soft outlines, in which screens, one for each color, are placed on the fabric. Then, the color paste is pressed through a wooden squeegee.

Fig 2.6. Hand Screen printing

2.1.2. Fabric printing methods

Types of printing

Fabric printing seems to be surrounded by many “myths and legends”. Our clients often have problems with understanding and choosing the right method of fabric printing, which has a colossal effect on the final result of their work. Whether your project turns out exactly as you

planned depends on the choice of the right printing method, medium and type of dye. Since we have not found a comprehensive and substantive summary of types of printing anywhere on the Internet, we decided to collect everything in one place. Division into analogue and digital fabric printing methods is the basic way of categorization of the printing methods. Below, try to explain different methods and their characteristic features.

Types of screen printing

- **Flat screen printing** : most often used for printing on ready-made objects (t-shirts, bags)
- **Rotary screen printing**: used for printing on entire rolls of fabric. As far as this fabric printing method is concerned, the initial cost is high, because the preparation of cylinders significantly raises the price.
- **Hand-screen printing** – introduced to the studio by Andy Warhol, it has been quickly accepted by the independent artists who often screen print manually in their workshops using homemade constructions.

Screen printing - an analogue method of fabric printing:

- High cost of entry preparation of expensive screens
- Each color requires the preparation of a separate screen
- Limited number of colors
- Number of colors used in the project has a significant impact on the cost of printing
- Cost-effective when printing in bulk with an increase in the number of goods produced, the price of a single unit noticeably decreases
- Due to the cost of preparation of the screens, it is not suitable for printing individual pieces (and small volumes)
- It is not possible to perform a sample print.

i. Digital printing

Digital printing on fabric acts similar to a home inkjet printer. In fact, this method of fabric printing does not impose any restrictions on the project itself you can print any graphic on the fabric, without any limitations on the number of colors or tonal transitions between the colors.

Printing is the result of applying microscopic droplets of paint (dye) on fabric resulting in the creation of a pattern. The printer is able to reproduce virtually any color from the normal color palette through a combination of four basic colors from the CMYK palette (cyan, magenta, yellow, black) and additional so-called spot colors (e.g., orange, blue). On the other hand, digital printing also brings limitations: very narrow possibilities of using special colors (metallic, fluorescent) or, for example, PANTONE palette.

Digital printing is usually carried out on white fabric – so printing white dots on a black background boils down to printing the entire surface black and leaving unprinted "white dots". Such a "difficult" color scheme is, therefore, the basic premise to choose a different method (in this case, for example, the screen printing method). Digital printing on fabric works perfectly for printing photos, detailed patterns, tonal transitions and graphically complex designs.

Fig 2.7. Digital printing output

Digital printing:

- No printing screens – No initial cost
- The ability to print even a single copy
- No color limitations
- The number of colors and the appearance of the print does not affect the cost of manufacturing
- Economy of scale is definitely lower than it is when screen printing – printing the first and the hundredth meter costs basically the same
- Ability to perform a sample print

The division into analogue and digital printing is the basic categorization of printing on fabric. However, there are also other divisions – see which ones best meet your expectations when it comes to your projects.

Due to the medium being overprinted, we divide the fabric printing methods into:

- DTG printing (direct to garment)
- Roll-to-roll printing (fabric on a roll)

DTG printing (direct to garment)

In free translation, DTG means “directly on clothing”.

It is a printing method that involves the application of patterns and colors directly to the base, which in this case is a finished clothing product. The sewing of the product takes place before the printing process and the components are ready for use the moment they are removed from the printer.

DTG is perfect if you want to print on finished products such as:

- T-shirts
- Polo shirts
- Sweatshirts
- Bags

Fig 2.8. T-shirt printing using direct printing method

When printing on fabric using the DTG method, there is no need to prepare printing plates or screens, which directly affects and reduces the cost of small volume production (no initial,

“start” cost). DTG printing method gives the possibility of personalization even at small amounts. When printing with the DTG method, however, we have a limited print area (depending on the machine used, but we will usually not achieve a surface larger than 50x70 cm).

The minimal amount of the printout starts with one piece (however, the higher the volume, the lower the unit price). The price is influenced by the quantity of the printouts, the size of the print and the color of the fabric on which the pattern is printed. If the final product on which you want to print is of a color other than white. Then a white surface is always printed underneath the pattern, which significantly alters the price.

Regarding the type of dye used, printing on fabric can be divided into:

- Fabric printing using pigment inks
- Fabric printing using reactive dyes
- Fabric printing using acid dyes
- Dye-sublimation printing

The process of finishing (preparing the material for printing) and heating (fixing the color on the surface) considerably increases the ease of use of the fabrics printed with pigment. Printed with pigment ink and properly treated cotton (washed in a washing machine on a delicate program, with a cleaner that does not contain strong detergents or only chemically, without the use of water) guarantees the longer lifetime of beautifully printed cotton fabrics and knitwear.

During fabric printing with pigment inks, it is problematic to generate bright colors. Moreover, black will be slightly less deep in comparison with the one achieved during printing using reactive dyes. The pigment is better suited for lighter, e.g., pastel, inhomogeneous surfaces. Watercolor flowers in light, pale colors are the perfect design for printing with pigment inks. Digital printing is a surface print, potentially susceptible to damage. For this reason, it is not recommended to rub (or “clean down”) materials printed with pigment ink, especially wet.

Dye-sublimation printing

Application: Used primarily for printing on synthetic fibers (polyester) and blends (which are mostly composed of polyester). Additionally, it is unsuitable for prints on cotton.

Sublimation is a process in which matter moves from a solid state to a gaseous state (bypassing the liquid state). When printing using sublimation inks, this process occurs during the heating phase, i.e. fixing the print using a temperature of up to 200 degrees Celsius. The dyes then sublimate, merging with the material.

The process of printing using sublimation inks can be carried out in two ways:

- Direct sublimation
- Intermediate sublimation

As far as direct sublimation is concerned, sublimation inks are applied to the material directly using a digital printer? In the case of indirect sublimation, we are dealing with transfer printing. The pattern is printed on transfer paper and then using a calendar or a flat press, where it is exposed to high temperature (dry or steam), it is transferred to the base material. During this process, sublimation is accountable for transferring the print to the fabric.

In practice, most often, you will meet the following fabric printing methods, which are the outcome of the abovementioned divisions merging. After reading the text, you already know which type of printmaking will be the best for your projects, and which you should avoid. We summarize the most popular methods and their hybrids on the market below:

- **Flat screen printing** – for graphically simple prints, e.g. on T-shirts
- **DTG digital printing** – for complicated prints, e.g. on T-shirts
- **Digital roll-to-roll** printing with pigment inks – when you want to do low/medium-volume print on cotton, and you care about the time
- **Digital roll-to-roll printing** with reactive dyes – when you want to make medium/high-volume printing on cotton and a long order completion time is not a problem
- **Digital roll-to-roll dye-sublimation printing**: When you want to print on polyester

2.1.3. Automation in Textile Printing

a. Print Paste Automation

In dye house, the printing sector uses dyes & pigments in the form of powder or liquid in the printing process. In fact, 90% of printing uses only powder, like Reactive dye or Disperse

dye. Only 10% use liquid dyes for printing. Liquid dyes need separate tank to store and also need to be kept in constant circulation so as to avoid sedimentation and spoiling of the entire batch. So, in both cases the dye preparation process is one that needs proper care.

b. Automatic Dosing System

Color Service has an innovative solution that allows a printing department to use both powder and liquid dyes in the same dosing system. The Color Service automatic printing color kitchen is composed of two main units- a thickener depending on the quantity of print paste required, the unit picks up a drum and delivers it to an initial thickener dosing head. For liquid dyes such as pigments, dosing can be done with the same thickener dosing head. But in case of powder dyes, the drum goes to a powder dosing unit on a conveyer. After ending of powder dosing, the drum goes back to print paste dosing unit. The drum is move to the next stage to complete the remaining amount of thickener.

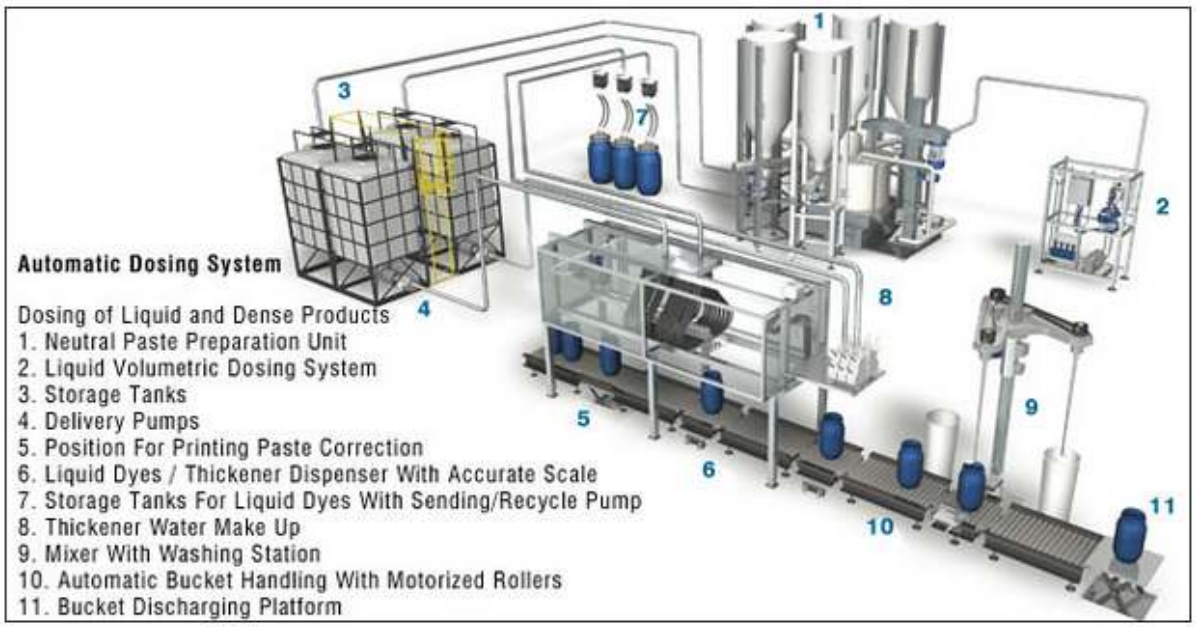

Fig 2.9. Automatic dosing system

2.2. Interaction of Chemicals and auxiliaries

Auxiliary chemical substances, also known as process chemical substances, are necessary to make textile processes work, but they do not provide any desired properties to the final article

and are therefore not meant to remain in the finished textiles. Some examples of auxiliary chemical substances are:

- Organic solvents
- Surfactants
- Softeners
- Salts
- Acids and bases
- Biocides as preservatives

Today, portfolio of textile printing products includes:

- Ready-to-use pastes and pigment dispersions for continuous printing
- Screen printing ranges (water-based, Plastisol, PVC-free Plastisol-like, silicones)
- Digital printing pre-treatments
- Pigment-based inks for digital printing

2.3. Properties and functions of pigments, dyes & auxiliaries

Uses of Pigments:

- ✓ Use in natural, synthetic and glass fiber dyeing.
- ✓ It is mostly use for printing.
- ✓ Use for blended fabric dyeing.
- ✓ Use in dope dyeing

It also used for the coloration of metal, wood, stone, soap, detergent, colored pencil, PVC, rubber, paper and other surfaces as paint.

Types of Pigment

There are two types of Pigment. They are-

- ✓ Natural pigment.
- ✓ Synthetic pigment.

Natural pigment are divided by two types.

- ✓ Organic pigment (chlorophyll Indigo)
- ✓ Inorganic pigment (inonoxide)

Synthetic pigment also divided by two types.

- ✓ Organic pigment. (litholred, peocockblue etc.)
- ✓ Inorganic pigment. (sulphide, chromate etc.)

Organic pigment are two types. Such as-

1. Natural organic.

   Vegetable organic.

   Animal organic.

2. Synthetic organic.

   Azo.

   Non-azo.

Properties / Qualities of a Good Pigment:

- Pigment should have minimum particle sizes (0.2-0.4).
- Pigment should have maximum covering power.
- Pigment should have freely mixing power.
- Pigment should be chemically inert.
- Pigment should have good resistance to chemicals.
- Pigment should be resistance to solvent.
- Pigment should have acceptable brilliance, hardness and stability on dyed and printed goods.
- Pigment should have good wet, light, and abrasion resistance.

Pigment should have good characteristics for excellent dispersion including:

- Particle size and distribution
- Electrical charge
- Specific gravity
- Purity and crystalline structure
- Condition of precipitation
- Should be applied to all fiber
- Should be cheap

Textile Chemicals and Auxiliaries with Their Functions:

The process of conversion of natural and man-made textile fibers is according to end uses and attractive qualities as per the need of customers who involving the uses of a large number of organic and inorganic chemicals known as textile chemicals. Some chemicals are used in textile auxiliaries or textiles are given below:

1) **Detergent:** Detergents are nothing but a chemical that is used for clearing the textile materials or to remove fats, oil, and wax.

2) **Emulsifier:** The chemical which is used to mix up the oil and water is called an emulsifier.
3) **Dye Retarding or Leveling Agents:** The chemicals which are used for dyeing just to give level shade or even dyeing is called the leveling agent.
4) **Dye Fixing Agent:** Dye fixing agent is not anything but a chemical that helps to fix up the dye particle into the inner position of the fiber with the bondage.
5) **Rubbing Fastness Agents:** Rubbing fastness agent is a chemical that will help to improve rubbing resistance power, this type of agent is used. It is nothing but color permanency agents. It is in three types. Such as washing fastness, light fastness, and rubbing fastness.
6) **Printing Thickener:** Thickener is a thick mass that imparts stickiness and plasticity to the printing paste, so that it may be applied on the fabric surface without bleeding or spreading and be capable of maintaining the design outlines. It is the main part of the printing. Example: Potato paste, rice, carboxyl-methyl cellulose.
7) **De-foaming Agents:** The chemicals which help to prevent foam formation is termed as de-foaming agents. Example: De-foamer, Anti-foam, etc.

Self-Check-2.1	Written Test

Directions: Answer all the questions listed below.

Part I. Choose the correct answer from a given alternatives. Answer on the provided space.

_____ 1. Which one of the following chemical is used to mix up the oil and water?

A. Thickener B. Emulsifier C. Caustic soda D. Binder

_____ 2. Pigment should have minimum particle sizes (0.2-0.4).

A. True B. False

_____ 3. Pigment should have good characteristics for excellent dispersion including except

A. Electrical charge
B. Specific gravity
C. Condition of precipitation
D. Should be Expensive

Part II: Give short answer for the following questions

1. What is printing thickener?
2. What are types of pigment?
3. Write some chemicals and auxiliaries used in textile printing.
4. What are screen printing methods?

Unit Three: Set up and loading machine

This unit is developed to provide you the necessary information regarding the following content coverage and topics:

- Printing paste and screen
- Printing machinery

This unit will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Check and load printing paste and screen
- Make the machine ready for printing.

3.1. Printing paste and screen

Printing is defined as localized dyeing. To achieve this printing auxiliaries are essential which enables a processing operation in printing to be carried out more effectively. Machines used for printing the fabrics are printed conventionally using the table screen printing machines manually. More perfection and production can be achieved using a modern automatic flatbed screen printing machine.

3.1.1. Printing Paste

In textile printing industry, a printing paste is prepared by dissolving the dyes in hot water to which is added a solvent and urea. This type of solution is stirred into a thickener that is easily removed by washing. Small amounts of oxidizing agents are added here. Printing pastes are prepared by using four main components such as the coloring matter used (dyes or pigments), the binding agent, the solvent, and the auxiliaries.

Procedures of Printing Process

A typical printing process involves the following steps:

1. Preparation of fabric
2. Developing of design or pattern desired
3. Preparation of print paste
4. Printing of fabric
5. Drying
6. Fixation of dyestuff
7. Washing-off or after treatment

The above printing process steps are for the flat screen, rotary screen and engraved roller printing processes.

1. **Fabric of Preparation**

It is the key for obtaining consistent high quality printing results. Cloth need to be washed, bleached, brushed, sheared by being passed over rapidly revolving knives arranged spirally round an axle which rapidly and effectually cuts off all knots, leaving the cloth perfectly smooth in order to promote maximum dye penetration for best color fastness properties.

If the color is off shade in a conventional dyeing process, it is often possible to over-dye the fabric to a darker color, thus preserving the value of the fabric. Unlike dyeing, printing cannot be reprocessed for poor quality printed fabric.

2. Developing of Design

Some of the accessories of developing design are:

- ✓ Computer
- ✓ Transparent paper
- ✓ Light box
- ✓ Printer
- ✓ Squeegee
- ✓ Lacquer and photo synthesizer
- ✓ Silk, polyester fabric or metallic mesh,
- ✓ Ironing and others.

3. Preparation of Printing Paste

Type of specific formulation depends on:

- ✓ Fiber
- ✓ Colorant system used
- ✓ Type of printing machine

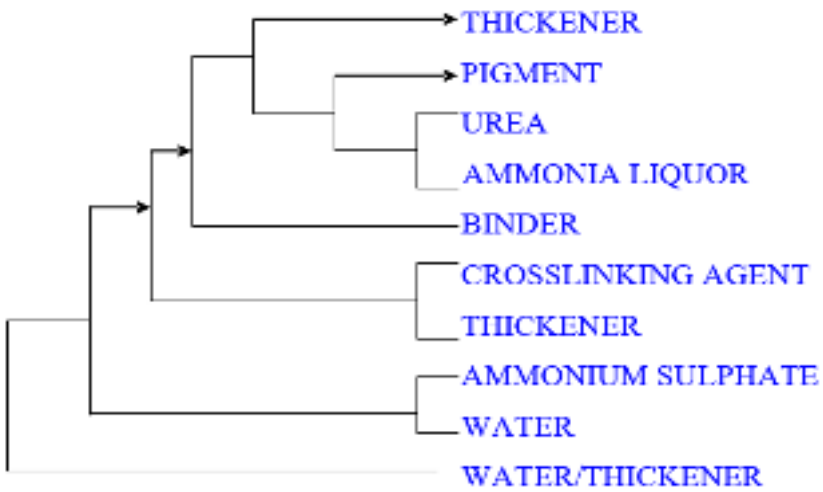

Fig 3.1. Printing past ingredients

Characteristics of Textile Printing Paste

The choice of thickener in a print paste determines not only the paste viscosity but also a number of other essential factors. These include the following:

1. The print paste stability, particularly on storage. Compatibility of thickeners with respect to the added dyes and chemicals is critical.
2. The adhesion and flexibility of the printed paste film.
3. The ease of removal of the residual film of paste remaining on the fabric after fixation. After printing, the film of residual thickening agent is usually washed from the fabric.
4. The cost of the thickening agent. The cost of the thickener and the costs associated with its removal from the fabric should be as low as possible.
5. The environmental impact of thickeners in the effluent leaving the print works.

Table 3.1. Typical Non-emulsion Pigment Printing Paste recipes

SL No.	Chemical	Amount (%)	Role
01	Pigment	15	Colorants
02	Trimethylolmelamine	14	Pigment binder
03	NH4(H2PO4) 10% aq	1	Catalyst for binder crosslinking
04	Water	35	
05	Gum tragacanth dispersion 6%	35	Thickener

3.1.2. Printing paste ingredients

Printing auxiliaries include textile chemical thickener, binding agent, cross linking agent, emulsifier, fixing agent, dispersing agent, de-foamers etc.

- **Dyestuffs and Pigments**

Either dyes or pigments are used as printing colorants.

Printing Dyes

- ✓ They are typically more expensive to use,
- ✓ They are fiber specific and have varying brightness and fastness properties.
- ✓ They have little or no negative impact on the feel or hand of the final product.
- ✓ Typically dyes are considered the superior product by the public.

Printing Pigments

- ✓ They are not fiber specific,
- ✓ No subsequent washing
- ✓ They are less expensive to use and exhibit varying fastness and brightness properties.
- ✓ They require binders or glue systems which can severely stiffen the fabric. This is often perceived as a negative property in the final product.
- ✓ Pigments are typically considered a lower quality printing system by the public. However, the majority of fabric blends are printed with pigments.

Comparison between Dyeing and Printing

Though dying and printing are the coloration processes using the same classes of dyes and other chemicals, they differ in the following aspects.

Table 3.2 Comparison between Dyeing and Printing

Dyeing	Printing
1. Uniform application on both sides of the fabric surface with single color only.	1. Single or multicolor application on one side of the fabric at selected portions only.
2. Dyes are applied in dilute form	2. Dyes are applied in paste form
3. In fabric preparation, Half bleaching is enough	3. full-bleaching with optical whitener is necessary
4. Color penetrates through the fabric.	4. Color is applied only on the surface.
5. More time is required in the batch applications.	5. Not applied in batch process. Applied only by continuous process alone. Therefore requires less time.
6. Fabric need not be in dry condition.	6. Fabric should be in a dry state.
7. Requires a single machine and the process is simple.	7. Requires complex machinery and the process is also complex.
8. Dyeing consumes more water.	8. Printing consumes less water.

- ➢ **Binder:** Binders are used in pigment printing as a thin film forming polymer. Ex. Melamine formaldehyde resin.
- ➢ **Emulsifier (Dispersing Agent):** Dispersing agents are necessary in the print paste to prevent aggregation of the dyestuff in the highly concentrated pastes. E.g. Diethylene glycol.

- **Cross-Linking Agent:** Crosslinking agent for pigment printing. It is particularly effective for prints taken on knitted, cellulosic fabrics, polyester /cotton, polyester/viscose and polyamides. Addition of Cross print CL to a pigment paste enhances its fastness properties especially wet rubbing fastness.
- **Antifoaming Agent:** Formation of foam during print paste preparation and application is quite common but should be avoided. Foam may produce speck dyeing. The antifoaming agents help in foam generation.
- **Hygroscopic Agent:** Hygroscopic Agents: The materials which absorb water from the moisture is termed as the hygroscopic agent. It is one type of electrolytic which sucks up the water and is soluble. Example: NaCl. The function of hygroscopic agents is to take up sufficient amount of water (moisture) during steaming to give mobility to the dyes to move into the fiber. For example Urea and Glycerin.
- **Softener:** Softening Agents: The chemicals which are used to soften the textile materials is called softening agents. Example: Control oil, Parafin.
- **Wetting Agent:** Wetting Agent: The chemical which is used for quickly moistening or watering the textile materials is termed as the wetting agent.
- **Thickener:** To make viscous paste of dyes in water, a thickener is used. For example: emulsion thickener, sodium alginate and starch etc. the thickener will be dependent on the class of dyes to be printed and the style of printing.
- **Reducing Agent and Oxidizing Agent: The** chemicals which help to increase oxygen or electronegative part release the hydrogen are termed as oxidizing and reducing agents respectively. Example: Hydrogen, Ozone, etc.
- **Acids and Alkali:** Depending on the types of dyes used in printing, acid or alkali is used in the print paste. An acid liberating salt is commonly used, for example ammonium chloride and di-ammonium hydrogen phosphate. For reactive printing on cotton, sodium carbonate or sodium bicarbonate are used.

Acids: According to the team of chemistry, the compound that dissolves in water and provide H^+ (proton) is called acid. Some of the examples are HCl, H_2SO_4, HNO_3, CH_3COOH etc. In textile processing, acid is considered one of the most important chemical. For example, the uses of some most common acids are listed here:

Table 3.3. Some most common acids

Sulphuric acid (H_2SO_4)	Widely used in washing and mordanting, carbonizing of

	wool, acid dyeing on wool, etc. Salts of this acid are also used.
Hydrochloric acid (HCI)	Used in washing and dyeing, in diazotization, in souring, etc. salts of this acid are also used.
Acetic acid (CH_3COOH)	Used for dyeing and for neutralization.
Oxalic acid ($C_2H_2O_4$)	To remove the metallic stain from fabric and garments etc.

Alkali: Sodium and potassium hydroxide, sodium carbonate, potassium carbonate etc. These control PH and fix dye on the fabric. According to the term of chemistry, the compound that provides OH^- (hydroxyl ion) is called alkali. Some of the examples are NaOH, Na_2CO_3, CaO, Na_2O etc. Uses of some common alkalis are:

Table 3.4. Uses of some common alkalis

NaOH	Used in scouring, **mercerizing**, dyeing, soap formation, washing etc.
Na_2CO_3	Widely used in reactive **dyeing**.
$Ca(OH)_2$	To remove the hardness of water, formation of bleaching chemicals, mordant and indigo vat etc.

- **Carrier and Swelling Agent**

These accelerate the rate of dye penetration by fiber polymer, swell the fiber and reduce crystallinity.

- ✓ **Swelling agents:** Resorcinol, phenol, polyethylene glycol etc.
- ✓ **Carrier:** Diphenyl

3.1.3. Printing Screen

Preparing the screen in screen printing resembles preparation of a template, where individual parts of the grid are covered, and a specific shape is obtained on the fabric. By means of screen printing, one color is printed at a time as each color is a separate layer. For this reason, screen printing is not particularly recommended for multicolor prints in such cases, digital printing will work much better. Screen printing method can be used both with material beams (in such instance a rotational screen is used) or on ready-made clothing items (T-shirts, bags, accessories).

Screen Engraving

The process of putting designs to be printed on both rotary and flat screens is known as screen engraving. The most widely used process for screen engraving is known as the lacquer method.

The overall process begins with the print design. Once the design is agreed upon, a textile artist separates the design into its individual colors. Each design component of each color is then made into a positive in black opaque ink on clear plastic film; the design is then reproduced color by color.

The flat or rotary screen is evenly coated with a liquid water-soluble photosensitive resin. The screen is dried and stored in the dark. When ready for engraving, the coated screen is then covered in the exact required location with the opaque design positive. High intensity light is then directed onto the screen. Wherever the light hits the screen, it hardens the resin and forms a water insoluble barrier.

Where light is prevented from hitting the screen due to the design positive, the resin remains water soluble. After the proper amount of light exposure time, determined by the choice of resin, the screen is washed and dried. The design areas of the screen are opened, and print paste is allowed to flow freely through, but the non-design areas are closed. This method is used for nearly all flat screens.

Laser Engraving

For rotary screens, the most modern method of screen making is known as laser engraving. Here, the original design is digitized on a CAD (computer-aided design) system. Once again, a skilled textile designer separates each color of the design. At the same time, rotary screens are coated with resin, and the resin is completely hardened.

The coated screen is then loaded on a mandrel, which is attached to a laser engraver. The machine engraves the screen using the digitized CAD print design data. Again only one color per screen is possible. There is also a technique for engraving screens using nickel electroplating technology to form the design on the screen. This technology is known as the Galvano method, but is now seldom used. In the case of screen printing, some general print defects should be mentioned. They are as Follows:

- Out of registration – pattern out of fit.
- Glue streaks – from the rubber blanket.
- Color smear.
- Color out – from a lack of print paste.
- Creased fabric.

- Pinholes in any screen.
- Damage to the screen leading to misprints.
- Lint on the fabric causes pick-off.

3.2. Printing machinery

Machines used for printing the fabrics are explained in the fourth coming section. Fabric are printed conventionally using the table screen printing machines manually. More perfection and production can be achieved using as modern automatic flatbed screen printing machine. Today's most important development in printing machinery lies in rotary screen printing machines. Before we go into the details of the printing machinery, let us discuss about the preparation of the screens used for flat bed and rotary screen printing.

3.2.1. Flat screen printing machines

The printing operation in a flatbed screen printing machine can be made fully automatic by standardizing the stages of preparation and producing the print including screen holding, addition of print paste, pressing the paste on to the cloth, lifting the screen and carrying the cloth forward to the next screen printing screen position. The automation of these stages makes the reproduction of printing results quite easy. The fabric is suitably fed to the machine in a crease free manner.

A number of stationary screens (from 8 to 12, but some machines are equipped with up to 24 different screens) are placed along the printing machine. The screens are simultaneously lifted, while the textile, which is glued to a moving endless rubber belt, is advanced to the pattern-repeat point. Then the screens are lowered again and the paste is squeezed through the screens onto the fabric. The printed material moves forward one frame at each application and as it leaves the last frame it is finally dried and it is ready for fixation.

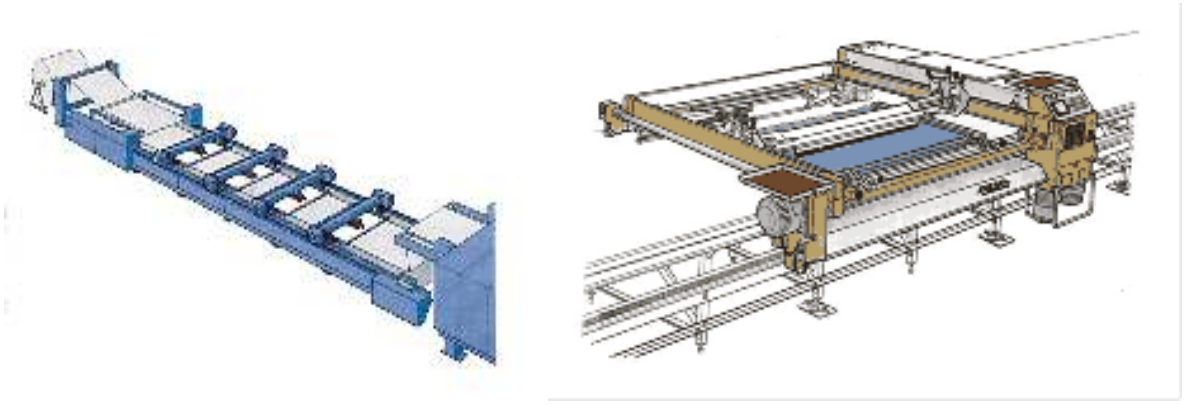

Fig 3.2. Flat-screen printing machine

In this machine the continuous rubber belt, after pulling away the fabric is moved downward in continuous mode over a guide roller and washed with water and rotating brushes to remove the printing paste residues and the glue, if necessary. After this, the belt is sent back to the gluing device. In some cases the glue is applied in liquid form by a squeegee, while in other machines the belts are pre-coated with thermoplastic glues.

A piece of nylon bolting cloth or metal gauge (phosphobraze) is stretched and nailed to a strong wooden frame, strengthened by metal brackets at the corner. The frames are usually 26” x 55” (measured externally) and 23” x 52” (measured internally) for printing 45” wide cloth. When metal frame is used for making the screen, the bolting cloth may be fixed to the frame by using a solution of polyvinyl acetate in a suitable solvent.

After applying the solution to the screen cloth, it is dried in the dark room at room temperature. The positive of the design is placed on a glass-topped table and the dried photosensitive screen is placed over it. The exposure is started from under the glass table using mercury vapor lamp or fluorescent tube lights with uniform intensity of light all over the screen. The screens are then washed in the dark, first with hot and then with cold water.

3.2.2. Rotary screen printing machines

Rotary screen printing involves a series of revolving metal cylinder, each with revolving screens, each with a stationary squeegee inside which forces the print paste onto the fabric. Twenty or more colors can be printed at the same time. The process is much quicker and more efficient than flat screen printing.

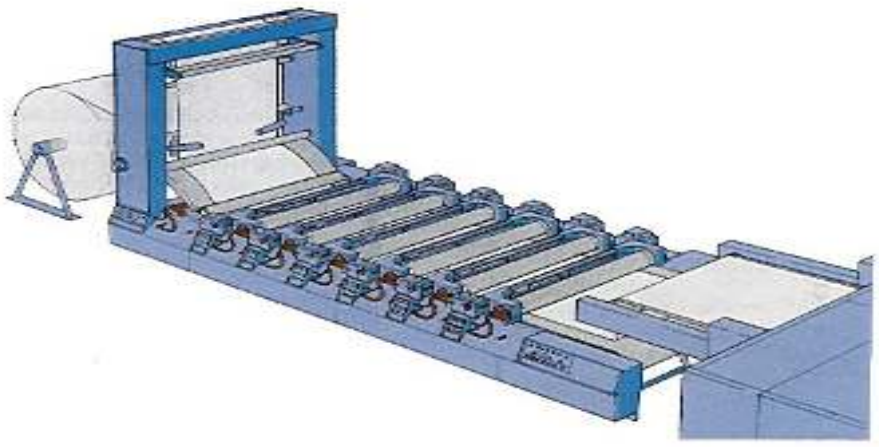

Fig 3.3. Rotary screen machines

Printing Paste Feeding System for a Rotary Screen Printing Machine

Rotary-screen printing machines are equipped with both gluing and washing devices analogous to those described earlier for flat-screen printing. The belt is washed in order to remove the residues of paste and adhesive. Not only the belt, but also the screens and the paste input systems (hoses, pipes, pumps, squeegees, etc.) have to be cleaned up at each colour change.

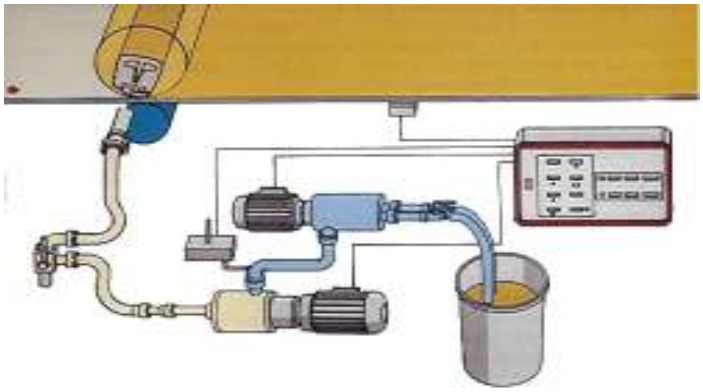

Fig 3.4. Printing-Paste Feeding System

3.2.3. Manual printing machines

It is one of printing machine which can be printed manually or by human power. The design is prepared manually also.

3.2.4. Garment printing machines

This type of printing machine imparts prints to already constructed garments. Other printing machines and methods are beyond this level, this includes: Stencil printing, Roller Engraving, heat transfer, Digital printing.

Self-Check-3.1	Written Test

Directions: Answer all the questions listed below.

Part I. Choose the correct answer from a given alternatives. Answer on the provided space.

_____ 1. Which one of the following chemical used for printing paste preparation?

B. Hydrogen peroxide B. Thickener C. Caustic soda D. Salt

_____ 2. Which one of the following type of printing machine imparts prints to already constructed garments?

B. Manual printing B. Garment printing machine C. Rotary screen D. Hand printing

_____ 3. Which one of the following is example of oxidizing and Reducing Agents?

E. Hydrogen B. hydrochloric acid C. Caustic soda D. Salt

Part II Give short answer for the following questions

1. What are printing past ingredients?
2. What are the function of binder in the printing paste?

Operation Sheet 3.1

Operation Title	**Checking and loading printing paste and screen**
Purpose	To demonstrate loading printing paste and screen to meet production requirement.
Equipment tools and materials	Scissors, load shifting device, PPE, trial fabric, readymade screen and prepared paste.
Conditions or situations for the operation	The operation process can be performed by following the procedure and steps illustrated on the information sheet.
Procedures	Review unit two information Receive prepared screen Load prepared screen on the printing machine Adjust the trial fabric Receive prepared paste and check Load/connect the past tank with printing machine Check loaded paste and screen Ready for perform printing operation
Precautions	Follow the correct procedure/steps in listed above. Perform the given operation based on the operational requirement
Quality criteria	The operation can be performed by following occupational health and safety rule. Use of proper OHS materials • Safe operation of machines and correcting operational faults • Use of technical specifications manuals • Performing quality standards and practices • Applying OHS practices, including hazard control measures

- Recording and reporting production data

LAP test 3.1	Practical Demonstration

Name: _____ Date: _____

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within 2 hours.

Task 1. Checking prepared printing paste

Task 2. Checking prepared printing screen

Task 3. Loading the printing paste in the screen

Unit Four: Operate and monitor printing machine

This unit is developed to provide you the necessary information regarding the following content coverage and topics:

- Operation of printing machine
- Major and minor faults

This unit will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Operate printing machine
- Monitor printing operations
- Identify, correct and report major and minor faults

4.1. Operation of printing machine

Introduction

After the necessary things of printing (fabric, design, paste and other tools are prepared operating according to manufacturer's specification, operating is followed and after the process has been carried stopping is followed.

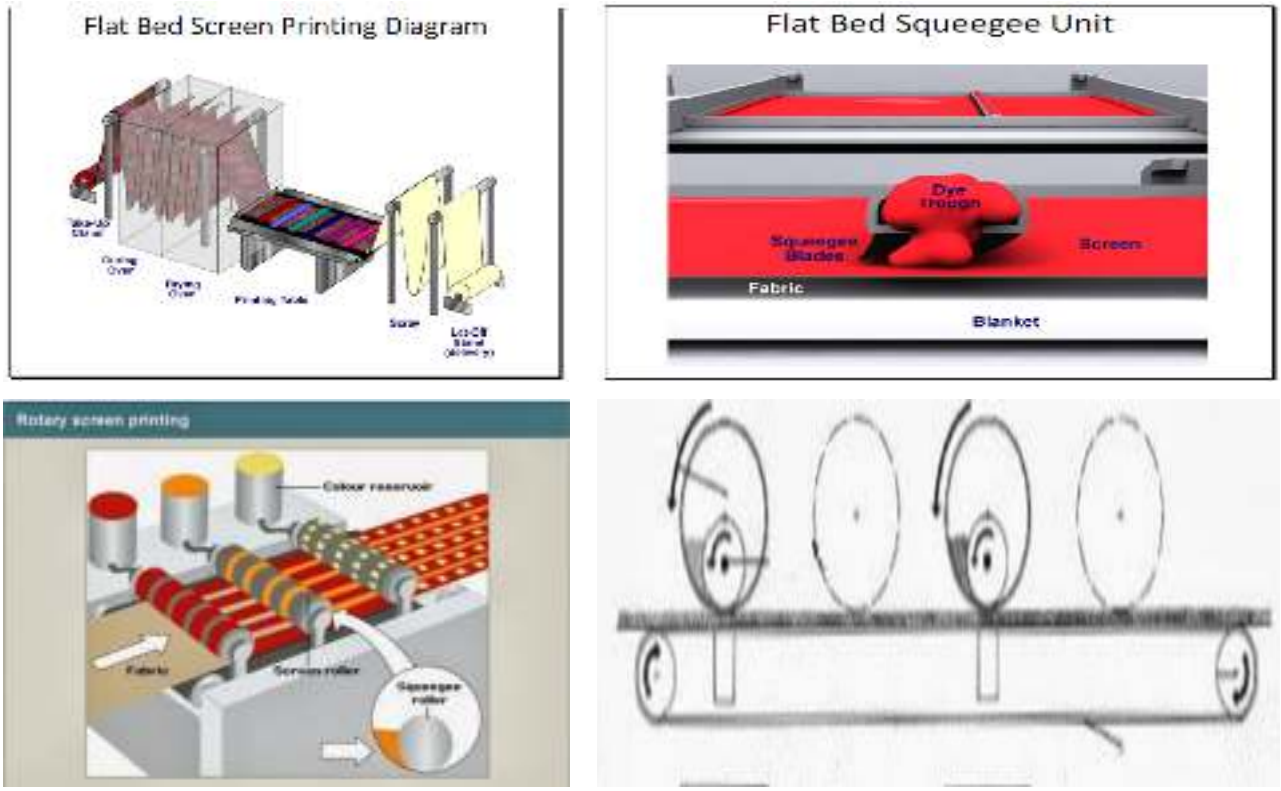

Fig 4.1. Printing machineries

- **Rotary Screen Printing**

In basic operation, rotary screen and flat screen-printing machines are very similar. Both use the same type of in-feed device, glue trough, rotating blanket (print table), dryer, and fixation equipment. The process involves initially feeding fabric onto the rubber blanket. As the fabric travels under the rotary screens, the screens turn with the fabric. Print paste is continuously fed to the interior of the screen through a color bar or pipe. As the screen rotates, the squeegee device pushes print paste through the design areas of the screen onto the fabric. As

in flat-bed screen printing, only one color can be printed by each screen. After print application, the process is the same as flat screen printing.

Digital printing machine operational procedures

The digital printing process involves printing on different media like paper, fabric, acrylic, plastic, etc., directly from a digital image. It is professionally done print work and small jobs from desktop publishing and other digital sources which are printed via inkjet printers of large format or high volume. It can also be done on demand and in a short time; images can be easily altered for each impression as well.

Step 1: Some digital printing companies have their own artists who create custom designs based on your requirements and instructions.

Step 2: When the final design is approved, the artwork is saved in the appropriate format with the correct resolution as mentioned earlier, to make it easy for the printer to recognize and print the product without error.

Step 3: First, the print heads are cleaned with a special fluid so that they don't become dry and suffer damage. This step is repeated after every 100 prints; sometimes the heads need to be cleaned even before 100 prints are completed, depending on the amount of color in the print.

Step 4: In this phase a series of checks are conducted. With every printing, some waste ink is produced by the printer, and it is collected in a drum.

Step 5: The stage is set for printing the customer's artwork on the product they desire once all the checks have been conducted successfully.

Step 6: There are different sized pallets to hold the product. Depending on what is being printed on, the appropriate sized pallet is attached to the machine, and the product is laid out on it, ready for printing.

Step 7: The material or product to be printed is laid absolutely flat on the board without any creases. If there are any creases, the print will be distorted.

Step 8: The digital printer begins the actual printing by moving the print heads from side to side, on the material, spraying the design on to it.

Step 9: The material or product is removed from the pallet with great care once the printing is complete. It is then conveyed through a huge dryer at the appropriate temperature, to ensure that the print is baked onto the item, or adheres securely.

Step 10: The last step is the quality check. Once we are satisfied about the quality, the products are packaged and readied to be dispatched.

4.2. Major and minor faults

Defects that occur in the fabric during the operation of printing are called printing defects. Printing defects may occur due to many reasons such as the following:

- The printing procedure did not take place properly
- The fabric was not prepared properly before printing
- The fabric had defects prior to printing

Some Issues that are faced by Printing Department:

- Excess prepared print paste goes waste.
- Stored print paste becomes hard and may not be made fluid again.
- A big area is required for storing the complete print paste carboys for the entire day's printing.
- Human error in handling the print paste.
- Inconsistency in print paste preparation.

These color preparation challenges can be easily overcome by installing an appropriate Automatic Print Paste Dispensing System in a dye house in printing department.

a) Mismatch of designs

Improper tension of screens, worn out thermoplastic coating, deviations in blanket guide controlling system, loose end rings, and pressure roll not working, insufficient quantity of color in the screen, defective working of printing head, magnetic clamps and inadequate temperature are the normal reasons for misfit of the design.

b) Migration of the paste/ Bleeding

Bleeding: Bleeding defect occurs in the fabric when the color on design on the fabric runs out as a result of which the design outlines becomes unclear. The causes for this type of defect can be as follows -

- The print paste has low viscosity
- The concentration of the dyestuff in the print paste is too high

c) Blocking of design on the screen

The design blocking on the screen defect occurs in the screen due to different surface extremal materials or pigment paste that adhere materials to the screen during the screen preparation and printing process.

d) Contamination: Contamination is the presence of a constituent, impurity, or some other undesirable element that spoils. Corrupts, infects, make unit, or makes inferior a material, physical body, natural environment, workplace. Occur by the contaminated paste, chemicals and auxiliary.

e) Creasing/Scrimps: A break or line in a fabric generally caused by a sharp fold. Creases may be either desirable or undesirable, depending upon the situation. A crease may be intentionally pressed into a fabric by application of pressure and heat and sometimes moisture. Creasing defect is when due to a crease in the fabric, uneven printing occurs.

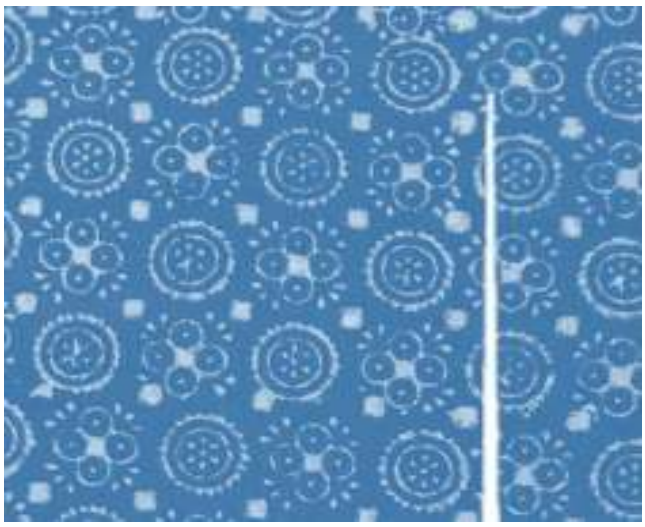

Fig 4.2. Creasing defect

Self-Check-4.1	Written Test

Directions: Give short answer for the following questions

1. What are Printing Defects?
2. List the printing machines?
3. Write down types of screen printing machines?
4. Select two printing machines and write the difference among them?

Operation Sheet 4.1

Operation title	Operating rotor screen printing machine
Purpose	To demonstrate operating printing machine
Equipment tools and materials	Bleached fabric, lab scale rotary screen printing machine, adjustable wrench, production recording sheet, pencils and PPE.
Conditions or situations for the operation	The operation process can be performed by following the procedure and steps illustrated on the information sheet.
Procedures	Check machine set-up, loaded paste and screen Load and stich main printing fabric Run/start the printing machine Monitor machine operation Stop machine when finished the operation Record the product information Dispatch product to next process
Precautions	Follow the correct procedure/steps in listed above. Perform the given operation based on the operational requirement
Quality criteria	The operation can be performed by following occupational health and safety rule. Use of proper OHS materials • Safe operation of machines and correcting operational faults • Use of technical specifications manuals • Performing quality standards and practices • Applying OHS practices, including hazard control measures • Recording and reporting production data

LAP test 4.1	Practical Demonstration

Name: _____ Date: _____

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within 4 hours.

Task 1. Checking machine setting and loaded paste and screen

Task 2. Operating rotary screen printing machine

Task 3. Monitoring machine operation

Unit Five: Complete printing operations

This unit is developed to provide you the necessary information regarding the following content coverage and topics:

- Unloading and dispatching printed product
- Production records

This unit will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Unload and dispatch printed product
- Complete production records

5.1. Unloading and dispatching printed product

Unloading means removed the printed product which may be fabric or garment from the printing machine by using load shifting equipment or manually after the process has been done. While unloading we assure that the using of OHS and following of machine manufacturer‘s procedure**.**

Product dispatching is activity that is performed after the product is doffed and checked to confirm the required standard. So product dispatching is simply distributing the prepared product to the next line process or customers for use.

Dispatching is the routine of setting productive activities in motion through the release of orders and necessary instructions according to pre-planned times and sequence of operations embodied in route sheets and loading schedules. In other words, once a job is in an area where an operation is to be performed, it has to be determined when and by whom the job will be processed and also the sequence of waiting orders to be processed. The decision of assigning the various jobs to different machines and equipment is called Dispatching

5.1.1. Functions of Dispatching

- To check the availability of input materials and ensure the movement of material from store to first process and then from process to process.
- To ensure the availability of all production and inspection aids.
- To obtain the requisite drawings, specifications and material lists.
- To assign the work appropriate machine, workplace and men.
- The issue of job orders authorizing operations in accordance with dates and times previously planned and entered on load charts and route sheets.
- The issue of time tickets, instruction cards and other required items to the workers who are to perform the various activities.
- The issue of inspection orders after each operation in order to determine result regarding the quality of products if excessive spoilage occurs, to find out its causes.

- Clean up on jobs, collection of time tickets, blueprints and instruction cards and their return to appropriate section of production control depth.
- To ensure that the work is forwarded to next depth. Or storeroom etc.
- To record the beginning and completion times of jobs on time tickets for calculation of time interval. To forward time ticket to accounts depth for preparing wages.
- To record and report idle time of men and machines and request for corrective action required.

The companies provide suitable transportation vehicles like trucks to ensure the safety and timely delivery of the goods. They are the experts as they know how to place the goods in the transportation vehicle so that goods don't get damaged while the vehicle is moving. The service should be highly systematic, organized and reliable without causing any anxiety to the customers.

- The functional separation concept should continue during transportation of clean textiles to the customer.
- Transport clean and soiled output in containers that functionally separate them from other output in the vehicle.
- Consider cleaning and packaging. Reusable bags, containers, or carts used to transport the product must be properly cleaned before they are used to transport clean or soiled linen in order to maintain functional separation.
- Hand sanitizer dispenser should be available for use in all delivery trucks.
- Spill Kits should also be available for use when necessary.

5.2. Production records

Record means that compile a data or datum of something; either production, quality, raw material, absenteeism, faults or other. And it can be recorded indifferent ways. Let see the following hourly production record interims of table.

- Record the quality of product
- Record the amount products
- Record specification of product against to standards
- Record the limitation of products
- Record the strength and weakness of products
- Confirm the products against to all quality parameters

Table 5.1 Daily production record and report format

List of machines	Working hours								Total product
	1ST Hr.	2nd Hr.	3rd Hr.	4thH Hr.	5th Hr.	6th Hr.	7th Hr.	8th Hr.	
M/C 1									
M/C 2									
M/C 3									
M/C 4									
M/C 5									

Self-Check-5.1	Written Test

Directions: Give short answer for the following questions

1. What is production record means?
2. Create a table which helps to record weekly production of seven printing machines?
3. Explain, what dispatching means?
4. How does dispatching will be carried out?
5. What is unloading means?

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