የሥራ እና ክህሎት ሚኒስቴር
MINISTRY OF LABOR AND SKILLS

Textile Processing Technology

Level-II

Based on March 2022, Curriculum Version 1

Module Title: - Perform dyeing operations

Module code: IND TPT2 M04 0222

Nominal duration: 80hr

Prepared by: Ministry of Labor and Skill

August, 2022

Addis Ababa, Ethiopia

Contents

List of Figures

List of Tables

Acknowledgment

Ministry of Labor and Skills wish to extend thanks and appreciation to the many representatives of TVET instructors and respective industry experts who donated their time and expertise to the development of this Teaching, Training and Learning Materials (TTLM).

Acronym

1. **MLR:** Molar liquor Ratio
2. **SOP:** Standard operating procedures
3. **WHS:** Complying with work health and safety
4. **PPE:** Using personal protective equipment
5. **LAP:** Learning Activity and Performance
6. **PPE:** Personal protective Equipment
7. **UV** Ray: Ultra-Violet Ray
8. **DF:** Dilution Factor

Introduction to the Module

In textile processing technology filed; the dyeing process helps to know how the dye interact with textile materials and what parameters are used in dying process; how to adjust different dyeing machines according to dyeing parameters; how to operate and monitor dyeing machine according to job requirements; how to complete dyeing operation and check dyeing quality.

This module is designed to meet the industry requirement under the Textile Processing Technology occupational standard, particularly for the unit of competency: **Performing dyeing operations.**

This module covers the units:

- Job requirements
- Dyeing processes
- Dyeing machine adjustment
- Dyeing machine operation and monitoring
- Dyeing operations completion
- Dye outcomes

Learning Objective of the Module

- Determine job requirements
- Understand Dyeing processes
- Set up and load machine
- Operate and monitor dyeing machine
- Complete dyeing operations
- Check dye outcomes

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 (sops)
- Complying with work health and safety (WHS)
- Using personal protective equipment (PPE)
- 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:

- Follow standard operating procedures (SOPs)
- Comply with work health and safety (WHS) requirements at all times
- Use appropriate personal protective equipment (PPE) in accordance with SOPs
- Identify job requirements from specifications, drawings, job sheets or work instructions

1.1Standard operating procedures (SOPs)

Standard operating procedures are written, step by step instructions that describe how to perform a routine activity. Employees should complete them in the exact same way every time so that the business can remain consistent. Standard operating procedures help maintain safety and efficiency for departments such as:

- Production /operations
- Sales and customer service
- Employee training
- Legal
- Financial

A standing operating procedure should never be difficult to read or vaguely worded.

It should be brief, easy to understand and contain actions steps that are simple follow A good standard operating procedures should clearly outline the steps and inform the employee of any safety concerns.

The standard operating procedures should be the bases for training any new employees. They should also be updated every year to ensure they stay relevant to the current needs of the organization.

1.2 Complying with work health and safety (WHS)

Compliance with work health and safety is the state of being in accordance with established guidelines of work health and safety or specifications, or the process of becoming so. The definition of compliance can also encompass efforts to ensure that organizations are abiding by both industry regulations and government legislation.

Compliance is a prevalent business concern, partly because of an ever-increasing number of regulations that require companies to be vigilant about maintaining a full understanding of their regulatory requirements for compliance.

To adhere to compliance standards, an organization must follow requirements or regulations imposed by either itself or government legislation.

Complying with work health and safety (WHS) include three elements. These are:

Hazard identification and control, risk assessment and implementation of risk reduction measures

1.2.1 Hazard identification and control

Concepts of hazards:

Hazard: Anything (e.g. condition, situation, practice, behavior) that has the potential to cause harm.

Hazard Identification:

This is the process of examining each work area and work task for the purpose of identifying all the hazards which are "inherent in the job".

Types of Hazards in a Workplace:

Commonly they are of five types. These are ergonomic hazards, physical hazards, biological hazards, chemical hazards and psycho- social hazards.

Ergonomic hazards:

Ergonomic hazards are problems that can occur when a worker's physical workplace do not match up with his physical size or work positions. These types of hazards may occur in both office and industrial settings. Example: poor seating in computer class and weaving class.

Physical hazards:

These are workplace hazards that can affect the body. They may include radiation and excessive noise levels, falls.

Chemical hazards:

This may result if an employee inhales or absorbs harmful chemicals through his mouth, nose or via skin contact. Chemical hazards can come in several forms, such as liquids, vapors, gases or solids.

Biological work hazards:

It may occur if workers are exposed to living organisms, such as parasites, viruses, fungi and bacteria. These types of work hazards may also come from toxins.

Psycho-social hazards:

This can arise out of the many different ways that people interact with each other. This type of hazard may show up as negative work place conditions like bullying, violence or sexual harassment. This is due to stress outside or inside the work place, the type of work being done or the attitudes and behaviors that different people bring to their jobs.

Hazard control measure:

All workplace hazards (chemical, physical, etc.) can be controlled by a variety of methods. Some methods of hazard control are more efficient than others, but a combination of methods usually provides a safer workplace than relying on only one method. Some methods of control are cheaper than others but may not provide the most effective way to reduce exposures.

Generally, there are five major categories of control measures: these are:

a) Elimination,
b) Substitution,
c) Engineering controls,
d) Administrative controls and
e) Personal protective equipment.

a) Elimination

Elimination of a specific hazard or hazardous work process, or preventing it from entering the workplace, is the most effective method of control. "Eliminate hazards at the "development stage".

It is important to consider worker health and safety when work processes are still in the planning stages. For example, when purchasing machines, safety should be the first concern, not cost. Machines should conform to national safety standards; they should be designed with the correct guard on them to eliminate the danger of a worker getting caught in the machine while using it.

Machines that are not produced with the proper guards on them may cost less to purchase, but cost more in terms of accidents, loss of production, compensation, etc. Unfortunately, many used machines that do not meet safety standards are exported to developing countries, causing workers to pay the price with accidents, hearing loss from noise, etc.

b) Substitution

If a dangerous chemical or work process cannot be eliminated, then try to replace it with a safer substitute. Not all substitute materials are really "safer" - they may be better than the original hazard but can still be dangerous. When you look for safer substitutes, try to choose a less volatile (volatile liquids vaporize, or evaporate easily) instead of a highly volatile one, choose a solid instead of a liquid, etc.

Protective measures are important when working with all chemicals, even if you are using a "safer" substitute.

There are a number of sources for information on substitute materials such as your employer, the chemical manufacturer, the local factory/labor inspectorate, local colleges or universities, the local fire department, your local library, International Trade Secretariats and the International Labor Office

c) Engineering controls

There are a number of common control measures which are called "engineering controls". These include enclosure, isolation and ventilation. If a hazardous substance or work process cannot be eliminated or substituted, then fully enclosing it so workers do not come into contact with it is the next best method of control.

Isolation can be an effective method of control if a hazardous job can be moved to a part of the workplace where fewer people will be exposed, or if the job can be performed at a time when fewer people will be exposed. Alternatively, the worker can be isolated from a hazardous job. Isolating a work process or a worker does not eliminate the hazard; therefore elimination is always a better choice than isolation.

General ventilation can be used for keeping the workplace comfortable, and local exhaust ventilation for removing air pollutants. General ventilation is one of the least effective methods of controlling hazards. Ventilation systems must be checked and serviced regularly. Sprinkle some dust or hold a piece of cloth near the exhaust outlet to see if the air movement in your workplace is adequate.

d) Administrative controls

Administrative controls limiting the amount of time workers spend at a hazardous job. It can be used together with other methods of control to reduce exposure to hazards. An example of administrative controls being used together with engineering controls and personal protective equipment is: a four-hour limit for work in a fully enclosed, high noise area where ear protectors are required. Some examples of administrative controls include:

- Changing work schedules (for example, two people may be able to work for four hours each at a job instead of one person working for eight hours at that job);
- Giving workers longer rest periods or shorter work shifts to reduce exposure time;
- Moving a hazardous work process to an area where fewer people will be exposed;
- Changing a work process to a shift when fewer people are working.

Remember: administrative controls only reduce the amount of time you are exposed to a hazard - they do not eliminate exposures.

e) Personal protective equipment

PPE is the least effective method for controlling hazards in the workplace and should be used only when hazards cannot be controlled sufficiently by other methods. PPE can be uncomfortable, decrease work performance, and can create new health and safety hazards. Workers in PPE should take regular breaks. Hot or humid working conditions decrease the effectiveness of PPE. Under these conditions, workers should take frequent breaks and drink plenty of fluids. The type of PPE required depends on the hazard, the way exposure affects the body and the exposure time. Examples of PPE include:

- Safety glasses
- Ear protectors
- Respirators with filters
- Dust masks
- Gloves
- Protective suits
- Safety shoes

If PPE does not fit you well it may not protect you; this is particularly important with respirators. All PPE should be checked for leaks. All workers using PPE should be trained in the proper use, maintenance and limitations of PPE.

Before thinking about what control measures are needed, first you need to know whether there are health and safety problems in your workplace.

Methods of identifying health and safety problems in workplace:

- Observe your workplace;
- Investigate complaints from workers;
- Examine accident and near-miss records;
- Examine sickness figures;
- Use simple surveys to ask your co-workers about their health and safety concerns;
- Use check-lists to help you inspect your workplace;
- Learn the results of inspections that are done by the employer, the union or anyone else;
- Read reports or other information about your workplace

1.2.2 Risk assessment

Risk Assessment is defined as the process of assessing the risks associated with each of the hazards identified so the nature of the risk can be understood. This includes the nature of the harm that may result from the hazard, the severity of that harm and the likelihood of this occurring.

Risk Assessment Procedure

The risk assessment procedure can best be illustrated in the following way.

Step-1: identify hazards

Step-2: Assess Risks

Step-3: Control Risks

Step-4: Review created measures

Step 1: Identify Hazards

In order to identify hazards the following are recommended:

a. Past incidents/accidents are examined to see what happened and whether it could occur again.
b. Employees be consulted to find out what they consider are safety issues.
c. Work areas are inspected to find out what is happening now. Identified hazards should be documented to allow further action.

d. Information about equipment (e.g. plant, operating instructions) and Material Safety Data Sheets are reviewed to determine relevant safety precautions.
e. Welcome creative thinking about what could go wrong takes place, i.e. what hazardous event could take place here?

Step 2: Assess Risks

It involves considering the possible results of someone being exposed to a hazard and the likelihood of this occurring. It determines how severe a risk is and existing control measures are effective.

Step 3: Controlling Risks

Once a risk rating is determined, each hazard has its risk control measures evaluated using the Evaluation of Control Effectiveness Table. This allows for determination of any additional requirement necessary.

Table 1.1: *Evaluation of control Effectiveness*

Well Designed Control ?		Effectively Implemented ?	
3	Needs improvement	3	Deficient *(b)*
2	Adequate	2	Marginal
1	Strong	1	Effective

Step 4: Review created measures

The Hierarchy of Controls (see diagram below) ranks control options from highest level of protection and reliability to lowest. This should be used to determine the most effective control/s.

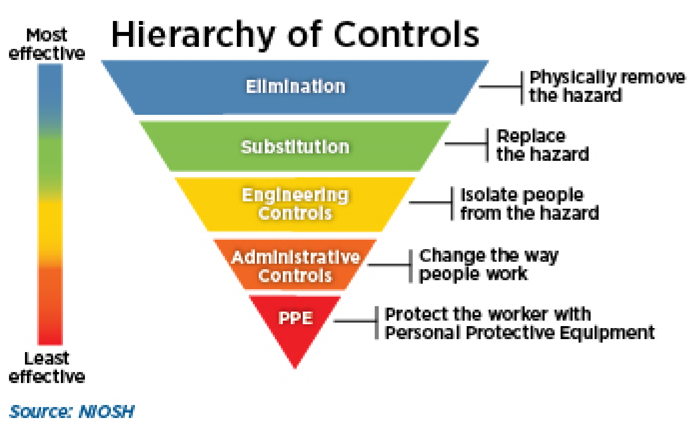


Figure-1.1: *Hierarchy of Controls*

The effectiveness of control measures can be checked through regular reviews as well as consultation with workers.

1.2.3 Implementation of risk reduction measures

Specifically to this competence Risk reduction measures implementation may include. Manual handling techniques, Standard operating procedures, Personal protective equipment , Safe materials handling, Taking rest breaks, Ergonomic workplaces arrangement , Following marked walkways, Safe equipment storage, Housekeeping, Reporting accidents and incidents and Environmental practices. These are explained as follow.

1.3 Using Personal protection equipments (PPE)

Personal protective equipment (PPE) is a tool that you use to guarantee your own safety. Personal Protective Equipment includes: fire retardant or chemical-proof clothing for over all body, gloves for hands, hard hats or helmets for head, breathing musk for respirators, safety spectacles for eyes, goggles or face shields for faces and boots for foot.

Eye and face protection equipment's are used to protect against flying particles and foreign bodies, corrosive chemicals, fumes, lasers and radiation. The two basic problems in wearing eye and face protectors are:

a) How to provide effective protection which is acceptable for wearing over long hours of work without undue discomfort and
b) The unpopularity of eye and face protection due to restriction of vision. The wearer's peripheral vision is limited by the side frames.

There are different types of eye and face protection equipment. At any workplaces, safety clothes required for specific work must be given to workers and must be supervised by their respective work manager whether they wear or not.

1.4 Identifying job requirements

A job is defined as anything a person is expected or obliged to do, duty and responsibility he /she has or the process or requirements, details, etc., of working or
the execution/completing or performance of a task.

Job requirements may include the following:

- Job Specifications,
- Drawings,
- Job sheets or
- Work instructions

A job specification: is the list of recommended qualities for a person to qualify for and succeed in a position. While the job description includes the title position, responsibilities and summary, the specification identifies the skills, traits, education and experience a candidate might need to qualify for that job.

Drawings: are sketches that are used by designers such as architects, engineers and interior designers as a quick and simple way of exploring initial ideas for designs.

A job sheet: is a document that outlines all the relevant information about a job, task, or project. Technicians use the information on the sheet to start a job and add more information as the job's requirements change along the way.

Work Instructions: are documents that clearly and precisely describe the correct way to perform certain tasks that may cause inconvenience or damage if not done in the established manner.

The requirements for a job vary according to the nature of the job itself. However, a certain work ethic must be cultivated to succeed in any job and this is fundamental to an individual's sense of himself as a worker, as part of production relations and a fundamental economic being.

The basic requirements for a job remain the same no matter what the job is, where it is located or what professional and educational qualifications are required for it.

These are listed as follows:

- ❖ Discipline
- ❖ Enthusiasm/interest
- ❖ Soft Skills

Qualifications and each of them are discussed as below.

Discipline:

Nothing is possible without discipline. Any job requires a fundamental core of discipline from the worker or the employee and this is a quality which is independent of age, stature/size, job and so on. Discipline is absolutely indispensable and provides the impetus/energy for work that can be repetitive, boring and even unsatisfactory at times.

Enthusiasm:

Enthusiasm/ interest for work are also a pre-requisite for any job. An innate love for the job, which in modern parlance/ phrasing is known as job satisfaction, is a core requirement for any job. The drive to succeed, to innovate, to do well and to make one's profession into one's livelihood is a critical drive which needs to be present in the employee or cultivated as soon as possible. Any job is difficult to perfectly carry out without interest.

Qualifications:

This is a more material, tactile need for a job which can be conveyed through degrees and certificates. However education is not limited to what is taught in colleges or vocational training courses.

It is the burning desire to learn more to reach the depths of knowledge about a particular field of interest; to complete the job and learn from it that marks the true enthusiast and the truly learned.

Soft Skills:

Soft skills include those skills which ensure that a job is executed well and the employee can carry himself in the proper manner too. For example: good and smooth communication, computer skills, proficiency in language if needed, presentable appearance, the ability to manage crises are all soft skills which are fundamentally important in any job and which must be cultivated consciously.

Thus, the requirements of a job, though specific to it, cover also a general spectrum. These make for better employees and better individuals.

Self-Check – 1

Test-I Multiple choices

Instruction: select the correct answer for the give choice. You have given 1 Minute for each question. Each question carries 2 Point.

1. Which pillar is included in work health and safety?
   A. Hazard identification and control,
   B. risk assessment
   C. implementation of risk reduction measures
   D. All
2. Which one is not a type of workplace hazard?
   A. Ergonomic
   B. Chemical
   C. Biological
   D. Comfort
3. Which hazard control measure is most effective?
   A. Elimination
   B. Substitution,
   C. Engineering controls,
   D. Personal protective equipment.
4. Which is the source of job requirements?
   A. Job Specifications,
   B. Drawings,
   C. Job sheets or
   D. Work instructions
   E. All

Test II: short Answer writing

Instruction: write short answer for the given question. You are provided 10 minute for each question and each point has 5Points.

1. What are the two basic problems in wearing eye and face protectors in observing personal protection.
2. List down the basic requirements of job.
3. List and describe types of Workplace Hazards.
4. List and describe the five major categories of hazard control measures.

Note: Satisfactory rating – above 15% Unsatisfactory - below 15%

You can ask you teacher for the copy of the correct answers

Unit Two: Dyeing processes

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

- Understanding dyeing processes and its significance
- Understanding dyeing technologies and its significance
- Understanding interaction of dyes, Chemical s & auxiliaries with each other and textile
- Identifying dyes, chemicals & auxiliaries properties & functions
- Selecting dyes, chemicals & auxiliaries
- Preparing dyes & chemical recipe formulation and process parameters setting

This guide 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 dyeing processes, technologies and its significance.
- Understand interaction of Dyes, Chemical s & auxiliaries with each other & textiles
- Identify properties & functions of dyes, Chemicals & auxiliaries used
- Select dyes, Chemicals & auxiliaries used in dyeing by getting support from his supervisor.
- Prepare dyes & Chemical recipe formulation and setting of process parameters by getting support from his supervisor

2.1Understanding dyeing processes and its significance

A dyeing process is the interaction between a dye and a fiber or uniform coloration of textile materials (i.e. fiber, yarn or fabric); as well as the movement of dye into the internal part of the fiber. Generally, a dyeing process involves adsorption (transfer of dyes from the aqueous solution onto the fiber surface) and diffusion (dyes diffused into the fiber).

In addition to direct absorption, dyeing may also involve the precipitation of dyes inside the fiber (vat dyes), or chemical reaction with the fiber (reactive dyes). From the view of coloration, printing can be considered as partial dyeing with different colors on fabric to form an attractive pattern.

Stages of dyeing process:

The dyeing process of textile substrates comprises four stages (Choudhury, 2006):

a) Transport of the dye molecules from solution to the substrate surface (i.e. Exhaustion).
b) Dye adsorption on the substrate surface.
c) Diffusion or penetration of the dye from the substrate surface to the interior of the fiber through its amorphous regions.
d) Fixation of the dye onto and/or within the substrate via covalent bonds, hydrogen bonds, ion-exchange or van der Waals forces, or through insolubilisation of the pre-dissolved dye inside the fiber.

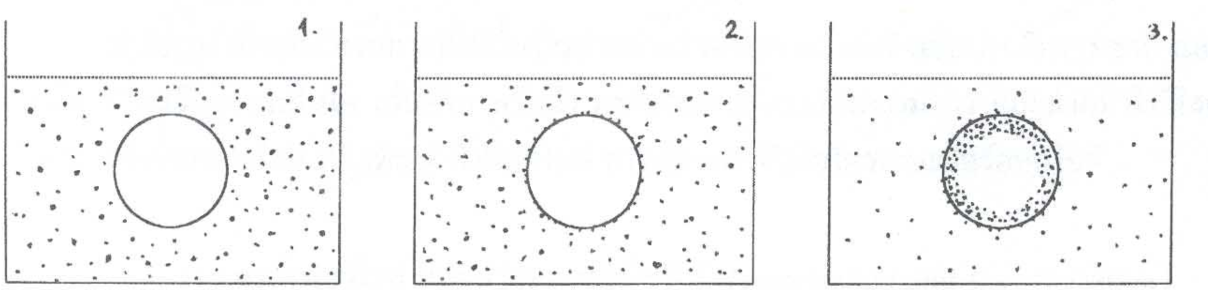


Figure-2.1: *Dyeing process*

Key explanation of the above figure:

Fig-1: Moving of dyestuff from dyebath to surface of the fiber

Fig-2: Adsorption of the dyestuff into the surface of the fiber

Fig-3: Diffusion of the dyestuff into the center of the fiber

Dyeing can be carried out in batch or in continuous/semi – continuous mode. The choice between the two processes depends on the type of makeup, the chosen class of dye, the equipment available and the cost involved. Both continuous and discontinuous dyeing involves the following steps.

- Preparation of the dye
- Dyeing
- Fixation
- Washing and drying

Significance of dyeing process:

Dyeing and printing is known to be an ancient technique of enhancing the look of a fabric. As dyeing and printing is considered a beautiful art of surface ornamentation, it is predominantly taught in most fashion designing institutes.

Factors affecting rate of dyeing:

- Degree of agitation of the bath
- Liquor ratio
- Type and construction of the fabric
- Dye bath temperature and pH
- Concentration of dye and dyeing assistants
- Dye substantively

Dyeing stages:

Dye can be applied on fiber stage, sliver stage, yarn stage, fabric stage and garments

- Fiber stage (fiber dyeing)
- Sliver stage (sliver dyeing)
- Yarn stage (yarn dyeing/ package dyeing)
- Fabric stage (fabric dyeing)
- Garment stage (garment dyeing)

Dyeing Terminologies:

a) ***Dyestuff:*** It is an organic or inorganic substance which can absorb light & reflect some lights to show color and which are water soluble
b) ***Pigment:*** It is a substance that can absorb light & reflect some lights to show color but it is water insoluble substances normally it is used for printing(with presence of binder)
c) ***Exhaustion:*** It is the movement of dye molecule from dye bath to surface of the fabric
d) ***Fixation****:* It is the ability of adhere of dye inside the fiber
e) ***Fastness:*** It is the resistance to fading due to washing, light, rubbing and etc.
f) ***Substantively:*** It is the attraction between dye and fiber under given dye concentration
g) ***Affinity:*** It is the ability of dye to move from solution phase to fiber phase
h) ***Diffusion:*** It is the penetration ability of dye through the pores of fiber
i) ***Adsorption****:* It is the transfer of dye from aqueous solution to the fiber surface
j) ***Absorption:*** It is both adsorption and penetration ability of dyes.

2.2 Understanding dyeing technologies and its significance

a) Bale Dyeing technology:

This is a low cost method to dye cotton cloth. The material is sent without scouring or singeing, through a cold water bath where the sized warp has affinity for the dye. Imitation chambray and comparable fabrics are often dyed this way.

b) Batik Dyeing technology:

This is one of the oldest forms known to man. It originated in Java. Portions of the fabric are coated with wax so that only un-waxed areas will take on the dye matter. The operation may be repeated several times and several colors may used for the fantastic effects.

c) Beam Dyeing technology:

In this method the warp is dyed prior to weaving. It is wound onto a perforated beam and the dye is forced through the perforations thereby saturating the yarn with color.

d) Burl or speck Dyeing technology :

This is done mostly on woolens or worsteds, colored specks and blemishes are covered by the use of special colored links which come in many colors and shades. It is a hand operation.

e) Chain Dyeing technology:

This is used when yarns and cloth are low in tensile strength. Several cuts or pieces of cloth are tacked end-to-end and run through in a continuous chain in the dye color. This method affords high production.

f) Cross Dyeing technology:

This is a very popular method in which varied color effects are obtained in the one dye bath for a cloth which contains fibers with varying affinities for the dye used. For example, a blue dyestuff might give nylon 6 a dark blue shade, nylon 6, 6 a light blue shade, and have no affinity for polyester area unmarked or white.

g) Jig Dyeing technology:

This is done in a jig, kier, vat, beck or vessel in an open formation of the goods. The fabric goes from one roller to another through a deep dye bath until the desired shade is achieved.

h) Piece Dyeing technology:

The dyeing of fabrics in the cut, bolt or piece form is called piece dyeing. It follows the weaving of the goods and provides a single color for the material, such as blue serge, a green organdy.

i) Random Dyeing technology:

Coloring only certain designated portions of the yarn. There are three ways of doing this type of coloring:

Skeins may be tightly dyed in two or more places and dyed at one side of the dye with one color and at the other side with another one. Color may be printed onto the skeins which are spread out on the blanket fabric of the printing machine.

Cones or packages of yarn on hollow spindles may be arranged to form channels through which the yarn, by means of air-operated punch, and the dyestuff are drawn through these holes by suction. The yarn in the immediate area of the punch absorbs the dye and the random effects are thereby attained.

j) Raw Stock Dyeing technology:

Dyeing of fiber stock precedes spinning of the yarn. Dyeing follows the degreasing of wool fibers and drying of the stock.

k) Solution Dyeing technology:

This is also called dope dyeing or spun dyeing; the pigment color is bonded-in in the solution and is picked up as the filaments are being formed in the liquor. Cellulosic and non-cellulosic fibers are dyed to perfection by this method. The colors are bright, clear, clean and fast.

l) Yarn dyed technology:

Yarn which has been dyed prior to the weaving of the goods; follows spinning of the yarn. It may be done in either partial immersion or total immersion of the yarn.

2.3 Understanding interaction of dyes, Chemical s & auxiliaries with each other and textile

The process of attachment of the dye molecule to the fiber is one of absorption: that is the dye molecules concentrate on the fiber surface. There are four kinds of forces by which dye molecules are bound to the fiber:

a) **Ionic forces:** this bond occurs when oppositely charged ions are attracted. Acid dyes contain a sulfonic or a carboxylic group, which forms a strong salt linkage to a basic group in the wool molecule. The strength of this bond is responsible for the wash fastness of good acid dyes.

b) **Hydrogen bonding:** Hydrogen bonding occurs when there is a strong electrical attraction between the dye and the fiber. Hydrogen bonding is possible with polar fibers.

c) **Vander Wals' forces:** Van der Waals forces are forces between molecules with closed shells. Consisting of several types of interaction, these forces are called Van der...

d) **Covalent chemical linkages:** Covalent or chemical bonding occurs in a chemical reaction between the fiber and the dye. This reaction occurs when the fiber is clean and the dye is in close contact with the surface. The chemical bond is the most heat resistant of all types of bonds. Dyes that form such bonds are long lasting and do not fade easily on exposure to sunlight and chemicals.

2.4 Identifying dyes, chemicals & auxiliaries properties & functions

Identifying dyes properties & functions:

Dyes are organic compounds with two components namely Chromophore, which imparts color and Auxochrome that help in substantivity of dyes. Dyes are classified into natural dyes and synthetic dyes.

a) Natural dyes:

Natural dyes are color substances obtained from natural sources. Natural dyes are used for all types of textile dyeing and printing until the middle of nineteenth century. The use of natural dyes were reduced due to the advent of synthetic dyes, though they were economical and posses excellent fastness properties. However, the growing consumer awareness on the harmful impact of synthetic dyes, concern for environment worldwide and stringent environmental laws lead to the revival of natural dyes.

Advantages of Natural Dyes

- Natural dyes are extracted from natural sources and hence they are eco-friendly
- Produces soft and soothing colors
- These dyes provide excellent protection from UV rays
- Natural dyes like turmeric have anti-microbial properties and hence protect the fabrics and wearers from microbial attack.
- Some natural dyes possess mosquito repellent and flame resistant property.
- They can be obtained from the natural sources which are abundant in a particular area. Hence supply of raw materials will be continuous and transport charges will be lower.

Disadvantages of Natural Dyes

- Natural dyes are difficult to store
- Dye extraction is a time consuming process
- Reproducibility of the same color shade is difficult
- Impurities in natural dyes fades away the color produced
- Availability of these dyes depends on the seasons
- Natural dyeing process is difficult to standardize

Classification of Natural Dyes

Natural dyes are classified in to three types based on the source of origin namely vegetable dyes, animal dyes and mineral dyes

b) **Synthetic dyes**

Dyes that are produced chemically are called as synthetic dyes. These are classified based on the chemical composition of the dye. This includes: Direct Dyes, Reactive Dyes, Basic Dyes, Acid Dyes, Mordant or Chrome Dyes, Disperse Dyes, Vat Dyes, Sulphur Dyes, Azoic Dyes or Napthol Dyes, Pigment Dyes, Optical Brightners and etc. description of some synthetic dyes are as below.

Direct Dyes:

Direct dyes are a relatively inexpensive and easy way of dyeing natural cellulose fibers like cotton and regenerated cellulose fibers like viscose and rayon. Although they do not have good fastness to washing or other wet processes. Hydrogen bonding and Van der Woals forces help bind the dye to the fiber. Fastness properties may be improved by after treatment-a post dyeing chemicals.

Reactive Dyes:

Reactive dyes from strong Covalent bonds with cellulosic fibers like cotton and regenerated cellulosic fiber like viscose, rayon. The formation of the covalent bond between dye and fiber means reactive dyes give extremely high wash and wet fastness properties.

Vat Dyes:

Vat dyes are used to dye cotton and viscose, rayon. Vat dyes are insoluble and so cannot penetrate the fibers in solution. They can however be reduced to a soluble form called the leuco form in the presence of alkali and a reducing agent. Vat dyeing is a multistage process. The leuco molecules are then oxidized to be insoluble once more and develop the color inside the fiber. Vat dyes have excellent wash fastness properties but the color range is more limited and more expensive. Sulphur dyes are similar to vat dyes but are cheaper, less environmentally friendly and are limited to flat dull colors.

Azoic Dyes:

Azoic dyes are applied to cotton and viscose, rayon. The textile is impregnated with a naphthal based, coupling compound and immersed in a dye bath containing a diazotised base triggering a precipitation reaction. The color is manufactured inside the fiber by the coupling of the two components. Since the dye molecules are large and insoluble, they have excellent wash fastness properties. Poor rub fastness can be a problem due to dye formation on the textile surface. Insufficient after washing will give poor fastness to wet treatments.

Acid Dyes:

Acid dyes have a direct affinity for protein fibers and are the main class of dyestuff for dyeing wool. Nylon also has an affinity for acid dyes. The attraction between dye and fiber is the result of negatively charged dye particles called anions associating with positively charged basic groups in the fiber generally under acid conditions.

Disperse Dyes:

Disperse dye are applied to Polyester. Polyester has a lightly packed molecular structure called a crystalline structure. It is hydrophobic or water heating. Heat opens up the crystalline structure to allow disperse dye molecules to enter the fiber from solution where they have been held in suspension. The dye is trapped in the fiber upon cooling and held by physical forces to produce good fastness properties. Disperse dyes may be applied at elevated temperatures from pressurized vessels or at the boil with the assistance of a chemical called a carrier.

Basic Dyes:

Acrylic fibers are dyed with the brilliant and intense modified basic dyes. Basic dyes are positively charged or cationic. These positively charged cations are attracted to negatively charged anions in the acrylic fiber. The reaction of the cation and anion form salt linkages and the fiber is colored with good wash and light fastness properties.

Composition of commercial dyes:

Commercial dyes are available as:

- Fine powders
- Granular
- Aqueous paste
- Liquid solutions or dispersions

Common criteria for dyeing are:

- Liquor ratio
- Consumption of water (cooling and washing water)
- Consumption of energy (heat energy)
- Consumption of dyes
- consumption of dyeing auxiliary (fixing and washing agents)

Factors involved in the selection of dyes

- Types of fibers present
- Form of the textile material and the degree of levelness required
- Fastness properties required
- Dyeing method to be used, the overall cost, and the machinery available
- Actual color requested by the customer

Dye classification:

Dye type	(Solubility/ Ionic character	Fiber affinity	Dye bath auxiliaries	Fastness properties	End-uses	Comment s
Direct	Water Soluble (anionic	Cellulosics (cotton, viscose)	Common Salt (Nacl)	Light Poor to good Washing poor	Low quality apparel fabrics/mattress covers which are not washed often	After treatment can improve fastness
Acid leveling	Water soluble (anionic	Protein fibers (wool, silk, Nylon	Acid + glaubers salt (Na2so4	Light good/mode rate Washing moderate	Carpet yarns, dress material, Suiting's, overcoats, knitting yarns	
Acid (Milling	Water soluble (anionic	Polyamide fibers (nylon), Wool Silk	Neutral/ weakly acidic dye bath + leveling agent	Light-good Washing good	Carpet yarns, dress material, Suiting, overcoats, knitting yarns	
Vat	Insoluble in water (nonionic in insoluble form), anionic on solubilizatin	Cellulosic (cotton, viscose	Alkali + reducing agent for solubilization	Light excellent Washing excellent	High quality curtains, furnishing, shirts, towels, sewing threads	Expensive. Bright colors often difficult to achieve

Reactive	Water soluble (anionic	Cellulosic (also protein and polyamide fibers)	Applied to cellulosic from a dye bath subsequently made alkaline	Light-good/ excellent Washingexcellent	Curtains, furnishings, apparel fabrics, toweling, sewing threads	Excellent shade range. High fastness due to covalent dye/fiber bond
Basic	Water soluble (cationic	Acrylics (occasionally protein fibers	Weakly acidic dye bath	Light good/moderate Washing good	Furnishings, apparel fabrics	Bright shades, excellent ti nctorial strength
Disperse	Insoluble in water (nonionic	All synthetics	dispersing agent, Organic acid for pH	Fastness property good on polyester, Moderate on nylon	Apparel fabrics, bed sheets, carpets	Best fastness on polyester, through this substrate is also the most difficult to dye. Good leveling properties

Dyeing chemicals & auxiliaries properties and function:

Dyeing auxiliaries play an important role in the determination of the final dyeing quality. The formation of additional complexes with dyes and auxiliary agents enhances the exhaustion of dyes on textile substrates. For aqueous-based dyeing, dye auxiliaries such as chelating agents, dispersing agents, leveling agents, electrolyte, pH control agents, detergents, wetting agents, dyeing Assistants, emulsifying agents, dyeing after treatment chemicals, lubricants and softeners and surfactants form complexes with the dye on natural and synthetic fibers.

2.5 Selecting dyes, chemicals & auxiliaries

a) Chemicals & auxiliaries used with Direct dyes:

A levelling agent such as sodium carbonate is added for even dyeing. At the end of dyeing, exhaustion agent such as salt (NaCl) is added which helps the dye to leave the liquor and get attached to the fibre.

b) Chemicals & auxiliaries used with Reactive dyes

NaCl or Glauber's salt for exhaustion of dye, sodium carbonate or sodium hydroxide for fixation of dye and washing off.

c) Chemicals & auxiliaries used with Basic Dyes

Mordant are used along with a basic dyes for fibers such as cotton, linen, acetate, nylon and polyester. For dye preparation, the dyestuff is mixed with equal amount of acetic acid followed by warm water under constant stirring.

d) Chemicals & auxiliaries used with Acid Dyes

Acids are required with soluble acid dyes. Examples of required acids are sulphuric, acetic, formic acid etc along with water soluble acid dyes.

e) Chemicals & auxiliaries used with Mordant or Chrome Dyes

Mordants are used along with natural dyes and some synthetic dyes to increase its affinity towards fibers and form a link between the dye molecule and the fiber.

f) Chemicals & auxiliaries used with Disperse Dyes

Adding dispersing agents along with increased temperature will increase its solubility. It is insoluble in water. They are suitable for dyeing hydrophobic fibers like nylon, polyester, acrylic and other synthetic fibers. Disperse dyes are non -ionic or neutral in nature. They have an excellent fastness to washing and sunlight exposure.

g) Chemicals & auxiliaries used with Vat Dyes

Reducing agent is used to convert dyes into leuco compounds, which is soluble in alkalis. The process of making the dyes soluble is known as Vatting. Initially they are insoluble in water but soluble in alkali. The leuco compounds are either colorless or exhibit a color that is different from the color of final product, which is achieved after oxidation. Once the dye is attached to the fiber, it gets oxidized and changed into an insoluble color product that gets trapped inside the fiber. Indigo is an example of vat dyes.

h) Chemicals & auxiliaries used with Sulphur Dyes

Reducing agents and alkali are used as solubiliser along with sulphur dyes. This reducing agent may include sodium sulphide or sodium hydrosulphite which can convert insoluble sulphur into leuco compounds. After dyeing the fabric, the dye is converted into insoluble form by the addition of potassium dichromate and acetic acid. Sulphur dyes do not produce brighter shades.

i) Chemicals & auxiliaries used with pigment Dyes

Pigments are not true dyes because they have no affinity for the fiber. They are applied and held to the fabric with the help of adhesives and resins.

2.6 Preparing dyes & chemical recipe formulation and process parameters setting

Different dyeing methods use different dyes, chemical recipe formulation and process parameters setting. These dyes may include: direct dye, reactive dye, acid dye, disperse dye and etc. Dyeing process parameters to be set according to dye used may include: temperature, PH, Time, Pressure, Speed and MLR. Chemical recipe formulation and process parameters setting for some dyes are explained as below.

a) Typical recipe for dyeing of cotton by direct dye:

- Direct dye --- X%
- Salt (NaCl) -- 5.0-20.0 g/L
- Soda ash (Na_2CO_3) ------------------------------ 1.0-5.0 g/L
- Wetting agent ------------------------------------ 1.0-2.0 g/L
- Sequestering agent ------------------------------- 1.0-2.0 g/L
- Leveling agent ------------------------------------ 0.5-1.0 g/L
- M. L. R. -- 1:5 – 1:10
- PH -- Neutral to slight alkaline
- Temperature --------------------------------------- 90-100^{0}C
- Time -- 50-60 min

b) Dyeing of cotton with vat dye typical recipe

- Vat dyes -- X g/L
- Wetting agent --------------------------------------- 0.5-1 g/L
- Sequestering agent -------------------------------- 1.0-2.0 g/L
- Dispersing agent ----------------------------------- Y g/L
- Caustic soda (66-70^{0}Tw) ------------------------- 15-30 g/L
- Hydroze -- 10-20 g/L

Recipe for Oxidation:

- Hydrogen peroxide -------------------------------- 0.2-1.0 g/L
- Temperature --------------------------------------- 25-60^{0}C

c) Typical recipe for dyeing of wool:

- Acid dye -- X%
- Wetting agent -- 0.5-1.0 g/L
- Leveling agent --------------------------------------- 1.0-3.0 g/L
- Glauber salt -- 10-20 g/L
- Acetic/sulphuric acid -------------------------------- 1-4 g/L
- Temperature -- 90-100^{0}C
- Time -- 30-50 minutes
- M:L --- 1:10

d) Typical dyeing recipe with DCT (cold brand) reactive dyes:

- Reactive dye (cold brand) owf ---------------------- 1.5 – 2%
- Wetting agent -- 1 g/L
- Sequestering agent ------------------------------------ 1 g/L
- Leveling agent -- 1 g/L
- Anti-creasing agent ---------------------------------- 1 g/L
- Common salt (NaCl) -------------------------------- 40 g/L
- Soda ash (Na_2CO_3) (pH-11.5) ---------------------- 12 g/L
- M:L ratio -- 1:20
- Time -- 1 hour
- Temperature -- 60^0C

e) Typical recipe for dyeing of polyester:

- Disperse dyes --- X%
- Dispersing agent ------------------------------------ 0.5-1.0 g/L
- Leveling agent -- 1.0-2.0 g/L
- Sequestering agent ---------------------------------- 1.0-2.0 g/L
- Acetic acid (50%) ------------------------------------ 0.5-2 g/L
- Carrier -- 2-5%
- Temperature --- 90-100^0C
- Time --- 50-120 minutes
- M:L -- 1:10

f) Typical recipe for dyeing jute fabric:

- Basic dyes -- X%
- Glacial acetic acid ---------------------------------- 1.0-3.0 g/L
- Glauber salt --- 10-20 g/L
- Wetting agent --------------------------------------- 0.5-1.0 g/L
- Sequestering agent --------------------------------- 1.0-2.0 g/L
- Temperature --- 80-90^0C
- Time --- 30-50 minutes
- M:L -- 1:10

a) Dyeing with Direct Dyes:

Chemicals: Direct dyes, sodium chloride, sodium phosphate, leveling agent, and copper-Sulphate, acetic acid (30%).

Substrate used: bleached cotton fabric.

Process parameters: Temperature: 100C^{o}, Time: 1:35hr, MLR: 1:30

Table-2.1: Direct Dye recipe

	MLR: 1:30
Chemicals used	Test 1
Direct dye (% o.w.f.)	1
Sodium carbonate (g)	1
Leveling agent (g)	0.5
Sodium chloride (g)	10
Water (L)	1

Chemical recipe calculation:

a. <u>Prepare the fabric sample weight.</u>

❖ 1gm = 30ml from MLR given

? =1000ml

$\frac{1000ml*1gm}{30ml}$ = **<u>33.33gm</u>** of cotton bleached fabric.

b. <u>Prepare Direct Dye.</u>

❖ Amount of direct dye = 1% 0f o.w.f

=1% (33.33gm) = **0.3333gm** of direct dye

c. <u>Prepare Na_2CO_3.</u>

Amount of $\mathbf{Na_2CO_3}$ required is: 1gm it is already given for 1liter of water in the table.

d. <u>Prepare Leveling agent.</u>

Amount of **leveling agent** required is: 0.5gm, it is already given for 1liter of water in the table.

a. Prepare NaCl.

Amount of **NaCl** required is: 10gm, it is already given for 1liter of water in the table.

Recipe used for after treatment:

Copper-Sulphate	0.5 g
Acetic acid (30%)	0.5g
MLR	1:30
Liquor Volume	1L

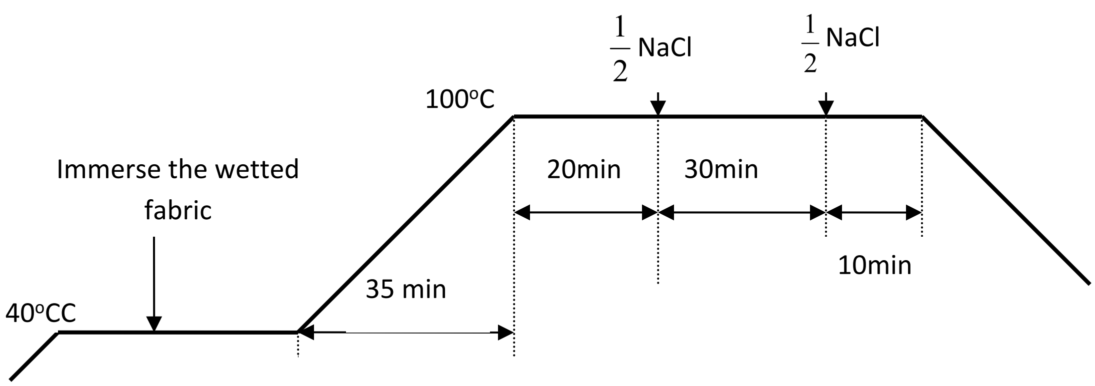


Figure- 2.2: *Direct dyeing cycle*

b) Dyeing with Reactive Dyes (Option-A)

In the case of option-A, amount of liquor needed is already given and weight of substrate will be determined finally. Detail calculation will be seen as below.

Chemicals: Reactive dyes, sodium chloride and sodium carbonate

Substrate used: bleached cotton fabric.

Process parameters: Temperature: 60C°, Time: 1:40hr, MLR: 1:5

Table-2.2: *Reactive Dyeing recipe*

	Dyeing Recipe
Chemicals used	Test 1
Reactive dye (% o.w.f.)	1
Sodium carbonate (g)	15
Sodium chloride (g)	20
Water (L)	1

Chemical recipe calculation:

a. <u>Prepare the fabric sample weight.</u>

- ❖ 1gm = 5ml from MLR given

  ? =1000ml

$\frac{1000ml*1gm}{5ml}$ = **200gm** of cotton bleached fabric.

b. <u>Prepare Reactive Dye.</u>

- ❖ Amount of reactive dye = 1% 0f o.w.f

  =1% (200gm) = **2gm** of reactive dye

c. Prepare Na_2CO_3.

Amount of $\mathbf{Na_2CO_3}$ required is: 15gm it is already given for 1liter of water in the table.

d. <u>Prepare NaCl.</u>

Amount of **NaCl** required is: 20gm, it is already given for 1liter of water in the table.

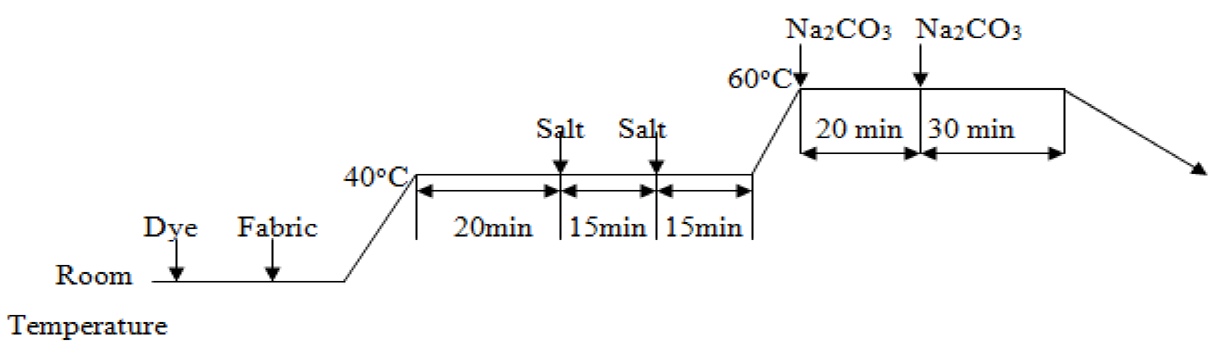


Figure 2.3: *Reactive Dyeing Cycle using jig*

c) Dyeing with Reactive Dyes (Option-B)

In the case of option-B, weight of substrate to be dyed will be given and then amount of liquor will be determined finally. Detail calculation will be seen as below.

Chemicals: Reactive dye, Sodium chloride and Sodium carbonate

Substrate used: bleached cotton fabric.

Process parameters: Temperature: 60C°, Time: 2hr, MLR: 1:5

Table 2.3: *Reactive Dyeing recipe*

	MLR: 1:5 Temperature= 60 ^{0}C Time= 2hr
Chemicals used	**Concentration**
Reactive dye (% o.w.f.)	1
Sodium chloride	20g/l
Sodium carbonate	10g/l

Procedure:

1) Take 10gm sample of bleached fabric

a) **Prepare the dyeing liquor.**

Water, 1gm = 5ml

10gm =?

$\frac{10gm*5ml}{1g}$ = **50ml** of water

b) **Prepare NaCl.**

NaCl, 20g = 1000ml

? =50ml

$\frac{20g*50ml}{1000ml}$ = **1gm** of NaCl

c) **Prepare Na_2CO_3.**

Na_2CO_3, 10g = 1000ml

? = 50ml

$\frac{10gM*50ml}{1000ml}$ = **1gm** of Na_2CO3

d) **Prepare Dye.**

Dye concentration (gm) = $\frac{1}{100}$ * (20gm) = **0.2gm,** from the above given data in the table.

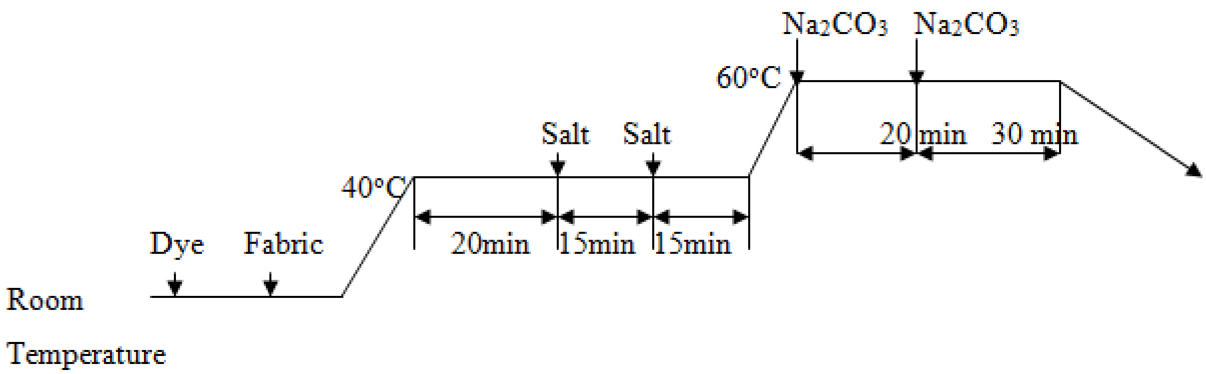


Figure 2.4: *Reactive Dyeing Cycle using Atmospheric Dyeing Machine*

Self check-2

Test-I Matching

Instruction: select the correct answer for the give choice. You have given 1 Minute for each question. Each question carries 2 Point.

1. Which stages of dyeing process is responsible for chemical bonding with the fiber?
   A. Adsorption
   B. Diffusion
   C. Fixation
   D. Dye molecules movement from solution to fiber
2. Which type of dyeing technology is used to dye materials without scouring or singeing?
   A. Bale dyeing technology
   B. Batik dyeing
   C. Beam dyeing
   D. Jig dyeing
3. Which type of interaction among dye and fiber has strong force?
   A. Ionic forces
   B. Hydrogen bonding
   C. Covalent chemical linkages
   D. Vander Wals' forces
4. Which one is component of dyes?
   A. Chromophore
   B. Auxochrome
   C. Residual
   D. A and B are correct
5. Which one is a disadvantage of natural dyes?
   A. Natural dyes are difficult to store
   B. Dye extraction is a time consuming process
   C. Reproducibility of the same color shade is difficult
   D. These dyes provide excellent protection from UV rays
   E. Except D all are correct

Test II: short Answer writing

Instruction: write short answer for the given question. You are provided 3 minute for each question and each point has 5Points.

1. What is dyeing?
2. List and discuss the four stages of dyeing processes?
3. List and describe dyeing steps/procedures?

Note: Satisfactory rating – above 13.5% Unsatisfactory - below 13.5%

You can ask you teacher for the copy of the correct answers

Unit Three: Dyeing machine adjustment

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

- Dye mixing
- Checking dye worksheet
- Measuring and loading textile materials , dyes, chemicals and auxiliaries
- Reporting non-conforming materials

This guide 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:

- Mix dye according to dye worksheet using correct measuring devices and personal protective equipment.
- Check dye worksheet and if required entered into the dyeing machine.
- Measure & load dyes, chemicals and auxiliaries precisely into the dosing tank or machine according to work health and safety (WHS) requirements.
- Weigh and load fibers, yarns or fabrics for dyeing according to specifications.
- Report non-conforming materials.
- Keep area around dye tank or machine clean during setting and loading

3.1 Dye mixing

Different textile dyes have their own dye mixing procedures. To prepare the dye solution the dye is mixed with a small quantity of cold water until homogenous paste is obtained. Then enough hot water (about 80^0C) is added to the paste to dissolve the dye completely. Finally, leveling agent is dissolved in the dye solution (for dyes difficult to level).

Dye compatibility must be checked and controlled since it affects dyeing process. Compatible dyeing behavior is a function of all the process variables and requires careful control of the dyeing temperature, salt and alkali concentrations, the dyeing time and the liquor ratio. Once the dye has reacted with the cellulose, it is completely immobilized and cannot migrate. Control of the process variables determines whether a given shade will be reproducible from batch to batch.

Before mixing different dyes with its auxiliaries, different methods are used to prepare their concentration. These methods are listed as follow.

a) Simple Dilution (Dilution Factor Method based on ratios)

A simple dilution is one in which a unit volume of a liquid material of interest is combined with an appropriate volume of a solvent liquid to achieve the desired concentration. The dilution factor is the total number of unit volumes in which your material will be dissolved. The diluted material must then be thoroughly mixed to achieve the true dilution.

For example, a 1:5 dilution (verbalize as "1 to 5" dilution) entails combining 1 unit volume of solute (the material to be diluted) + 4 unit volumes of the solvent medium (hence, 1 + 4 = 5 = dilution factor). The dilution factor is frequently expressed using exponents: 1:5 would be 5e-1; 1:100 would be 10e-2, and so on.

Example 1: Frozen orange juice concentrate is usually diluted with 4 additional cans of cold water (the dilution solvent) giving a dilution factor of 5, i.e., the orange concentrate represents one unit volume to which you have added 4 more cans (same unit volumes) of water. So the orange concentrate is now distributed through 5 unit volumes. This would be called a 1:5 dilution, and the OJ is now 1/5 as concentrated as it was originally. So, in a simple dilution, add one less unit volume of solvent than the desired dilution factor value.

Example 2: Suppose you must prepare 400 ml of a disinfectant that requires 1:8 dilution from a concentrated stock solution with water. Divide the volume needed by the dilution factor (400 ml / 8 = 50 ml) to determine the unit volume. The dilution is then done as 50 ml concentrated disinfectant + 350 ml water.

b) Serial Dilution

A serial dilution is simply a series of simple dilutions which amplifies the dilution factor quickly beginning with a small initial quantity of material (i.e., bacterial culture, a chemical, orange juice, etc.). The source of dilution material (solute) for each step comes from the diluted material of the previous dilution step.

In a serial dilution the total dilution factor at any point is the product of the individual dilution factors in each step leading up to it. Final dilution factor (DF) = DF1 * DF2 * DF3 etc.

Example: In a typical microbiology exercise the students perform a three step 1:100 serial dilution of a bacterial culture (see figure below) in the process of quantifying the number of viable bacteria in a culture (see figure below). Each step in this example uses a 1 ml total volume. The initial step combines 1 unit volume of bacterial ulture (10 ul) with 99 unit volumes of broth (990 ul) = 1:100 dilution. In the second step, one unit volume of the 1:100 dilution is combined with 99 unit volumes of broth now yielding a total dilution of 1:100x100 = 1:10,000 dilution. Repeated again (the third step) the total dilution would be 1:100x10,000 = 1:1,000,000 total dilution. The concentration of bacteria is now one million times less than in the original sample.

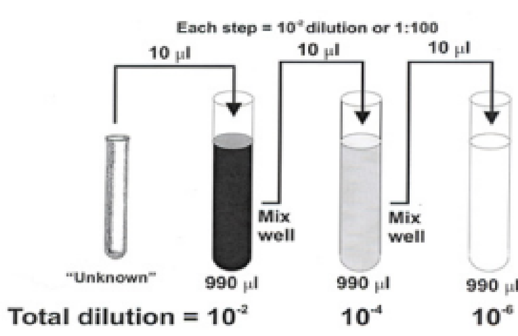


Figure 3.1: *Serial Dilution*

c) Making fixed volumes of specific concentrations from liquid reagents:

Very often you will need to make a specific volume of known concentration from stock solutions, or perhaps due to limited availability of liquid materials (some chemicals are very expensive and are only sold and used in small quantities, e.g., micrograms), or to limit the amount of chemical waste. The formula below is a quick approach to calculating such dilutions where:

V = volume, C = concentration; in whatever units you are working. (stock solution attributes) V1C1=V2C2 (new solution attributes)

Example: Suppose you have 3 ml of a stock solution of 100 mg/ml ampicillin (= C1) and you want to make 200 ul (= V2) of solution having 25 mg/ ml (= C2). You need to know what volume (V1) of the stock to use as part of the 200 ul total volumes needed.

V1 = the volume of stock you will start with. This is your unknown.

C1 = 100 mg/ ml in the stock solution

V2 = total volume needed at the new concentration = 200 ul = 0.2 ml

C2 = the new concentration = 25 mg/ ml By algebraic rearrangement: V1 = (V2 x C2) / C1 V1 = (0.2 ml x 25 mg/ml) / 100 mg/ml and after cancelling the units,

V1 = 0.05 ml, or 50 ul, So, you would take 0.05 ml = 50 ul of stock solution and dilute it with 150 ul of solvent to get the 200 ul of 25 mg/ ml solution needed. Remember that the amount of solvent used is based upon the final volume needed, so you have to subtract the starting volume form the final to calculate it.

d) Moles and Molar solutions (unit = M = moles/L)

Sometimes it may be more efficient to use molarity when expressing chemical concentrations. A mole is defined as exactly 6.023 x 1023 atoms, or molecules, of a substance (this is called Avagadro's number, N). The mass of one mole of an element is its atomic mass (g) and is noted for each element in the periodic table.

Molecular weight is the mass (g) of a substance based on the summed atomic masses of the elements in the chemical formula. Formula weight refers to chemicals for which no discrete molecules exist; for example, NaCl in solid form is made up of Na+ and Cl- ions, but there are no true molecules of NaCl.

The formula weight of 1 mole NaCl would therefore be the sum of 1 atomic mass of each ion. The molecular weight (or FW) is provided as part of the information on the label of a chemical bottle. The number of moles in an arbitrary mass of an element or compound can be calculated as: Number of moles = weight (g)/ atomic (or molecular) weight (g)

Molarity (M) is the unit used to describe the number of moles of an element or compound in one liter (L) of solution (M = moles/L) and is thus a unit of concentration. By this definition, a 1.0 M solution is equivalent to one molecular weight (g/mole) of a compound brought up to 1 liter (1.0 L) volume with solvent (e.g., water) at a fixed temperature (liquids expand and contract with temperature and thus can change molarity).

Example 1: To prepare a liter of a molar solution from a dry reagent,
Multiply the molecular weight (or FW) by the desired molarity to determine how many grams of reagent to use:
Suppose a compound â€™s MW = 194.3 g/mole;
To make 0.15 M solution use 194.3 g/mole * 0.15 moles/L = 29.145 g/L
You would dissolve the specified mass of reagent in a fraction of the total volume of solvent (at STP) and then raise the volume to exactly one liter by adding additional solvent and mixing thoroughly.

Example 2: To prepare a specific volume of a specific molar solution from a dry reagent
A chemical has a FW of 180 g/mole and you need 25 ml (0.025 L) of 0.15 M (M = moles/L) solution. How many grams of the chemical are needed to make this solution?
#grams/desired volume (L) = desired molarities (mole/L) * FW (g/mole)
by algebraic rearrangement, #grams = desired volume (L) * desired molarity (mole/L) * FW (g/mole) #grams = 0.025 L * 0.15 mole/L * 180 g/mole after cancelling the units, #grams = 0.675 g So, you need 0.675 g/25 ml

e) Percent Solutions (% = parts per hundred or grams/100 ml)

Many reagents are mixed as percent solutions either as weight per volume (w/v) when starting with dry reagents or volume per volume (v/v) when starting with liquid reagents. When preparing solutions from dry reagents, the same mass of any reagent is used to make a given percent concentration although the molar concentrations would be different.

In general,

Weight percent (w/v) = [mass of solute (g)/ volume of solution (ml)] x 100, and,

Volume percent (v/v) = [volume of solute (ml)/ volume of solution (ml)] x 100

For example, a 100 ml of 10% solution of any dry reagent would contain 10 g dry reagent in a final volume of 100 ml.Â A 10% (v/v) solution would contain 10 ml solute/ 100 ml solution volume.

Example 1: If you want to make 200 ml of 3 % NaCl you would need 0.03 g/ml x 200 ml = 6.0 g NaCl in 200 ml water. When using liquid reagents the percent concentration is based upon volume per volume, and is similarly calculated as % concentration x volume needed = volume of reagent to use.

Example 2: If you want to make 2 L of 70% ethanol from 100% ethanol you would mix 0.70 ml/ml x 2000 ml = 1400 ml ethanol with 600 ml water.

To convert from % solution to molarity, multiply the % solution by 10 to express the percent solution grams/L, and then divide by the formula weight.

$$\text{Molarity} = \frac{(\text{grams reagent}/100\text{ ml}) * 10}{\text{FW}}$$

Example 1: Convert a 6.5 % solution of a chemical with FW = 325.6 to molarity,

[(6.5 g/100 ml) * 10] / 325.6 g/mole = [65 g/L] / 325.6g/mole = **0.1996 M**

To convert from molarity to percent solution, multiply the molarity by the FW and divide by 10:

f) Normality (N): Conversion to Molarity

Normality = n*M where n = number of protons (H+) in a molecule of the acid.

Example: In the formula for concentrated sulfuric (36 N H_2SO_4), there are two protons, so, its molarity= N/2. So, 36N H_2SO_4 = 36/2 = 18 M

3.2 Checking dye worksheet

Concepts of worksheet

Worksheet is a kind of learning aid. Generally the worksheet is a learning tool as a match or perhaps a means of promoting the implementation of the education plan.

Along the way of education, worksheet purpose to get ideas and application of concepts.

Components of dye worksheet:

Components of worksheet are depending on the activity to be performed. Example for dyeing activity, the dye worksheet composes the following elements.

a) Purpose of specific dyeing activity
b) Theoretical Background of specific dyeing process
c) Materials used for specific dyeing process
d) Materials/Chemicals/Equipment's/Apparatus:
e) Dyeing recipes and after treatment Recipe
f) Procedures for specific dyeing process and etc.
g) May be certain questions to be answered.

Generally before dyeing is conducted, its dye worksheet must be checked and analyzed before start specific dyeing process. Try to see the following dye worksheet for direct dyeing of cotton fabrics.

Experimental Objectives

- To carry out dyeing of cotton fabrics with direct dyes
- To understand the action of electrolytes on the exhaustion of direct dyes on cotton
- To carry out after treatment of dyed cotton fabrics using copper salts ($CuSO_4$)
- Compare wet – fastness properties before and after subsequent treatments

Theoretical Background

Direct dyes are so called because they dye cellulosic such as cotton without the need for a mordant. Direct dyes are anionic in nature. These dyes are water soluble, even though some of them require the presence of sodium carbonate to dissolve; their solubility increases with an increase in the number of solubilizing groups and with temperature, and decreases in relation to molecular weight.

Direct dyeing of cotton fabrics is influenced by different factors. Among the factors are action of temperature, action of electrolytes (neural and alkaline), liquor ratio and agitation. The major problem of using direct dyes for dyeing cotton fabrics is poor wet fastness characteristics.

Materials/Chemicals/Equipment's/Apparatus:

Materials/chemicals: Bleached cotton fabric, direct dyes, sodium chloride, Glaubers' salt (sodium sulphate), leveling agent, copper-sulphate, acetic acid (80%), and formic acid (85%).

Equipment's/Apparatus: Weighing balance, scissors, ruler, stirrers, stoves, measuring cylinders, beakers, and other accessories.

Dyeing and after treatment Recipe:

Table 3.1: *Dyeing Recipe*

	MLR: 1:30 PH : Neutral Dyeing temperature = 90 – 100 ^{0}C Dyeing time = 30 – 45 min			
Chemicals used	**Concentration**			
	Test 1	**Test 2**	**Test 3**	**Test 4**
Direct dye (% o.w.f.)	0.5 -1	0.5 - 1	0.5 -1	0.5 -1
Sodium chloride or sodium sulphate (gpl)	15	10	5	0
Leveling agent (gpl)	0.1-0.5	0.1-0.5	0.1-0.5	0.1-0.5

Table 3.2: *After treatment recipe*

	MLR: 1:30 PH : Acidic Treatment temperature = 50- 70 ^{0}C Treatment time = 30 min
Chemicals used	**Concentration**
Copper sulphate (o.w.f)	1 – 4
Acetic acid (80 %) (o.w.f)	0.5 - 1.5
Formic acid (85 %) (o.w.f)	0.5 – 1 (optional)

Procedure:

a. Prepare the direct dye solution: To prepare the dye solution the dye is mixed with a small quantity of cold water until homogenous paste is obtained. Then enough hot water (about 80^0C) is added to the paste to dissolve the dye completely. Finally, leveling agent is dissolved in the dye solution (for dyes difficult to level).

b. Dyeing: Carry out the dyeing process according to the following dyeing cycle.

Temperature

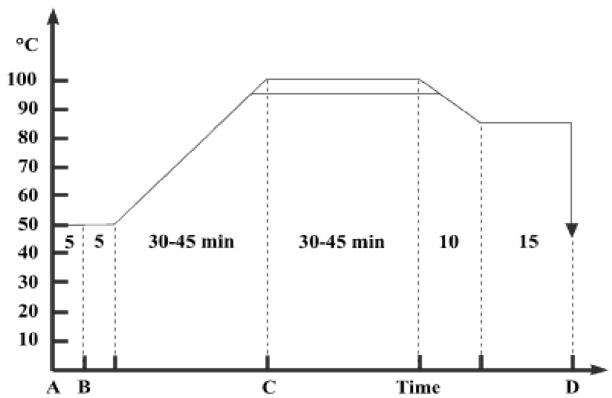


Figure 3.2: *Dyeing cycle: Direct dyeing of cotton fabrics*

- At ‘A’ start with the prepared dye solution in a beaker with the fabric sample immersed in it.
- At ‘B’ add 1/5th of the total amount of the neutral electrolyte (sodium chloride or sodium sulphate) required.
- At ‘C’ add 4/5th of the total amount of the neutral electrolyte (sodium chloride or sodium sulphate) required.
- At ‘D’ rinse the sample twice with cold water.
- Dry the dyed fabric.
- Keep half of the dyed sample for wet- fastness treatment.

c. After treatment for fastness improvement:

Prepare after treatment solution: To prepare the after treatment solution acetic acid is dissolved in water and to this the copper sulphate is added and dissolved completely. To acidify the solution formic acid can be added.

Carry out after treatment: To carry out after treatment half of the dyed cotton fabric sample is introduced into the prepared solution at 50 – 70 ^{0}C and is kept there for half an hour. It is then washed well and if necessary 10mins soaping at 40 – 50 ^{0}C can be carried out.

3.3 Measuring and loading textile materials, dyes, chemicals and auxiliaries

Before loading textile materials, dyes, chemicals and auxiliaries on to dyeing machines, its recipe must be calculated first according to their MLR and then measured with their respective measuring device.

A device used to measure weight or mass is known as beam balance. These are also known as mass scales, weight scales. The system is made up of a weigh scale indicator. Before the textile samples (yarn or fabric) are weighed, the weighing device must be calibrated first.

Calibration is the process of testing the scale, to ensure the level of accuracy you require. In a laboratory setting, results are dependent upon exact scale calibration.

An inaccurate scale could significantly hurt your results. Incorrect measurements could result in product quality issues or scrapped batches. The most common practice is the following: start with zeroing the instrument without any load.

Procedures of weighing yarn or fabric for dyeing:

Option-1:

- **a.** With nothing on the pan, set to zero by pressing the "on" button.
- **b.** Place weighing bottle or vial on balance and set to zero again.
- **c.** Transfer sample into container slowly, until you reach the desired mass and then write down the result.

Option-2:

- **a.** With nothing on the pan, set to zero by pressing the "on" button.
- **b.** Place the sample on to weighing balance slowly, until you reach the desired mass and then write down the result.

After desired amount of textile material, dyes and its auxiliaries are weighed to their standard, they are loaded to the dyeing machines according their procedures for each dye type. Different dyes have different loading procedures on dyeing machine. Try to understand the following dye and its chemical loading procedures.

a) How to load reactive dye and its dyeing auxiliaries:

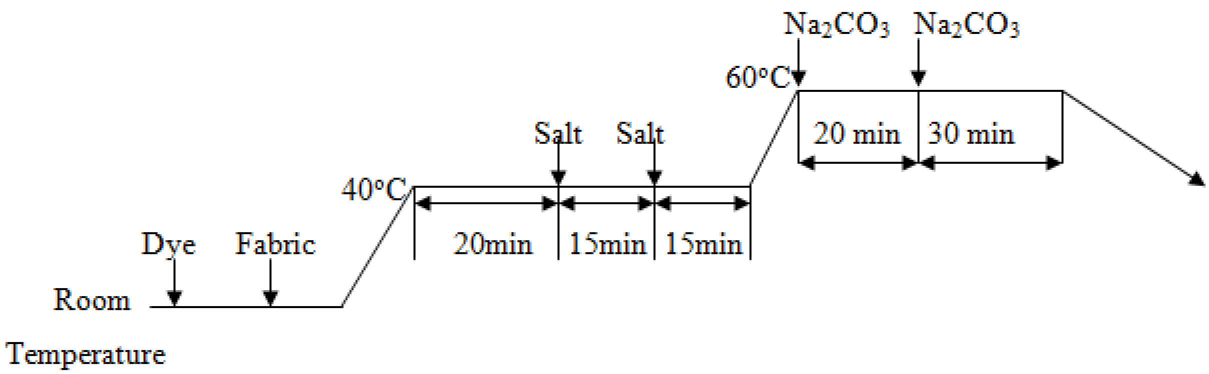


Figure 3.3 *Loading reactive dye and its chemicals*

b) How to load vat dye and its dyeing chemicals:

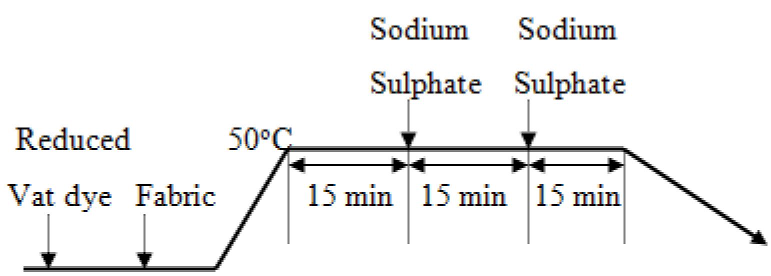


Figure 3.4 *Loading vat dye and its chemicals*

Generally all dyes have their own procedures to load dyes and their chemicals separately.

3.4 Reporting non-conforming materials

Non-conforming dyeing materials are unknowingly used materials during dyeing textile materials. Once they are observed in dyeing process, they must be reported to concerned personnel to fix their solutions unless they lead to faulty dyeing.

These may include:

- Improper mixing of the Softener.
- Batch to batch weight variation of dyes and chemicals.
- Dyes lot variation.
- Entanglement of fabric.

- Faulty injection of alkali.
- Hardness of water.
- Improper salt addition.
- Improper dyes solubility.
- Uneven pretreatment (uneven scouring & bleaching).
- Lack of control on dyeing m/c

Self check-3

Test II: short Answer writing

Instruction: write short answer for the given question. You are provided 3 minute for each question and each point has 5Points.

1. Write and describe some components of dye worksheet?
2. Write at least five non-conforming dyeing materials.

Note: Satisfactory rating – above 6% Unsatisfactory - below 6%

You can ask you teacher for the copy of the correct answers

Unit Four: Dyeing machine Operation

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

- Operating dyeing machine
- Monitoring dyeing operations
- Identifying and correcting minor faults and reporting major machine faults
- Product requirements

This guide 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:

- Start, operate and stop dyeing machine according to manufacturer requirements.
- Monitor dyeing operations to ensure conformance with dye worksheet.
- Clean tank or machine when required.
- Identify, correct and report minor faults where necessary to meet specified product requirements.
- Report major machine faults or incorrect dyeing.

4.1 Operating dyeing machine

Some of dyeing machines used in textile dyeing process include: dyeing machine itself, Drying machine, Washing machine, Squeezing machine and etc. Their description is as below.

a. Dyeing machine:

Dyeing operation is done by different types of dyeing machine. Dyeing machines come in all shapes and sizes to accommodate the various forms and quantities of textile materials. Various types of textile dyeing machines are used to dye the textile materials. Dyeing machines can be classified in the following way.

According to textile material used:

- Fiber dyeing machine
- Yarn dyeing machine
- Fabric dyeing machine (Jet, Jigger, Pad/padding mangle , Beam, Winch , High temperature winch, Solvent dyeing machine)
- Garment dyeing machine

According to dyeing process:

- Open dyeing machine
- Enclosed dyeing machine

According to material and liquor movement:

- Material move but liquor does not circulate i.e; jigger
- Liquor circulates but a material does not move i.e; all package dyeing machine.
- Both materials and liquor circulate i.e; jet dyeing machine and etc.

b. Drying machine:

Drying machine is necessary to eliminate or reduce the water content of the fibers, yarns and fabrics following wet processes. Water evaporation leads to increase in dye concentration. Drying techniques may be classified as mechanical or thermal. Mechanical processes are used in general to remove the water which is mechanically bound to the fiber. Thermal processes consist in heating the water and converting it into steam.

Heat can be transferred by means of:

- Convection
- Infrared radiation
- Direct contact and etc.

c. Washing machine:

Washing machine is used to remove residual or excess chemicals remained on the dyed samples. This washing is carefully performed to the samples either open width or rope form. After washing the sample will be rinsed.

d. Squeezing machine:

Squeezing machine is used to remove from water from wet clothes while drying. This can be done by two ways. I.e. using Centrifugation technique and passing wet cloth between two heavy cylindrical rollers.

The concept behind centrifugation is - When a very fine suspension or a colloidal solution is whirled rapidly the heavier particles are forced towards the bottom of liquid and the lighter stay at the top.

4.2Monitoring dyeing operations

Different operations are controlled during dyeing textile materials. These operations may include: Dyeing process itself, Drying, Binding or fixation, Washing, Squeezing and etc. Their descriptions are as below.

a. Dyeing:

Dyeing is a method for coloring a textile material in which a dye is applied to the substrate in a uniform manner to obtain an even shade with a performance and fastness appropriate to its final use. So during dyeing all the dyeing parameters (time, temp. pressure and MLR) must be controlled by the operator to achieve quality dyeing.

The color produced should withstand external agencies such as washing, light, rubbing etc. to which textile material is subjected during use. The coloration should not restrict only to the fiber surface but should penetrate the fiber cross section also.

b. Binding or fixation:

Fixation is a formation of the “final “bond between the dye and the fiber with the mechanisms such as ionic bonding and hydrophobic forces. Generally, the operators need to monitor all its parameters (heat, time, speed and etc.) to ensure it better fixation.

c. Washing:

Washing is the activity intended to remove residual or excess chemicals remained on the dyed samples. This washing is carefully performed to the samples either open width or rope form. After washing the sample will be rinsed.

d. Squeezing:

Squeezing is removing out water from wet clothes while drying. Squeezing machine is monitored (increase /decrease speed or increase/decrease cylinder pressure) until required amount of water is removed from wet textile materials.

e. Drying:

Drying is in particular done by water evaporation, which is a high-energy consuming step. In any methods of drying, its parameters are monitored to remove enough amount of water from textile materials.

4.3 Identifying and correcting minor faults and reporting major machine faults

Identifying and correcting minor faults:

During dyeing any textile materials, we encounter different dyeing faults. These may include: uneven dyeing, Batch to Batch Shade variation, Patchy dyeing effect, Crease/ Wrinkle mark, Dye spot, Softener Mark and etc. so their causes and remedies are discussed below.

Uneven Dyeing:

Causes:

- Uneven pretreatment (uneven scouring & bleaching).
- Improper color dosing.
- Uneven heat-setting in case of synthetic fibers.
- Lack of control on dyeing m/c

Remedies:

- By ensuring even pretreatment.
- By ensuring even heat-setting in case of synthetic fibers.
- Proper dosing of dyes and chemicals.
- Proper controlling of dyeing m/c

Batch to Batch Shade Variation:

Causes:

- Fluctuation of Temperature.
- Improper dosing time of dyes & chemicals.
- Batch to batch weight variation of dyes and chemicals.
- Dyes lot variation.
- Improper reel speed, pump speed, liquor ratio.
- Improper pretreatment.

Remedies:

- Use standard dyes and chemicals.
- Maintain the same liquor ratio.
- Follow the standard pretreatment procedure.
- Maintain the same dyeing cycle.
- Identical dyeing procedure should be followed for the same depth of the Shade.
- Make sure that the operators add the right bulk chemicals at the same time and temperature in the process.
- The pH, hardness of supply water should check daily.

Patchy Dyeing Effect:

Causes:

- Entanglement of fabric.
- Faulty injection of alkali.
- Improper addition of color.
- Due to hardness of water.
- Due to improper salt addition.
- Dye migration during intermediate dyeing.

- Uneven heat in the machine, etc.

Remedies:

- By ensuring proper pretreatment.
- Proper dosing of dyes and chemicals.
- Heat should be same throughout the dye liquor.
- Proper salt addition.

Roll to Roll Variation or Meter to Meter Variation:

Causes:

- Poor migration property of dyes.
- Improper dyes solubility.
- Hardness of water.
- Faulty m/c speed, etc

Remedies:

- Use standard dyes and chemicals.
- Proper m/c speed.
- Use of soft water.

Crease Mark:

Causes:

- Poor opening of the fabric rope
- If pump pressure & reel speed is not equal

Remedies:

- Proper opening of fabric rope.
- Maintaining proper reel sped &pump speed.
- Higher liquor ratio

Dye Spot:

Causes:

- Improper Dissolving of dye particle in bath.
- Improper Dissolving of caustic soda particle in bath.

Remedies:

- By proper dissolving of dyes & chemicals
- By passing the dissolved dyestuff through a fine stainless steel mesh strainer, so that the large un-dissolved particles are removed.

Softener Mark:

Causes:

- Improper mixing of the Softener.
- Improper running time of the fabric during application of softener.
- Entanglement of the fabric during application of softener

Remedies:

- Maintaining proper reel sped &pump speed.
- Proper Mixing of the softener before addition.
- Prevent the entanglement of the fabric during application of softener

Reporting major machine faults:

Major dyeing machine faults are type of faults that are resulted from any textile machines during processing textile materials than other factors. Once these faults are observed it is the responsibility of the operator to report to the concerned personnel immediately. Some of the major machine faults may include the following:

Snagging:

Snagging appears on the knitted fabric surface, as a pulled up yarn float, showing up in a form of a large loop. It is caused by the pulling or the plucking of yarn from the surface, by the sharp objects. This fault can be seen in Soft flow dyeing, Tumble dryer & Centrifuge etc.

Bowing:

It appears as rows of courses or yarn dyed stripes along the fabric width.

It is caused by uneven distribution of tensions across the fabric width while dyeing or finishing the fabric. It is corrected, by reprocessing of the fabric by feeding it from the opposite end.

Curling the edge of fabric:

When laying the single jersey fabrics on the table the both side selvedge may be curling**.**

Folding marks:

Folding marks appear as distinct pressure marks, along the length of the fabric due to high pressure.

GSM Variation:-

The fabric will appear to have a visible variation in density, from roll to roll or within the same roll of the same dye lot. This is due to roll to roll variation in the process parameters (over feed &width wise stretching of the dyed fabric), on the stenter, compactor or calendar machines and due to roll to roll variation in the fabric stitch length.

Stains:

Stains appear as a spots or patches, of grease, oil or dyes of different color in a neat & clean finished fabric's surface. It is a common defect.

4.4Product requirements

Textile chemical processed products may require different quality parameters. Some of them may include: Shade, Fastness and etc. their descriptions are as below:

Shade:

Shade is depth of color or hue. It is a common word in dyeing, printing and finishing unit of a textile mill. Fabric shade variation is a major issue in textile mill. Fabric shade variance is the variation of shade in one roll of fabric or separate pieces of fabric that were intended to match. There are many reasons are responsible for the difference in shade in textile dyeing mill. For matching fabric shade, fabric shade checking is very important in dyeing floor. Fabric shade checking is the physical testing method of offline quality control assurance system.

Shade of the color varies depending on the light source under which sample is checked out. For this reason, buyer/ customers give specific light source under which sample will be checked. For this the following equipment is used.

Type of light source:

a) D-65 (artificial day light)
b) TL-84
c) F (filament light)

d) UV (ultraviolet blue light)

The shade is checked in several times, to ensure the customers demand and condition. Generally, the shade is checked at the following stages.

a) After dyeing.
b) After drying.
c) After trial for finishing.
d) After finishing.

Fastness:

Color fastness is the resistance of a material to change in any of its color characteristics, including the transfer of its colorants to adjacent materials; fading means the color changes and lightens; Bleeding is the transfer of one color to another material.

Color fastness to washing or rubbing can prevent the pollution of water eco-system, reduce wastage as well as protect the human skin from the chemical dyes. Therefore, color fastness grading is a crucial stage in the quality control of fabrics.

Self-Check-4

Test-I Multiple Choices

Instruction: select the correct answer for the give choice. You have given 1 Minute for each question. Each question carries 2 Point.

1. In which techniques water is removed from wet dyed fabric in squeezing machine while drying?
   - A. Centrifugation
   - B. Two heavy cylindrical rollers
   - C. Earth gravity
   - D. All except C
2. Which type of dyeing operation need to be monitored by dyeing operator?
   - A. Dyeing it self
   - B. Drying
   - C. Binding degree
   - D. All
3. How uneven dyeing is corrected in dyeing section?
   - A. By ensuring even pretreatment.
   - B. By ensuring even heat-setting in case of synthetic fibers.
   - C. Proper dosing of dyes and chemicals.
   - D. Proper controlling of dyeing m/c F. All
4. What is the cause of batch to batch shade variation?
   - A. Fluctuation of Temperature.
   - B. Batch to batch weight variation of dyes and chemicals.
   - C. Dyes lot variation.
   - D. All
5. Which of the following is a major dyeing machine fault?
   - A. Snagging C. GSM Variation
   - B. Stains D. All

6. In which stages dyeing shade is checked?
   A. After dyeing.
   B. After drying.
   C. After trial for finishing.
   D. After finishing E. All

Test II: short Answer writing

Instruction: write short answer for the given question. You are provided 3 minute for each question and each point has 5Points.

1. List down at least 4 dyeing faults and their remedies.
2. List and discuss how dyeing machines are classified?

Note: Satisfactory rating – above 12% Unsatisfactory - below 12%

You can ask you teacher for the copy of the correct answers

Operation Sheet 4.1

Operation Title: Operating jigger dyeing machine

Purpose:

- To operate and monitor jigger dyeing machine

Instruction: perform dyeing of bleached woven fabric according to the given dyeing parameters and procedures. You have given 2hr for the task and you are expected dye and check woven fabric.

Equipment, Tools & materials:

- Jigger dyeing machine, reactive dyes, woven fabrics, beaker, measuring cup, sodium chloride, sodium carbonate, soap powder, different safety tools and equipment.

Operation procedures:

1. Fabric is wetted with water and wound around the two cylinders of jigger carefully without folds.
2. Add dyeing solution in the trough of jigger and heat the solution and start dyeing.
3. After dyeing has been carried out at 40oC for 20 min, half of sodium chloride dissolved with 100ml water is added in the trough, the remaining sodium chloride is added after 35 min of dyeing time. (Given parameters are: MLR: 1:5, Reactive dye (%o.w.f.)=1, NaCl=20gm, Na2CO3=15gm, water=1L)
4. After 15 min, the temperature of the dye bath is elevated up to 60oC, and then half of sodium carbonate dissolved with 100 ml water is added in the trough. After 20 min the remaining sodium carbonate is added.
5. After 30 min, remove dyeing solution from the trough and add cold water in the trough, to wash the dyed fabric for 5 min. Then, wash the fabric with hot water (70-80^{o}C) for 5min.
6. Dyed fabric is soaped at 95^{o}C for 10 min.
7. The fabric is washed with hot water for 5min and washed with cold water for 5 min and then dried.

Quality criteria:

- Required uniform shade
- Good color fastness ant etc.

Precautions: use the jigger dyeing machine for this task.

Operation Sheet 4.2

Operation Title: Operating winch dyeing machine

Purpose: To operate and monitor winch dyeing machine

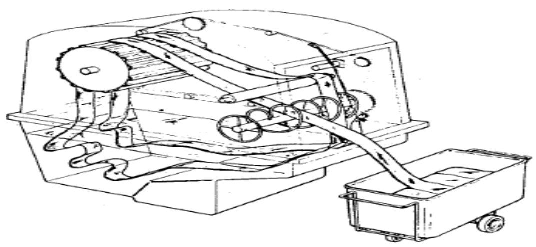
Instruction: perform dyeing of bleached knitted fabric according to the given dyeing parameters and procedures. You have given 2hr for the task and you are expected dye and check knitted fabric.

Equipment, Tools & materials:

Winch dyeing machine, dyes and its auxiliaries, knitted fabrics, beaker, measuring cup, soap powder, different safety tools and equipment.

Operation procedures:

1. Load the dye mixture into dye bath
2. Pass one edge of the fabric over the winch and the other edge below winch.
3. Then, sew them together to form a continuous rope. This rope passes from the dye bath over two elevated reels and then falls back into the bath see Figure below.



4. Set dyeing parameter (temp, time and rate) from control panel by pressing Mode.
5. Then execute the set data.
6. Close the machine to avoid steam and heat losses when dyeing.

2. Finally start running.

Conditions or situations for the operations:

The operation is take place in standard temperature & closed machine lid.

Quality criteria:

- Achieving required uniform shade
- Good color fastness ant etc.

Precautions: use the winch dyeing machine for this task.

LAP TEST-4

Instructions: Perform the following activities. You have given 2hr for each task. Each question carries 5 Points.

Task-1. Operate and monitor jigger dyeing machine.

Task-2. Operate and monitor winch dyeing machine

Task-3. Request your instructor for evaluation & feed buck.

Unit Five: Dyeing operations completion

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

- Unloading and dispatching product
- Completing Cleaning area
- Completing production records and other documentation

This guide 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:

- Fibers, Yarn or fabric is unloaded.
- Product is dispatched to next process.
- Cleaning of area is completed to ensure work environment is maintained in a safe and productive manner.
- Production records and other documentation are accurately completed.

5.1 Unloading and dispatching product

a) Unloading product:

Unloading is the activity performed after dyeing is completed. During this activity, the dyed samples get-rid off or removed from the specific dyeing machine. The dyed packages can be unloaded from dyeing machines in different forms. For example either in fiber forms, Yarn forms or fabric form.

Figure 5.1: *Fabric forms package*

Figure 5.2: *Yarn forms package*

Generally during unloading any dyed textile samples, care must be taken.

b) Dispatching product:

Dispatching is the physical handing of a manufacturing order to the operating facility (a worker) through the release of orders and instructions in accordance with a previously developed plan of activity (time and sequence) established by the scheduling section of the production planning and control department.

Dispatch function in production management executes planning function. Dispatching ensures that the plans are properly implemented. Dispatch function determines, by whom the job shall be done and it co-ordinates production. It is the key point of a production communications system. It creates a direct link between production and sales.

Dispatcher transmits orders to the various shops. A dispatcher is familiar with the productive capacity of each equipment. He always keeps an eye over the progress of orders which move at different speeds on different routes.

Dispatching aspects which have to be taken care of:

a) All production information should be available beforehand.
b) Various order cards and specification drawings should be ready.
c) Equipment's should be ready for use.
d) Progress of various orders should be properly recorded on the Gantt charts or display boards.
e) All production records should be properly maintained.

Dispatch function may be centralized or decentralized.

In a Centralized dispatch system:

A central dispatching department, orders directly to the work station. It maintains a full record of the characteristics and capacity of each equipment and work load against each machine. The orders are given to the shop supervisor, who runs his machines accordingly. In most of the cases, the supervisor can also give suggestions as regards loading of men and machines under him.

A centralized dispatching system has the following advantages:

- A greater degree of overall control can be achieved.
- Effective co-ordination between different facilities is possible.
- It has greater flexibility
- Because of urgency of orders, changes in schedules can be affected rapidly without upsetting the whole system.
- Progress of orders can be readily assessed at any time because all the information is available at a central place.
- There is effective and better utilization of manpower and machinery.

In a Decentralized dispatching system:

The shop supervisor performs the dispatch function. He decides the sequence of handling different orders. He dispatches the orders and materials to each equipment and worker and is required to complete the work within the prescribed duration.

In case he suspects delay, with due reasons, he informs the production control department.

A decentralized dispatching system has the following advantages.

a) Shop supervisor knows best about his shop; therefore, the work can be accomplished by the most appropriate worker and the machine.
b) Elaborate reports and duplication of postings can be avoided
c) Communication gap is reduced
d) It is easy to solve day-to-day problems
e) It keeps the natural urge of a section to be self-sufficient.

The advantages of a centralized system, more or less give an idea about the disadvantages of the decentralized system and vice versa.

5.2 Completing Cleaning area

After any work is performed, work area must be cleaned to its standards and get ready for the next activity. Poor floor conditions are a leading cause of incidents so cleaning up spilled oil and other liquids at once is important. Allowing dust to accumulate can also cause incidents. So regularly cleaning the floor can prevent their accumulation.

Areas that cannot be cleaned continuously, such as entrance ways, should have anti-slip flooring. Keeping floors in good order also means replacing any worn or damaged flooring that poses hazard. Generally area cleaning can use the following equipment and tools. Brooms, detergents, glove, breathing musk, safety clothes and etc.

5.3 Completing production records and other documentation

After all dyeing activities are carried out; the operators need to record/write down all dyeing output including amount of dyed yarn or amount of dyed fabric and any problems encountered in work place area. And the recorded data are kept for file in the future.

Figure 5.3: *Product documentation*

Documentation is a set of documents provided on paper or online, or on digital or analog media, such as audio tape or CDs.

Procedure and techniques of documentation:

It is vary from sector to sector. In general these may involve documenting drafting, formatting, submitting, reviewing, approving, distributing, reposting and tracking, etc. it could also involve creating content from scratch. Documentation should be easy to read and understand.

Self-Check -5

Test-I Multiple Choices

Instruction: select the correct answer for the give choice. You have given 1 Minute for each question. Each question carries 2 Point.

1. Which dispatching aspect is taken care of?
   A. All production information should be available beforehand.
   B. Various order cards and specification drawings should be ready.
   C. Equipment's should be ready for use.
   D. Progress of various orders should be properly recorded on the Gantt charts or display boards.
   E. All
2. Which one is the advantage of decentralized dispatching systems?
   A. It is easy to solve day-to-day problems
   B. Communication gap is reduced
   C. Because of urgency of orders, changes in schedules can be affected rapidly without upsetting the whole system.
   D. A and B are correct
3. Which procedure is performed in documentation process?
   A. Drafting
   B. Formatting
   C. Reviewing
   D. Approving E. All

Test II: short Answer writing

Instruction: write short answer for the given question. You are provided 3 minute for each question and each point has 5Points.

1. List down the three different package forms dyed materials to be unloaded.
2. Define what is dispatching?
3. What is the function of dispatching in production management?
4. List down the consequence of absence of area cleaning.
5. List at least 4 types of equipment and tools used in cleaning work area.

Note: Satisfactory rating – above 16.5%   Unsatisfactory - below 16.5%

You can ask you teacher for the copy of the correct answers

Unit Six: Dye outcomes

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

- Checking yarn or fabric quality
- Assessing yarn or fabric faults
- Rectifying or reporting yarn or fabric dyeing faults

This guide 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 yarn or fabric against quality standards for dye coloring.
- Assess yarn or fabric for faults and non-conformances.
- Rectify or report yarn or fabric dyeing faults.

6.1 Checking yarn or fabric quality

The main objective of checking dyed materials (yarn or fabric) is, to confirm their quality with pre-set quality standard. Example: color fastness, dye absorbed to yarn or fabric and etc must be checked before delivery. Many factors affect the strength of colorfastness. This may include:

a) Chemical nature of clothing,
b) Molecule structure of dye,
c) Molecular state of dye,
d) Amount of dye.
e) Type of conditions to which clothing is exposed

The outstandingly important property of a dyed material is the fastness of the shade. Colorfastness is defined as the strength of the clothes against fading or running out of clothing colors. Clothes that don't bleed color are always consumer's favorites. The fastness of a dye is related to the depth of the shade. There are different types of color fastness testing methods/machines in textile and apparel sector. These may include:

A. Weather-o-meter:

This is a machine used to test colorfastness against sunlight. Artificial lights used for this purpose and the number of hours to which clothes were exposed to this light are evaluated.

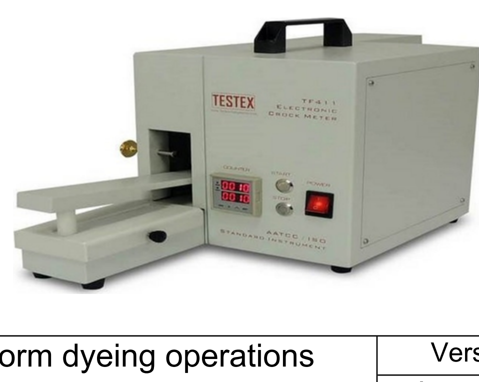
B. Launder-o-Meter

This is a machine used to test colorfastness to washing. During this process, clothes are put in containers with detergents/cleaning agents and metallic balls for friction and then evaluated for colorfastness quality.

C. Electronic Crock Meter

This device tests colorfastness to dry or wet rubbing. Nowadays, electronic crock meter is used in the textile industry instead of the mechanical one.

Figure 6.1: *Electronic Crock Meter*



D. Perspirometer

It is used to test the resistance of clothing colors to water and perspiration. Solutions similar to sweat in the composition are used to wet clothes and then pressure is applied to them. In this way, color fastness is accessed/checked via visual or instrumental means

Figure 6.2: *Perspiration tester*

Assessment of fastness involves a visual determination of either change in shade or staining of an adjacent material.

Most of the difficulties are overcome by the use of grey scales against which it has been found possible to compare loss of color or staining of any hue irrespective of depth. Its scale ranges from 5 to 1. 5 on this scale mean no color change after exposure to all kinds of agitating agents, whereas grade 1 involves a large amount of change in the original color of clothing.

It is necessary to use two scales, one for assessing change in color and the other for staining.

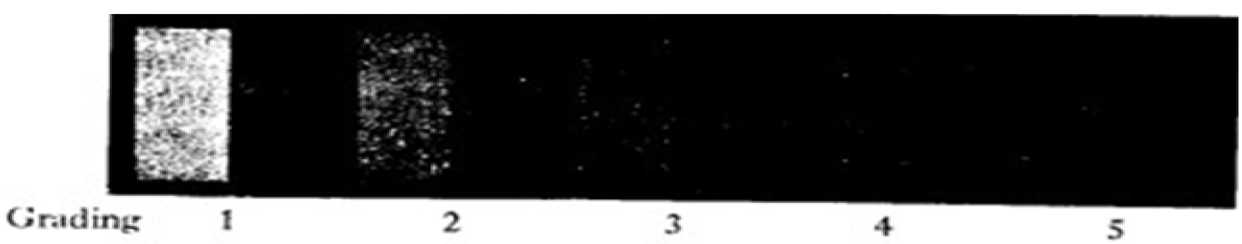


Figure 6.3: *Grey scale for alteration of color*

Table 6.1: *Color fastness rating*

Color difference	Fastness rating
0	5
4	4
8	3
16	2
32	1

In general there are different testers used in dyeing Lab to test the dyed textile materials. **Example:** Color Fastness Tester, washing fastness tester, light fastness tester, rubbing fastness tester, perspiration tester and etc.

6.2 Assessing yarn or fabric faults

When dyed yarn or fabric is assessed for its quality, different yarn or fabric dyeing faults may be observed during assessment. Some of yarn or fabric faults include: Inconsistent coloring, Marks, Contamination, Unlevel dyeing, Spot, Poor Color Fastness, and Dye Migration**.** Their description is as follow.

Inconsistent coloring or Shade variation:

It the color shades difference across the textile materials to be dyed. Small percentage of shade difference can move a material to rejection. So, it needs high care full during dyeing.

Marks:

Mark is the types of dyeing faults which can be seen on the surface of any dyed textile materials. These marks are of different types. Example: Softener Mark, Crease Mark, Folding marks and etc.

Contamination or Staining/bleeding:

It is the presence of a constituent, impurity or some undesirable elements that affect dyeing process.

Unlevel dyeing:

Unlevel dyeing is more specifically meter to meter variation of shade in fabric. So, basically when dyes cannot migrate properly in the whole fabric thus exhaustion of dyes in fabric becomes uneven which leads to running shade or uneven dyeing.

Spot: It is a small area that is a different color than the rest of your garment.

Poor Color Fastness:

Color fastness is rated poor if it does not comply with the tests by exposing to laundry, light, rubbing and other agencies such as perspiration.

Dye Migration:

Dye migration is the movement of dye from a dyed material (t-shirt) to another material (ink) in contact with the dyed material. It can occur on polyester and poly/cotton blend t-shirts and other garments when the garment is heated to temperatures in excess of 265°F (130°C), causing the dye in the garment to sublimate.

6.3 Rectifying or reporting yarn or fabric dyeing faults

Any observable yarn or fabric dyeing faults must be corrected or rectified and reported to concerned personnel. These yarns or fabric dyeing faults solutions or corrections that need be to fixed and reported may include:

- Follow the standard pretreatment procedure.
- Ensuring even heat-setting in case of synthetic fibers.
- Proper dosing of dyes and chemicals.
- Proper controlling of dyeing m/c
- Use standard dyes and chemicals.
- Maintain the same liquor ratio.
- Maintain the same dyeing cycle.
- The pH, hardness of supply water should check daily.
- Use of soft water.
- Proper opening of fabric rope.
- Maintaining proper reel sped &pump speed.

- By proper dissolving of dyes & chemicals
- By passing the dissolved dyestuff through a fine stainless steel mesh strainer, so that the large un-dissolved particles are removed.
- Proper Mixing of the softener before addition.
- Prevent the entanglement of the fabric during application of softener

Self-Check – 6

Test-I Multiple Choices

Instruction: select the correct answer for the give choice. You have given 1 Minute for each question. Each question carries 2 Point.

1. To determine fastness property of dyed textile material; it is subjected to which phenomenon?
   A. Light
   B. Washing
   C. Rubbing
   D. Perspiration E.A ll
2. How grey scale is read and interpreted during fastness testing?
   A. The bigger number scale reads corresponds with low fastness
   B. The bigger number scale reads corresponds with good fastness
   C. The smaller number scale reads corresponds with low fastness
   D. B and C are correct

Test II: short Answer writing

Instruction: write short answer for the given question. You are provided 3 minute for each question and each point has 5Points.

1. List down the probable faults assessment results of yarn or fabric dyeing.
2. List down at least 5 solutions or rectifications methods for yarn or fabric dyeing faults that are to be reported.

Note: Satisfactory rating – above 8% Unsatisfactory - below 8%

You can ask you teacher for the copy of the correct answers

Operation Sheet 6.1

Operation Title: performing color fastness to wash

Purpose: To check the resistance of a material to change in any of its color characteristics as result of washing with household detergent.

Instruction: perform wash fastness test for dyed fabric according to the given dyeing parameters and procedures. You have given 2hr for the task.

Equipment, Tools & materials:

Launder-o-Meter machine, bleached or undyed fabric, dyed fabrics, beaker, measuring cup, meter, detergent solution, different safety tools and equipment.

Operation procedures:

1. Yarn is knitted into a fabric from which a piece of the same dimensions can be obtained.
2. 10 X 4 cm a test specimen is cut from the material to be tested.
3. Two pieces of undyed fabric measuring 5X 4 cm is cut.
4. The specimen to be tested is placed between two undyed fabricand the three pieces are held together by stitching round the edges.
5. In the case of loose fiber the compressed mass is held in place by sewing it between pieces of cloth measuring 10 X 4cm.
6. Putting them in wash fastness tester machine.
7. After 30minutes remove it from machine rinse it with cold distilled water and cold running tap water for 10minute.
8. Then squeeze it and remove stitches from all sides.
9. Let dry it at temperature not above 60Co
10. The change in color of the uncovered portion of the specimen is assessed with Gray Scale No. 1 and the staining of the undyed materials with Gray Scale No. 2.

Figure 6.4: *Stitched sample*

Conditions or situations for the operations:

The operation is take place in standard temperature & closed machine lid.

Quality criteria: Required amount of soap must be used.

Precautions: solution made must contain 5 gpl of soap in which free alkali calculated as Na_2CO_3 should not be more than 0.3% free alkali calculated as NaOH should not be more than 0.1% and total fatty matter should not be more than 85%.

Operation Sheet 6.2

Operation Title: performing color fastness to perspiration

Purpose: To determine the fastness of colored textiles to the effects of acid and alkali perspiration.

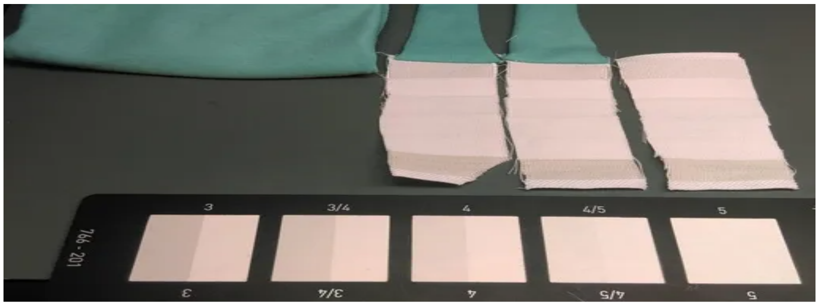
Instruction: perform perspiration fastness test for dyed fabric according to the given dyeing parameters and procedures. You have given 2hr for the task.

Equipment, Tools & materials:

Perspiration tester, Oven, Maintained at 37+-2 Degree centigrade, Multifiber test fabric, Grey scale, Color matching chamber, Acidic and Alkaline solution, Glass or Acrylic plat, Weight, bleached or undyed fabric, meter, different safety tools and equipment.

Operation procedures:

1. Two undyed cloths for each specimen each 6×6cm of the same kind of fiber as the sample.
2. Align the test specimen and multifiber fabric and sew together along the short edge to form a composite specimen.
3. Weigh each composite specimen. Calculate the amount of test solution according to a liquor ratio of 1:50 per specimen.
4. Thoroughly wet one composite sample in a solution of pH 8.0 at the liquor ratio of 20:1 and allow it to remain in this solution at room temperature for 30min. Pour off the solution and place the composite sample between two glasses plates measuring about 7.5×6.5cm under a force of about 4.5kg.
5. Treat the other sample in the same way but with the solution at pH 5.5.
6. Place the apparatus containing the samples in the oven for 4 hour at 37±2˚C
7. Separate the sample from the white cloth and dry them apart in air at the temperature not exceeding 60˚C.
8. After drying, assess all the specimens using the grey scale for assessing color change and assess all the components on the adjacent multi-fiber fabric using the grey scale for assessing staining.



Figur 6.5: *Stitched sample*

Conditions or situations for the operations:

The operation is take place in standard temperature & closed machine lid.

Quality criteria: Required amount of soap must be used.

Precautions: solution freshly prepared, containing 0.5g 1-histidine mono-hydrochloride mono-hydrate, 5g sodium chloride, and 2.2g sodium dihydrogen orthophosphate per liter brought to pH 5.5 with 0.1N sodium hydroxide.

LAP TEST-6

Instructions: perform the following tasks. You have given 2hr for each task. Each question carries 5Point.

Task-1. Perform color fastness to wash. (5points)

Task-2. Perform color fastness to perspiration. (5points)

Task-3. Request your instructor for evaluation & feed buck.