Testing and Quality Control of Reactive Dyed and Printed Woven Fabric on 100% Cotton

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Chapter 1: Introduction

If we relate textile industry with quality control than we would came to know that quality influences a great importance in market. The mills producing low quality level dyed and printed fabric and does not fulfill the demand of customers related to quality faces many difficulties related to their future orders.

Every mill should focus on testing in order to get good quality dyed and printed fabric which will help them compete the other products of dyed and printed fabric available in market.

The three basic aspects discussed above are very important related to quality in the field of dyeing and printing i.e. Competition, Productivity & Cost

This project has been done to know the influence of different factors on the quality of dyed fabric.

Variations in dyeing recipe and dyeing procedure has been done in order to know their effect on different properties like color fastness to washing, rubbing fastness and strength that how these factors if vary changes the testing results of dyed fabric.

For this purpose different techniques were used by changing dyeing recipe like changing:

- Concentration of salt
- Concentration of alkali
- Shade percentage

And the variables in dyeing procedure are:

- Temperature
- Time

Tests that have been done on the samples dyed with different recipes and at different time and temperature are as follows:

- Fabric strength BS 2576
- Colorfastness ISO 105-CO6
- Rubbing fastness AATCC D1776

SECTION 1
Literature Review

Chapter 2: Quality

2.1 Introduction:

Quality is the totality of features and characteristics of a product or service that bear on its ability to satisfy stated or implied needs. It is also useful to note that quality has several different attributes. The table given below lists eight basic dimensions that determine the quality of a particular product or service. [1]

Eight dimensions of quality

a) **Performance**

A products primary operating characteristics

b) **Features**

Supplements to a products basic functioning

c) **Reliability**

A probability of not malfunctioning during a specified period

d) **Conformance**

The degree to which a products design and operating characteristics meet established standards

e) **Durability**

A measure of product life

f) **Serviceability**

The speed and ease of repair

g) **Aesthetics**

How a product looks

h) **Perceived quality**

As seen by a customer [1]

2.2 Importance of quality:

Quality is an important concern for these basic reasons

- Competition
- Productivity
- Cost

2.2.1 Competition:

Quality has become one of the most competitive points in business today. A business that fails to keep face, may find itself falling behind not only foreign competition but also other local market.

2.2.2 Productivity:

Quality and productivity are related. If a firm installs a meaningful quality enhancement program three things are likely to result.

First the no of defeats is likely to decrease causing fewer returns from customers.

Second because the number of defects goes down, resources (material and people) dedicated to reworking flawed output will be decreased.

2.2.3 Cost:

Improved quality lowers costs. Poor quality results in higher return from customers, high warranty costs and lawsuits from customers injured by faulty products. Future sales are lost because of disgruntled customers. An organization with quality problems often has to increase inspection expenses just to catch defective products.

2.3 Quality Control of Dyed and Printed Fabric*:*

If we relate textile industry with quality control than we would came to know that quality influences a great importance in market. The mills producing low quality level dyed and printed fabric and does not fulfill the demand of customers related to quality faces many difficulties related to their future orders.

Every mill should focus on testing in order to get good quality dyed and printed fabric which will help them compete the other products of dyed and printed fabric available in market.

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2.4 Cotton:

Cool, soft, comfortable, the principal clothing fiber of the world. Its production is one of the major factors in world prosperity and economic stability. Cotton "breathes". What would we do without cotton? Since cotton wrinkles, polyester was added to give it wash and wear properties for a busy world. In recent times, the consumer determined that polyester, although easier to care for, took away the cool from cotton and also added a "pilling" effect to cotton/polyester blends. Consumers now often request "100% Cotton". Permanent finishes also added to the all cotton fabric gave a wash and wear property to cotton.

The cotton fiber is from the cotton plant's seed pod the fiber is hollow in the center and, under a microscope looks like a twisted ribbon. "Absorbent" cotton will retain 24-27 times its own weight in water and is stronger when wet than dry. This fiber absorbs and releases perspiration quickly, thus allowing the fabric to "breathe". Cotton can stand high temperatures and takes dyes easily. [2]

Boiling and sterilizing temperatures can also be used on cotton without disintegration. Cotton can also be ironed at relatively high temperatures, stands up to abrasion and wears well.

Mercerized cotton is treated to permanently straighten the cotton fibers which then become a smooth, rod-like fiber that is uniform in appearance with a high luster. Cotton is often blended with other fibers such as polyester, linen, wool, to "blend" the best properties of each fiber. [2]

2.4.1 Fiber structure and dyeing properties of cotton*:*

Cotton varies in its physical and chemical properties according to its origin. Varieties grown in different regions of the world vary in morphology and fine structure.

These varieties absorb dyes at different rates and to different saturation levels. In order to produce a commercially acceptable yarn, the spinner resort to blending different, varieties of cotton and thus obtains a homogeneous product. [3]

2.4.2 Cellulose Chemistry:

After scouring and bleaching, cotton is 99% pure cellulose. Cellulose is a macromolecule made up of anhydroglucose units united by 1, 4, oxygen bridges fig. The anhydroglucose units are linked together as beta-cellobiose; therefore, anhydro-beta-cellobiose is the repeating unit of the polymer chain. The number of these repeat units that are linked together to form the cellulose polymer is referred to as the degree of polymerization (dp). [4]

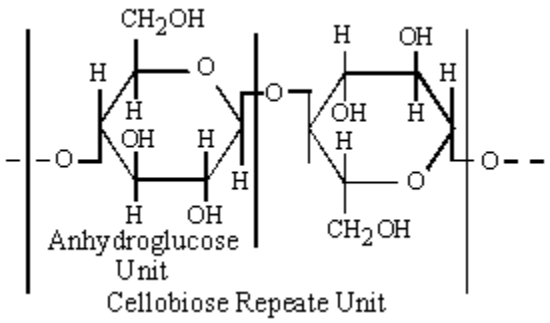

Fig 2.1 Chemical Structure of Cellulose

2.4.3 Crystalline and Amorphous region of cotton:

The literature on the physical structure of native cellulose (cotton) and regenerated cellulose (viscose) is extensive, sometimes conflicting and still open to changes in interpretation as new analytical techniques are developed. Nevertheless, for an understanding of dyeing and finishing it can be assumed that in all cellulosic fibers there are regions of differing degrees of molecular order and disorder resulting, at each extreme, in crystalline and amorphous regions respectively. The crystalline regions provide strength and rigidity, whereas the amorphous regions are associated with flexibility, absorption and reactivity.

The relative proportions and distribution of the crystalline and amorphous regions are of considerable importance, as they determine the behavior of the fiber towards chemical processing. It must be borne in mind that dyes and chemicals must diffuse into and be absorbed within the disordered (i.e. accessible) regions of the fiber.

The crystalline regions of the fibers are inaccessible to the penetration of dyes and many other chemicals. Diffusion-controlled processes are restricted to the disordered regions. These regions range from areas of low degrees of order to those that are completely disordered (the so-called amorphous regions). The fine structure of the cellulosic fiber therefore determines the accessibility of the fiber to dyes and chemicals such important parameters as rate, extent and uniformity of dyeing depend on these factors. [4]

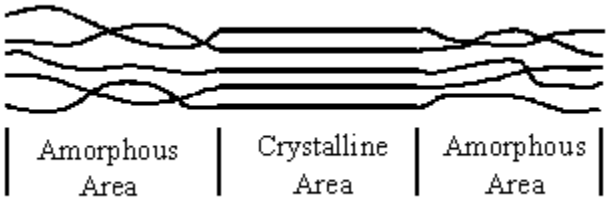

Fig 2.2 Amorphous and Crystalline Areas of Polymers

2.4.4 Properties of cotton depending on its structure:

The properties of cotton depend on the fiber structure at three levels of complexity.

These are:

- Molecular level, i.e. the degree of order of the matrix of cellulose molecules
- Fibril level, i.e. the orientation of the fibrils along the fiber axis
- Morphological level, i.e. structural differences between the surface and interior of the fiber

Differences at all three levels can occur with cotton as a result of fluctuating conditions during growth. The structure and hence the properties of the mature cotton fiber, can be modified by wetting, swelling, steaming or drying processes. The dyeing properties of cotton fibers depend on two important characteristics:

- Fiber diameter and internal structure
- Different varieties, grown in different regions of the world, vary in linear density (fiber weight per cm) by as much as 1:3 fiber diameter determines fineness of the staple and can vary by, as much as 5:1. [5]

2.4.5 Selection of dye for cotton*:*

To select a proper dye for fabric, it is necessary to know which dyes have an affinity for the vegetable, animal or manmade fibers. In general, the dyes used for cotton and linen may be used for rayons, but other fibers require different dyes.

When a dye colors fabric directly with one operation of impregnation, without the aid of an affixing agent, the dye is said to be a direct dye for that fiber. Direct dyes are the easiest to produce, the simplest to apply, and the cheapest in their initial cost as well as in application. They, however, like other dyes have their own limitations. One of these is the degree of colorfastness. Reactive dyes are costly to some extent but have good fastness properties. [5]

2.4.6 Fastness properties of dyes for cellulosic fibers:

Fastness of color refers to its ability to remain unchanged. Different dyes of different colors have different degrees of fatness to various conditions. For example, a color that may have good fastness to laundering may have poor fastness to light. Color fastness may be affected by such factors as perspiration, dry cleaning, bleach, salt water, swimming pool additives, atmospheric gases, or air pollutants. Also certain dyes may bleed or run, when wet a may cause discoloration of other fabrics. Some dyes may crock, or rub off, due to friction of wear.

Consequently, selection of the poor dye is crucial to its ultimate use. Fastness to light is important in draperies, for example, as they must stand strong light daily but do not need to be washed frequently. Fastness to washing is important in dress fabrics and house hold linens because they must undergo frequent washings. Therefore, both the kind of fiber to be dyed and the intended use for the fabric should be considered.

Once a color has been selected, it is essential that its formulation be kept consistent. Each batch that is dye must have its dye lot number. Since variations can occur in such factors such as chemical concentration, fiber structure, water content, or temperature and cause a slight change in color, each dye lot will be slightly different. Matching apparently the same color between two different pieces may become a problem. It is therefore important to use material from the same dye lot when piecing together such item is as apparel to drapery. [5]

Chapter 3: Dyeing

3.1 Dye and Dyeing:

A dye or a dyestuff is usually a colored organic compound or mixture that may be used for imparting color to a substrate such as cloth, paper, plastic or leather in a reasonably permanent fashion. In other words a dyed substrate should resistant to a normal laundry or cleansing procedures and stable to light.

It is important to remember all the dyes may not necessarily be colored substances. Therefore, optical brighteners or whiteners who may be called white dyes may be included in the term dye. Previously dyes were obtained from animal and vegetable sources. Today most of the vegetable dyes are synthetic dyes prepared from aromatic compounds which are obtained from coal tar or petroleum. [6]

A dye is composed of two parts:

- Chromophore
- Auxochrome

Chromophore is a coloring component, and auxochrome includes three portions:

- Solubility
- Carrier of dye
- Color parameter tweaking

Colored objects acquire their true colors because they absorb a definite portion (complementary color) of white light (visible portion of sunlight) unaffecting the rest. Some chemical groups such as azo (-N=N-), keto (X=O) etc which are responsible for the absorption of a portion of light are called choromophores and a compound containing a chromophore is called chromogen. When a chromogen contain other groups called anxochromes like amino (-NH2) group, the colored compounds acquire an additional property of getting bound to textile fibers. In other words colored compounds containing anxochromes are called dye.

Dyeing process suggest additional means of enhancing the appearance of the newly formed fabric. Dyeing process provide lasting beauty and delight to the beholder by adding color to fabrics. In the dyeing process, fiber, yarn, or fabric is impregnated with a dyestuff. [6]

3.2 Dye selection for cellulosic fibers:

All classes of dyes are useful in dyeing of textile fabrics made from cotton. For the cheaper end of the market direct and sulphur dyes are favored, whereas quality fabrics with high fastness properties are generally dyed with reactive dyes. In batch wise systems water soluble dyes are simple exhausted onto the cellulosic substrate in the presence of salt.

Textiles made from cellulosic fibers and blends can be found in numerous end uses and all at price levels. Such fabrics can meet the most exacting fastness requirements for military uses, work wear and furnishing fabrics. Using ranges of cheaper dyes, certain domestic textiles for which high wash fastness is not essential, e.g. bedspreads and curtains, as well as cheaper fashion clothing and leisurewear can be satisfactory processed to give adequate fastness properties.

The differences between the major classes of cellulosic dyes will now be discussed, leading to an appreciation of the factors that determine which class is chosen for a given substrate and end use. The first question to consider is why several major classes of dyes are necessary for cellulosic dyeing. The reasons are partly historical, arising from the way the dyeing of cotton has evolved, and partly because the various dye classes tend to complement one another. No single dye class meets all requirements; each has its own strengths and weaknesses. [6]

3.3.1 Factors influencing selection of dyes*:*

There is certain point, which should be kept in mind while choosing a suitable dye. Some of them are as follows:

- Type of dye
- Customer’s satisfaction
- Method of application
- Type of machine to be used
- Availability of other auxiliaries
- Cost of dye
- End use of fabric
- Fastness of dye
- Steaming time and temperature
- Type of fabric which is going to be processed
- Cost of production