CHAPTER 1

GENERAL INTRODUCTION

1.1 INTRODUCTION

Cotton is still the "King" of fibres because most of the world's apparel is made using Cotton. Cotton has excellent properties like high water absorbency, good moisture regain, wearing comfortability and easy dyeability. For these reasons, apparel industry is predominantly utilising cotton-based material and the share of cotton in total fibre consumption is about 50% (Wang et al 2003 and Karmakar 1999). This is the reason for selecting cotton fabric as a base for this work.

Cotton fabric needs to be prepared to remove the natural impurities and increase the absorbency for colouring. To dye cotton fabric sulphur, vat and direct dyestuffs of excellent fastness to light were used during the past decade. It has made possible for dyers and printers to produce a large variety of goods of guaranteed light fastness. In recent days, the usage of sulphur dyes is restricted due to effluent problem. Vat dye has complicated dyeing method and direct dye usage reduced due to lower wash fastness properties. So, the only alternative dye range available to meet the customer requirement is reactive dye.

In 2010, fifty percent of total dyes produced in India were reactive dyes. Today, reactive dyes are the largest single range of dyes used for the dyeing of cotton. Reactive dyes are becoming increasingly popular for dyeing
cellulosic fibres because of their wide range of shades, ease of application and excellent wash fastness properties. The improvement of the light fastness of reactive dyes on pale shades is extremely important, considering the superior dye fastness yielded by the reactive dyes over other classes. The present research work is designed to analyse the various factors and methods to improve light fastness.

1.2 COTTON IMPURITIES

Cotton is the purest form of cellulose found in nature, the seed hair of plants of the genus gossypium (Shore 1995). Cotton contains approximately 10% by weight of non-cellulosic substances such as lipids, waxes, pectic substances, organic acids, proteins/nitrogenous substances, non-cellulosic polysaccharides and other unidentified compounds included within the outer layer of the fibre (Karmakar 1999). These non-cellulosic materials create a physical hydrophobic barrier which protects the fibre from environment throughout the fibre development; they provide lubrication during textile processing, and affect the enhancement of the fabric’s wettability and absorbency (Hartzell & Durrant 2000).

The process of removing these impurities from cotton to increase absorbency is called as scouring. Usually cotton fibres are half-white in colour due to natural colour bodies in it. The process of removal of these colour bodies from fibres is known as bleaching. Before cotton fibre is coloured with reactive dyes, scouring and bleaching processes are essential to get even colour on fibre substrate.

1.3 REACTIVE DYES

Reactive dyes attach to the cellulosic fibres by forming strong covalent (molecular) chemical bond. These dyes were developed in the 1950s
as an economical process for achieving acceptable colour fastness. Bright shades and excellent wash fastness properties are the trademark of reactive dyes. Reactive dyes have water solubility and can possess various reactive groups, during the process of dyeing which react chemically with the fibre substrate to form covalent bond in presence of alkaline so that it becomes a part of the fibre itself.

The most commonly available reactive dyes have chlorotriazine (CT), vinylsulphone (VS), or CT-VS hetero-bifunctional functionality. Reactive dyes form covalent ether bonds like above with cellulose. With the chlorotriazine reactive group, the Cl group is replaced by the Cell-O-group through a nucleophilic substitution reaction. Both types of reactive groups can be used in the same dye structure to increase fixation. Reactive dye classes include trichloropyrimidine, mono-chlorotriazine (MCT), carboxypyridino triazine, dichloroquinoxaline, monofluoro-triazine, difluoropyrimidine, difluoromonochloro-pyrimidine, and phosphonic acid dyes. Reactive dyes are susceptible to damage due to chlorine and have moderate light fastness properties.

The ratio of the rate constant for reaction of the dye with the fibre and with water is a constant for a given dye over a wide range of alkaline pH values (Shore 1995). The processing of cotton with reactive dyes requires the following aspects to be considered electrolyte, bath liquor ratio, alkaline (pH) and temperature. Most (98%) commercial reactive dyes are fixed under alkaline conditions. In order to achieve maximum wash fastness of a reactive dyeing, the hydrolysed dye which is present in the fibre and held by weaker affinity forces should be completely removed. Otherwise, it would lower the wash fastness of the dyeing because of its lower substantivity to the cellulose. That is usually removed by soaping treatment at the boil (Shenai 1993).
1.4 COLOUR FASTNESS

The property of resistance of colour to the agency named washing, light, rubbing and gas fumes is called fastness (Textile Institute). Nowadays, consumers are more sophisticated than ever. They are conscious not only of style and comfort, but also of care and durability. They demand a quality product. Market studies show that consumers make many purchase choices based on the colour. Colour fastness refers to the ability of a dyed fabric to retain its original colour. Apparel and home furnishings are exposed to a wide variety of conditions which may affect the fastness of a colour, such as laundering, dry cleaning, gas fumes, light, perspiration and rubbing. Colour fastness within each dye classification is affected differently by each of these factors and also may vary within different colours in the same classification. Thus, the consumer has no real guarantee of the degree of colour fastness unless the product is described as "colourfast". Therefore, a fabric’s ability to retain its original colour is one of the most important properties of a textile product.

For customers satisfaction with respect to cotton the following fastness are very essential

- Wash fastness
- Rubbing fastness
- Light fastness

1.5 WASH FASTNESS

The property of resistance of colour to the washing agency is wash fastness. The wash fastness depends on dye and after treatment of dyeing. The reactive dyes react with cotton and form covalent bond. The energy required
to break this bond is similar to that required to degrade the substrate itself, thus accounting for the high wash fastness of these dyes. The unfixed colour removal is also an important factor for achieving good wash fastness. Colour fastness to washing is the common quality parameter, which is considered very important from the point of view of consumers. This test determines the change of colour and staining during the washing process by a consumer.

1.6 RUBBING FASTNESS

The property of resistance of colour to the rubbing agency is rubbing fastness. Rubbing fastness means staining of colour due to rubbing of the fabric. Colour fastness to rubbing is of greater importance in apparel (especially collars and hems) and upholstery fabrics. Construction of the fabric and nature of the colour whether it is pigment, reactive, disperse or direct have its own effect on fastness properties to rubbing. There are some colours like black, red, burgundy, navy blue which has poor rubbing fastness properties because of their chemical structure.

Black colour is a carbon base colour and the particle size of carbon is larger that is why rubbing properties are poor for black colour. To improve the colour fastness, more binder is added to these colours during printing. The construction of the fabric also affects the rubbing fastness properties.

1.7 LIGHT FASTNESS

The property of resistance of colour to the light agency is light fastness. The light fastness of dyed textile materials is one of the most important characteristics for apparel and upholstery goods. The light fastness of the dyed goods is evaluated by the amount of dye destruction in the fibre on exposure to an artificial light source which is similar to sun light. Factors affecting light fastness are the intensity and spectral composition of the light
used for exposure, the properties of fibre, the dye concentration in the fibre, the dye reactivity, the state of the dye in the fibre, the nature of the bond between the dye and fibre and the physical and the chemical constitution of the fibre. In combination shades, light fastness ratings are even lower than the lowest values of the individual dyes constituting in the mixture. Light stability is a characteristic which determines the capability of a material to retain its original properties after exposure to electromagnetic radiation in the visible and ultraviolet regions of the spectrum. In the case of dyed polymeric materials under the action of light, the dye is subjected to the destruction. The most obvious effect of exposure to light fading is the change in colour of the material.

1.8 PROBLEM OUTLINE

Reactive dyes are brilliant and cover the entire colour range. Due to the strong covalent bonds between dyestuff molecules and fibre functional groups, their colours are highly resistant to washing and rubbing. Light fastness is an important property that limiting the life cycle of dyed textile materials (Allen 1994). The light fastness of different types of dyes on the textile materials has been extensively discussed in numbers of technical papers, reviews and monographs, while only little attention has been paid to the light fastness of reactive dyes (Krichevskii et al 1975).

Most dye manufacturers, while providing information on fastness properties of the dyes in their standard shade cards, do not mention anything about combination shades. Usually when two or more dyes are used for a combination shade, the light fastness of the combination is governed by the lowest value of the individual dyes (Nandy 1999). Such a phenomenon has been termed catalytic fading and has been proved to be attributable to the action of singlet oxygen.
Light fastness is particularly important for products such as summer clothing and sportswear used under conditions of extensive sunshine (Cristea & Vilarem 2006). In this case it is preferred that fibres and dyestuff possess a comparable fastness, but this is practically hard to achieve. The combined impact of sunshine and other outdoor factors such as temperature, moisture content, and chemical composition of the atmosphere induce photo destruction of fibres and photofading of dyestuffs (Datyner et al 1977). The improvement of the light fastness of reactive dyes on pale shade is extremely important, considering that the dye fastness yielded by reactive dyes is superior to that of dyes of other classes (Allen et al 1992). The improvement of light fastness is therefore being sought at the present time (Oda 2008).

1.9 SCOPE OF THE PRESENT STUDY

Colour fastness of the garment decides the life of the garment. Care to be taken to achieve the good light fastness in each stage of processing is studied. The methods to reduce the light fading are also in the scope of this study.

The span of the present work includes:

- Investigation of the effect of yarn linear density on the fastness.
- Investigation of the effect of the type of fabric construction on light fastness.
- Investigation on the chemical structure of dyes and its effect on the light fastness of the dyed fabric.
- To study the influence of pretreatment and dyeing method on the light fastness of the coloured material.
- To study the effect of finish on the light fastness of the fabric.
Investigation of the light fastness improvement methods on dyed fabric.

The treatment given for light fastness was assessed in terms of colour change during light exposure, wash fastness in terms of colour staining and rubbing fastness as per the international standards.

1.10 STRUCTURE OF THE THESIS

The thesis is divided into 11 Chapters. Chapter 1 introduces the general subject and discusses the need for undertaking this work and also the objectives of the study.

Chapter 2 is an extensive literature survey on the subject. This literature review provides background and guidance for the entire study.

Chapter 3 describes the materials and the methods used for cotton pretreatment, dyeing, finishing and treating of reactive dyed cotton fabrics with antioxidants and ultraviolet absorbers. Further, the experimental procedures involved to carry out the various colour fastness tests are described.

The effect of yarn linear density and fabric structure on the light fastness is discussed in Chapter 4.

The effect of pretreatment methods such as grey boiling, enzymatic scouring, alkaline scouring, mercerisation and semi-bleaching on fastness of final goods are discussed in Chapter 5. Wash, rubbing and light fastness properties of fabrics pretreated by different methods are studied.

Chapter 6 discusses the influence of exhaust, cold pad-batch and pad- humidity fix process dyeing methods on fastness.
Chapter 7 analyses the influence of the chemical structure of the reactive dyes chemical structure on wash, rub and light fastness. Studies on the influence of the finish on wash, rubbing and light fastness is presented in Chapter 8. Percentage contribution of factors of light fastness is calculated using Taguchi method.

Chapter 9 &10 describes the methods to improve the light fastness of dyed goods. The durability of the treatment to light fastness after washing is also analysed.

Finally, the summary of the entire study and the conclusions drawn from it along with the scope for conducting further research in this area are presented in Chapter 11.