CHAPTER I

Introduction

Cellulose is the most abundant of all naturally occuring organic polymers. Although exploited in the forms of cotton, flax, wood and other textile fibers, the purest form of cellulose found in nature is cotton. Cotton is widely available and is the cheapest natural fiber used for clothing. Cotton dyeing evolves with somewhat complementary features of various classes of dyes such as reactive, direct, vat, sulphur and azoic dyes. In recent years, trend in usage of reactive dyes has been increased. Worldwide demand for this class of dye was already considerable and since that time further progress has been made at the expense of azoic, direct, sulphur and vat dyes. The distribution of reactive dyes for exhaust dyeing was estimated at 38% in package and hank dyeing, 36% in winch and paddle machines, 15% in jig dyeing and 11% mainly for loose fiber[1]. According to the structure and properties of cellulose are credited with the first recognition of the adventages to be gained by creating covalent bonds between dye and cellulosic fibers, hence giving dyeing with high wash fastness property. An example of a covalent bond between cellulose and a dye molecule is illustrated in Figure 1.1[1]. However, this type of covalent bond is susceptible to hydrolysis reaction which makes this reactive system commercially unviable.

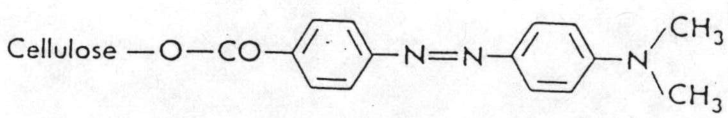
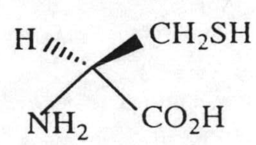
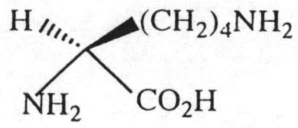


Figure 1.1 An ester bond between a dye molecule and cellulose.[1]

The first commercial reactive dyes were introduced in 1956[35] and have since proven their value in terms of brilliance, wide shade gamut and wet fastness properties. In the case of cotton dyeing, the majority of reactive dyes on the market still suffers from relatively poor uptake by the fiber. Cotton when dyed with reactive dyes gives total fixation efficiencies (dye-fiber covalent bonding in proportion to the original amount of dye applied) of approximately 70%[2]. In particular, fixation efficiency depends on the type of reactive group, the nature of the chromophore attached to the reactive group, the substantivity of the dye, the number of reactive groups per dye molecule and the dyeing process selected. In the conventional dyeing method, reactive dyes are applied to cotton fiber under alkaline dyeing conditions where the completing hydrolysis reaction inactivates some of the dye reactive groups making them unavailable for further reaction with the fiber. This reaction detracts greatly from the cotton reactive dyeing process leading to problems such as unacceptable levels of colour in effluents, generally, up to 30% of dye lost[2].

Another problem responsible for poor dye uptake is due to low reactivity of cellulosate anion itself. By comparison, when wool is dyed with reactive dyes even at relatively lower pH dyeing, total fixation efficiency is much greater than those obtained from cellulosics dyeing[6]. This is because wool is built up from 18 different amino acids with a variety of reactive groups such as listed in Table 1.1. These side groups such as cysteine and Lysine contain a free thiol and amino groups, respectively. These groups are found to be more reactive than the hydroxyl groups of cellulose. They can react with reactive dyes without the requirement of alkalis. Therefore, in the case of wool dyeing, the hydrolysis reaction of dyes is minimized.

Table 1.1 Examples of amino acid with a various reactive groups.[25]

Amino acids	**Functional groups**	**Chemical structures**
Cysteine	Thiol group	
Lysine	Primary ε-amino group	

The main objective of this project is, therefore, to improve the reactivity of cotton fiber by incorporating the more reactive amino group into cotton. To achieve that goal, cotton must be chemically modified using a modifying agent which will be synthesized in our laboratory. The Fourier-transform Infrared spectroscopy and nuclear magnetic resonance techniques are employed to characterize the modifying agent. After the modifying agent is applied to cotton fiber, further treatment with suitable amines such as ethylenediamine or tris-(2-aminoethyl)amine is then carried out in order to achieve the reactive fiber. In addition, the characterization of reactive fiber is also investigated using elemental analysis technique to determine for nitrogen content. Finally, the dyeing of resulting reactive fiber is carried out under alkali-free condition. The degree of dye fixation is then compared to those obtained from the dyeing of unmodified cotton under alkaline dyeing condition.