

## CHAPTER 1

### Introduction



The cellulosic yarn and fabric which come from the spinner, weaver and knitter are in rough conditions. The materials are harsh in handle and always contain impurities. It then becomes the task of the finishing plant to scour, bleach, mercerize, dye, print and finish these materials so that they acquire attractive appearances and appropriate qualities. The scouring and bleaching are the purifying processes which are used in removing the impurities present in the textile materials. Mercerization is a very useful method for giving cotton yarns and fabrics a higher lustre. Dyeing is employed to produce the required shade all over the yarn or fabric. Printing is used to produce patterns which may contain up to twelve different colours. After scouring, bleaching, mercerizing, dyeing and printing, the yarn and fabric have to be finished to bring the textile into presentable attractive conditions.

In the mercerization process, the yarn is allowed to react with sodium hydroxide solution, concentration of 15-40 % (wt/wt) under tension condition, cotton or cellulose which is in crystalline form is converted into alkali-cellulose which is in amorphous form. The fibre expands in diameter and shrinks in length, cross section of the fibre changes from the kidney shape to the circular shape which makes the fibre look more lustrous. Beside this, the porosity of fibre increases, and the fibre is more able to absorb dye molecule than the unmercerized cotton fibre.

In chemical engineering field, chemical kinetics is a very important subject, it concerns about the rate and mechanism of chemical reactions. The rate of a chemical reaction can vary from a value approaching infinity to zero. Most industrial important reactions occur at rates between these extremes. It is particularly important to know how the rate changes with operating parameters, the most important of which are temperature, pressure and concentration of reactant.

Along with kinetics, the engineering concepts are required to evaluate the conversion of reactant from a reactor. In a batch reactor, composition of reacting mass is a function of time.

The chemical reaction can be divided into two types, homogeneous reaction and heterogeneous reaction. Homogeneous reaction is a reaction which reactants are in the same phase (gas or liquid phase). Heterogeneous reaction is a reaction which reactants are in different phases (solid-liquid, solid-gas or gas-liquid) so that physical-resistances involve in this type of reaction. Heterogeneous reaction can be subdivided into two types, heterogeneous catalytic reaction and heterogeneous non-catalytic reaction.

Cotton yarn mercerization is a heterogeneous non-catalytic reaction between cotton fibres (solid phase) and sodium hydroxide solution (liquid phase) under tension condition. The reaction takes place by diffusion of sodium ions through liquid boundary layer and react with the cotton fibres at the surface of the fibres. As the reaction goes on, product alkali-cellulose formed around

cellulose core so that sodium ions also diffuse continuously through this layer. The global rate of mercerization may be controlled by either diffusion of sodium ions through liquid boundary layer, by diffusion of sodium ions through product alkali-cellulose or by the reaction stage at the reacting zone between alkali-cellulose and unreacted cellulose core.

The objects of this work are to determine the rate of mercerization, mechanism and the rate controlling step of the mechanism. Mathematical model of expanding product-shrinking core was developed to describe the mechanism of this process. The rate expression for each type of rate controlling step was obtained.



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