# Chapter I

## Introduction

Mixing has played an important role in chemical industries for a long time. To meet the complete objectives it is essential to determine the significant mixing parameter(s) and incorporate that knowledge into a successful commercial-scale design. Economic benefits, such as minimum power usage or low capacital cost, can be achieved by applying technology in manner that assures the specific process mind is optimized with respect to agitation, and that the ultimate mixer selection is an optimum design.

Mixing is perhaps the most universal of all processing operations. Both heat and mass transfer are greatly influenced by mixing. In fact, mixing is an integral part of all chemical processing. In spite of this, mixing has proved intractable to a rigid theoretical analysis. Thus, in comparison with the more theoretically developed chemical engineering operations, mixing is still regarded as something of an art.

Quillen [1] defines mixing as the intermingling of two or more dissimilar portions of a material, resulting in the attainment of a desired level of uniformity, either physical or chemical, in the final product. "Gases, confined in a container, mix rapidly by natural molecular diffusion. In liquids, however, natural diffusion is usually a slow process. To hasten molecular diffusion within liquids, the mechanical energy from a rotating agitator is utilized. Much of this mechanical energy may be wasted if the wrong kind of agitator is used to accomplish the desired process result. Parker [2] defines agitation as "the creation of state of activity such as flow or turbulence, apart from any mixing accomplished."

The rotation of an agitator in a confined liquid mass generates eddy currents. These are formed as a result of velocity gradients within the liquid. A rotating agitator produces high velocity liquid streams come into contact with stagnant or slower moving liquid, momentum transfer occurs. Low velocity liquid becomes entrained in faster moving streams, resulting in forced diffusion and liquid mixing.[3] Throughout this text, liquid mixing is regarded as forced diffusion in a confined liquid mass.

Fluid mixing can be characterized by six basic categories of processing pairs. Physical processing pairs and chemical processing pairs illustrate the difference between a physical degree of uniformity as one criterion and some type of chemical reaction or mass transfer as another criterion, for a given application class. In attempting to classify mixing operation it is helpful to consider the phases (solid, liquid or gas) involved in a particular process.

1. Single-phase liquid (miscible) mixing
2. Liquid-liquid (immiscible) mixing
3. Liquid-Solid mixing
4. Gas-liquid mixing
5. Three-phase contacting
6. Solids mixing

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For this experimentation, single-phase liquid (miscible) mixing is studied because it is necessary to mix together miscible liquids in many operations, e.g., the blending of petroleum products, pharmaceutical process, pulp and paper process and many processes in waste water treatment. This is sometimes regarded as a simple mixing duty since it involves neither chemical reaction nor interphase mass transfer. It is necessary only to reduce the non-uniformities, i.e. variations in concentration to some acceptable level. However, such blending operations can be difficult to achieve when the liquids have widely different viscosities or densities. Also, problems can be encountered if one of the liquids to be mixed forms only a small volume fraction of the final mix.

When chemical reactions occur between miscible liquids it is necessary to bring together the reactants at the molecular level by mixing before the reaction can occur.

From the history of mixing, many studies are concentrated on batch mixing. The continuous mixing is another kind of mixing pattern that is used in industrial processes. There are not many data and characteristic curves available for the continuous mixing. In this thesis, the aim is to study the mixing time in continuous mixing to complete the data for use in Industrial processes.

Experiments are carried out to study conditions effecting mixing in continuous stirred vessel. The effects and directions of the changes on the mixing system can be observed by mixing time. If the time of mixing employed is much longer than the required mixing time, time and energy would be wasted. In industrial processes, it means decreasing production capacity and increasing extra expenditure. If the effects of the parameters in continuous mixing vessel are known, it would be advantageous for the designing of the process simulation to achieve effective result.

The method to detect the change in the mixing system can be determined by many methods such as concentration, optical, dye, temperature [4] and conductivity. In this experimentation, conductivity method is selected to study the condition effecting the continuous mixing system because:

- Measurement of electrical conduction can be made with high sensitivity which means that the amount of tracer required can be kept so small that it will not interfere the process being studied.

- There is a wide choice of conductive tracers available therefore suitable tracer that is economical and comply with experimental condition can be easily selected.

Parameters effecting continuous mixing system are as follows. Baffles effect the mixing system by preventing the system from eddies that can cause incomplete mixing. Type of agitator effects the liquid systems used. The flow rate of liquid input leads to the different residence times of the mixing system and the speed of the agitators results in the condition of the mixing system.

The purposes of this experiment were to study the conditions effecting the continuous stirred vessel and observe the directions of the changes in mixing system with different conditions by using conductivity method.

The mixing system used in this study was a standard configuration flat bottom cylindrical tank. The major interested parameters were

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| Types of impeller | Three types of impeller, 6 bladed open turbine, 6 bladed disc turbine, and 6 bladed 45 degree pitch turbine. |
| Positions of impeller | at 1/2 and 1/3 tank's diameter above tank's bottom. |
| Speeds of impeller | 264.87, 441.57 and 618.27 rpm. |
| Diameter of tanks | 20, 25 and 30 cm. |
| Mean residence times | 30, 55, 85 and 125 minute |

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