CHAPTER II

LITERATURE REVIEW

Many experiments have made measurement of the 95 % mixing time in stirred vessels. For similar property liquids by releasing a volume of a passive tracer liquid into the flow and following the concentration throughout the process. The 95 % mixing time is defined as the time at which concentration fluctuation have decayed to within ± 5 % of the final mean concentration.

The tracer liquid may be marked using, for example, colored dye, electrolyte concentration, temperature; the tracer concentration could be defected by a light absorption, conductivity probes or thermocouples.

Smith and Schoenmakers (1988) studied the requirement of time to blend small quantities of fluid into a turbulent low viscosity liquid.

The experiment have been made in a standard flat bottom tank of diameter T = 0.29 m. with a six blade Rushton impeller of diameter D_i = 0.4 T = 0.116 m., with the disc plane 0.4 T. from the bottom. For the experiment in which viscous liquids were blended into a low viscosity bulk either thick sugar syrups containing some sodium hydroxide or solution of sodium carboxy methyl cellulose (1-2 %) were used.

For experimental investigation used a conductivity method to compare the time to assimilate various aqueous solutions into water in stirred vessel. The viscosity of the added fluids ranged up to about 1500 mPas.

The results of all the mixing time measured in the impeller discharge can be shown in Figure 2.1

This figure confirms the lack of importance of rheology when the additive is introduced over a period rather than instantaneously as a discrete mass.

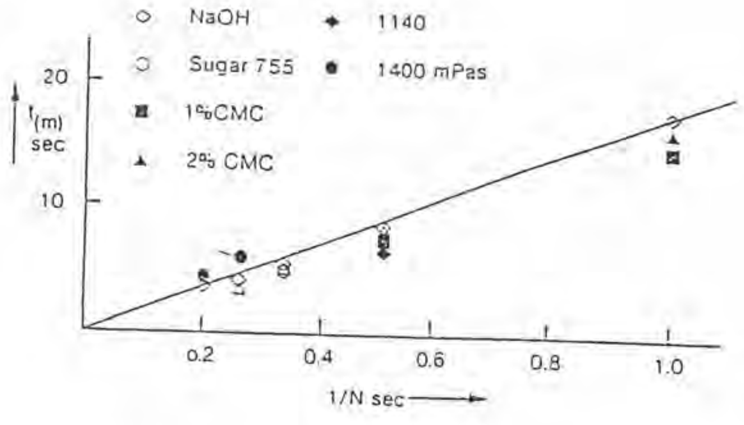

Figure 2.1 Mixing times, measured in impeller discharge, for all solutions used, related to impeller speed.

From the experimental has shown that when adding small volumes of high viscosity components to a turbulent low viscosity bulk :

1. Higher viscosity does not of itself retard the later stages of blending.

2. It is always better to introduce high viscosity liquid in an elongated stream rather than as droplets.

3. Addition near the impeller shaft on the free surface is generally reliable and efficient.

4. Higher impeller speeds reduce the danger of settling out and subsequent adhesion of the viscous material to arbitrary surfaces.

5. Providing care is taken to prevent clumps of highly viscous material sticking to fixed, the usual mixing time correlations provide an adequate basis for design.

Rielly and Burmester (1994) studied the mixing of miscible liquids with significant density and viscosity differences, in vessel of 0.29 m. and 0.13 m. diameter standard geometry tank agitated by Rushton turbine at rotational speeds 2-6 rps. and 6-bladed 45^{0} pitch-bladed impellers. Two cases of industrial are discussed in this paper :

Case (1) : A small quantity of high viscosity (glucose syrup) material was added into a low viscosity (water) bulk. Conductivity probes were used to measure the concentration time.

Case (2) : A viscous liquid was added into a high viscosity bulk (Carboxy Methyl Cellulose, CMC)

In this work were studied as described in detail as follow:

1. The effect of impeller speed
2. The method of addition
3. The location of addition
4. Influence of the impeller type

The measurements of dimensionless mixing times for each method can be shown in Figure 2.2, 2.3, 2.4

Numerical simulations of mixing process are compared with experimentally determined mixing times and with flow visualization.

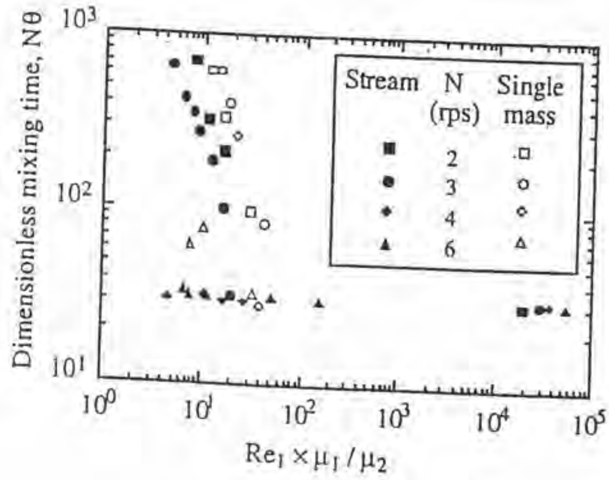

Figure 2.2 The effect of impeller speed

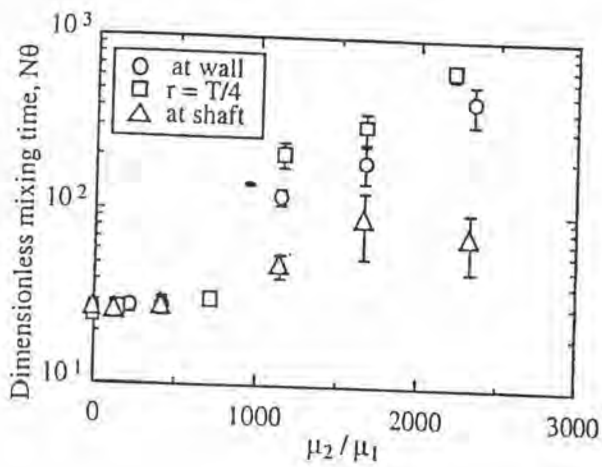

Figure 2.3 The effect of the addition point

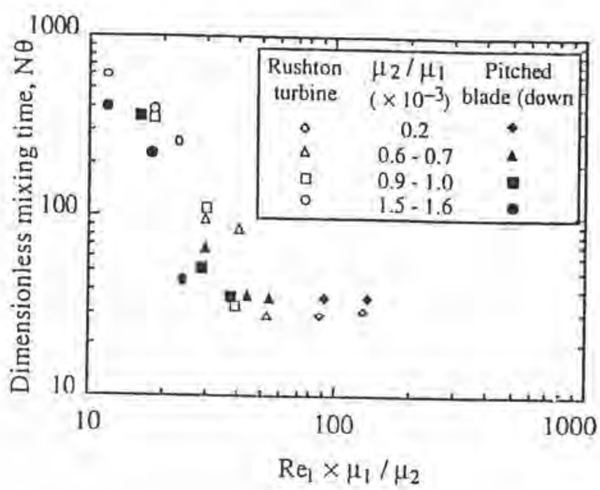

Figure 2.4 The efffect of the impeller type

Ahmad, Latto and Baird (1985) studied mixing of stratified liquids in batch mixing of the initially stratified layers of hot water and cold salt solution. The experiments were carried out in baffled tanks of diameter 28.8 and 90 cm. employing centrally-mounted marine propeller. The mixing times were measured from thermocouple record taken at different position in the tanks. The measurement of time at which the mixing starts at any point can be shown in Figure 2.5

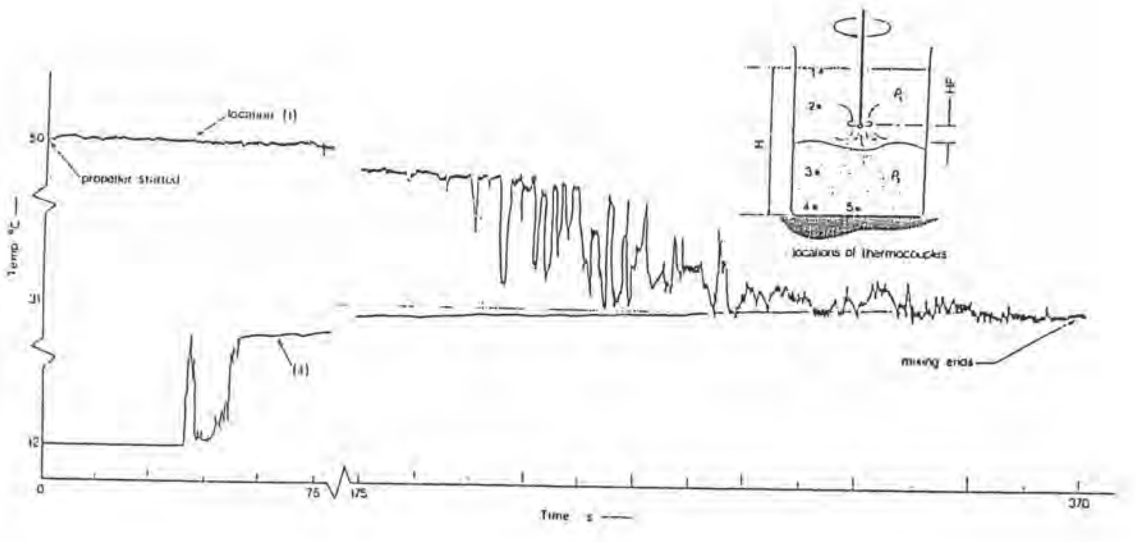

Figure 2.5 The measurement of time

The model development of mixing time can be derived in dimensionless of mixing time, τ, **($t_m ND_i^2 S$ / V)**, and Richardson number, Ri, ($\Delta\rho g H_l / \rho N^2 D_i^2$)

Dimensionless of mixing time is plotted against with overall Richardson number as shown in Figure 2.6

From this figure; A linear of data analysis provides the following equation for correlation line.

$$\tau = 0.1361\ R_{io} + 1.6933 \qquad (2.1)$$

A simple correlation for the energy efficient of mixing at low propeller speeds may be obtained as follows:-

$$\eta \approx 3.06\ (S/D_i)(D_iT/H_l^2)^{2.5} \qquad (2.2)$$

It is useful to have an expression for the mixing time in terms of power input / unit volume; t_m

$$t_m = \frac{0.0408\ gH_l^6}{[P/V]D_i^{1.5}ST^{2.5}} \qquad (2.3)$$

Saito, Arai and Kamiwano (1990) studied an extended technique for predicting the mixing time of high viscosity liquids in a mixer. The molecular diffusion and reaction between solutes each dissolved in the liquids were analyzed during the mixing. Concentration profiles were obtained by solving simultaneously the diffusion and reaction differential equation and a model equation representing the decrease of scale of segregation with time. The calculated mixing time is predicted as the elapsed time until the local maximum concentration of the solute become less than a chosen criterion of mixing. Mixing experiments were carried out with helical screw/draft tube mixers and helical ribbon-impeller mixers filled with corn syrups prepared at various viscosity. The chemical reactions were the reduction of I_2 to $2I^-$ in the presence of either $Na_2S_2O_3$ or Na_2HPO_4. It was found that the predicted mixing times were in fairly good agreement with those determined experimentally. The mixing time was found to depend mainly on the reaction rate of reactants as well as the operational conditions of mixer.

Ahmad, Latto and Baird (1985) studied mixing of stratified liquids in batch mixing of the initially stratified layers of hot water and cold salt solution. The experiments were carried out in baffled tanks of diameter 28.8 and 90 cm. employing centrally-mounted marine propeller. The mixing times were measured from thermocouple record taken at different position in the tanks. The measurement of time at which the mixing starts at any point can be shown in Figure 2.5

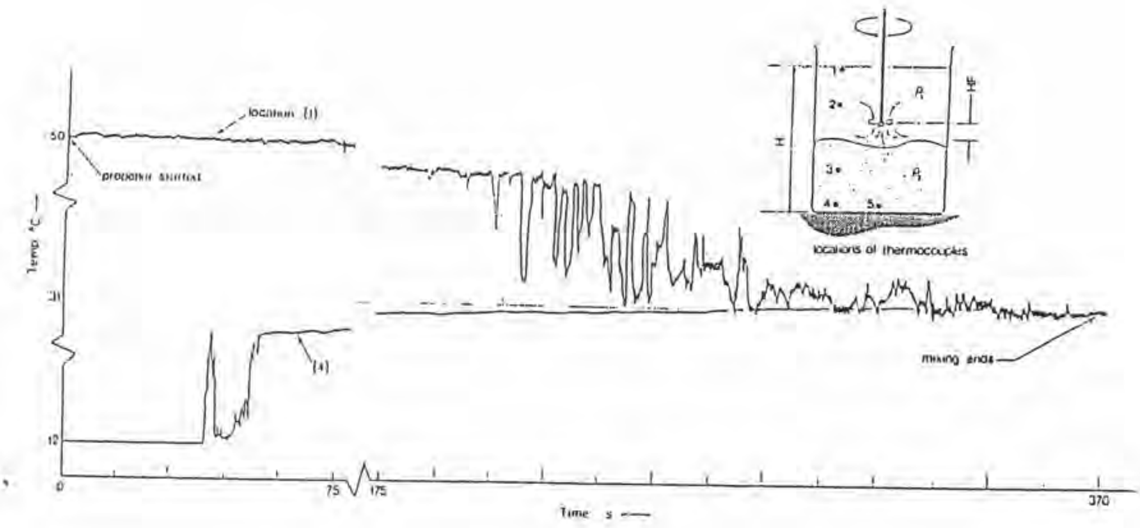

Figure 2.5 The measurement of time

The model development of mixing time can be derived in dimensionless of mixing time, τ, ($t_m N D_i^2 S / V$), and Richardson number, Ri, ($\Delta \rho g H_1 / \rho N^2 D_i^2$)

Dimensionless of mixing time is plotted against with overall Richardson number as shown in Figure 2.6

From this figure; A linear of data analysis provides the following equation for correlation line.

$$\tau = 0.1361 R_{io} + 1.6933 \qquad (2.1)$$

A simple correlation for the energy efficient of mixing at low propeller speeds may be obtained as follows:-

$$\eta \approx 3.06\ (S/D_i)(D_i T/H_l^2)^{2.5} \tag{2.2}$$

It is useful to have an expression for the mixing time in terms of power input / unit volume; t_m

$$t_m = \frac{0.0408\ gH_l^6}{[P/V]D_i^{1.5}ST^{2.5}} \tag{2.3}$$

Saito, Arai and Kamiwano (1990) studied an extended technique for predicting the mixing time of high viscosity liquids in a mixer. The molecular diffusion and reaction between solutes each dissolved in the liquids were analyzed during the mixing. Concentration profiles were obtained by solving simultaneously the diffusion and reaction differential equation and a model equation representing the decrease of scale of segregation with time. The calculated mixing time is predicted as the elapsed time until the local maximum concentration of the solute become less than a chosen criterion of mixing. Mixing experiments were carried out with helical screw/draft tube mixers and helical ribbon-impeller mixers filled with corn syrups prepared at various viscosity. The chemical reactions were the reduction of I_2 to $2I^-$ in the presence of either $Na_2S_2O_3$ or Na_2HPO_4. It was found that the predicted mixing times were in fairly good agreement with those determined experimentally. The mixing time was found to depend mainly on the reaction rate of reactants as well as the operational conditions of mixer.

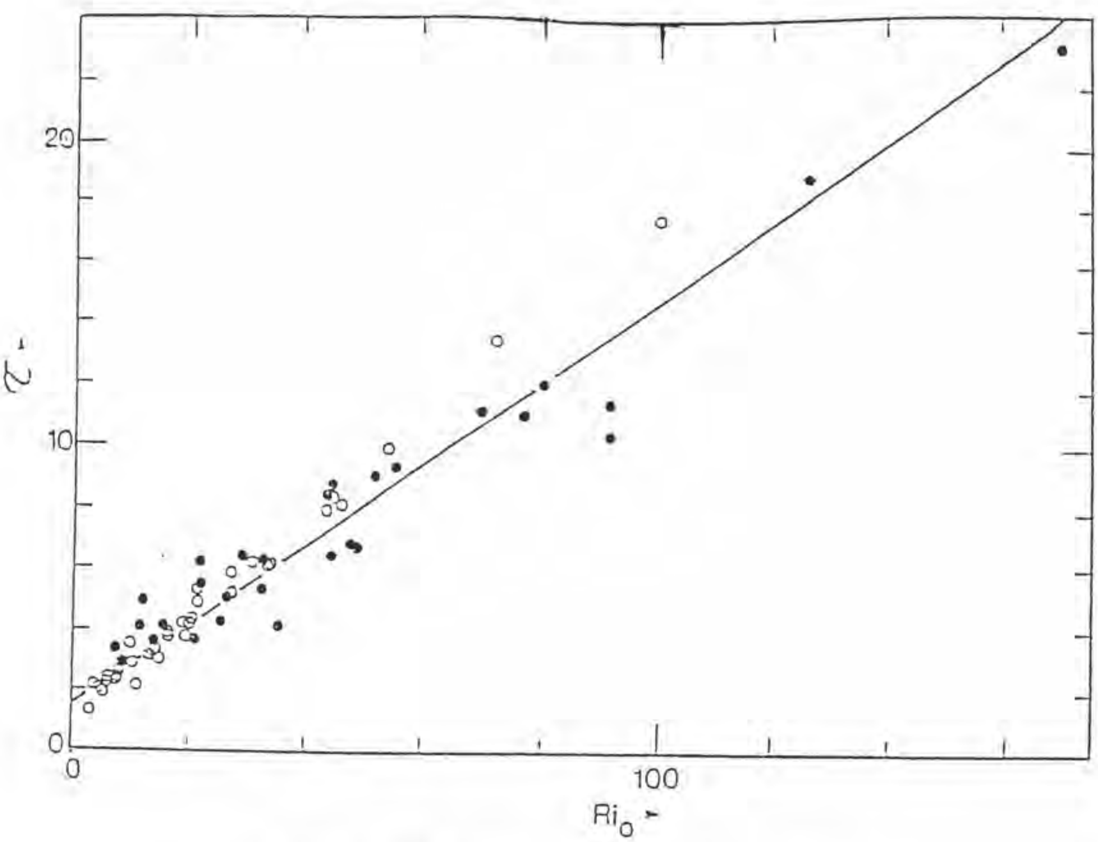

Figure 2.6 Dimensionless of mixing time