# Experiment 5
# Determination of the residence time using tracer techniques

**CHEN3010/ CHEN5040 - Chemical Reaction Engineering - S1 2024**

> **!** Prelab Module
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> Prelab module for experiment 5 Can be accessed here.

## 1 Objective

Determination of the residence time using tracer techniques

In this experiment we would like to measure the residence time distribution in a stirred tank reactor by using a step input technique. We will use KCl as a tracer.

## 2 Experimental procedure

The experiment will be carried out in a stirred tank reactor (Armfield Limited, model: CEM-MKII). A virtual tour is also provided that describes the setup in detail.

The continuous stirred tank reactor in the form of either a single tank or (more often) tanks in series, is used widely and is particularly suitable for liquid phase reactions. It is particularly used in the organic chemicals industry. Advantages include consistent product quality, straightforward automatic control and low manpower requirements.

The Armfield CEM-MKII Continuous Stirred Tank Reactor is specially designed to allow detailed study of this important process. Reactions are monitored by conductivity probe as the conductivity of the solution changes with conversion of the reactants to product and by temperature.

Please refer to equipment manual exercise C for further details.

### 2.1 Steps

1. Make up 2.5 litres of a solution of 0.1M KCL and fill one of the feed bottles. Fill the other feed bottle with demineralised water.
2. Using the Armfield data logger, initiate the program.
3. Set the reactor stirrer to a speed of '50%' and press 'Power on' button to start it up. The experiment can be carried out at room temperature initially. If other reactor temperatures are required this is achieved using the hot water circulator and setting the PID temperature controller in the software as detailed in previous experiments.
4. Start the water feed pump by setting the pump speed control to maximum in order to fill the reactor to the overflow as quickly as possible. When the reactor is full, stop the feed pump.
5. Start the KCL solution feed pump by setting the pump speed to 100 ml/min.
6. The conductivity of the reactor contents will begin to increase and, after a period of approximately 45 minutes to 1 hour, will approach the conductivity of the feed solution and will reach the steady state.
7. On conclusion of the experiment using the Armfield data logger, a set of readings of conductivity with time among other calculations will be stored in the computer.

## 3 Data analysis

Please refer to equipment manual exercise C for detailed data analysis.

## 4 Tasks

Prepare a report based on your interpretation of experimental data. The report should consider the following:

1. Describe the charectristics of the RTD
2. **Data analysis**: Perform data analysis in Excel to analyze the data obtained. Based on the analysis, report the mean residence time Present relevant graphs for all the data sets.