Microfluidic Fist Piston Flow Reactor

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Abstract **- Performing an lab experiment by a student while his study is an important parameter of engineering and science graduates for best understanding of concepts, a part in visualizing the equipment in industrial scale, to get an idea about operating the equipment, to understand the concept and mechanism behind it and to use it in the appropriate place wherever needed. On basis of chemical engineering discipline, the cost of equipment is high, consumes space and chemicals in a considerable extent. One of the growing fields in chemical and biosciences is Microfluidics where the control and manipulation is done at micro to pico liters of range and measurements in few 10-100 micrometers. Development of hand hold device using the applications of micro fluidics in the fields of Engineering and Technology is an important current research trend. Design of various reactors in lab scale with help of micro fluidics is the most emerging research trend in field of chemical sciences. Plug/Piston flow reactor is one such reactor in field of chemical sciences having numerous numbers of applications in industrial scale. This research study basically aims on designing of fist piston flow reactor using the application of micro fluidics for understanding the PFR (Plug Flow Reactor) concept by students and for laboratory studies.**

Index Terms **- Chemical Sciences, Fist, Laboratory, Microfluidics, Plug Flow Reactor, ReactorsI.**

I.INTRODUCTION

Important part of a graduate during his/her study is performing experiments in laboratory. It is an important step in teaching learning process which helps the students a lot in various ways to improve their selves. (1,2) Importance of performing lab experiments during a graduate study can be enlisted as follows:

- best understanding of concepts
- a part in visualizing the equipment in industrial scale
- to get an idea about operating the equipment
- to understand the concept and mechanism behind it
- to use it in the appropriate place wherever needed i.e research/academia/workplace etc.
- To make oneself strong in core areas of engineering.

Chemical Reaction Engineering is one of the important branches in the major and allied fields of Chemical Engineering. It is one vast area covering the major core process in chemical/allied industrial sectors. It majorly deals with studies related to reactors study, design and its performance, catalysts and various chemical reactions. It aims on analyzing and examining the chemical reactions in order to identify the best reactor for the operation and designing it. (3,4) Microfluidics is one of the interdisciplinary fast-growing field at engineering and technology dealing with miniature fluid systems. It is an invention of combining science and technology for control and manipulation of fluids in the range of micro (10-6) to Pico (10-12) liters, in network channels with measurements from tens to hundreds of micrometers. (5,6,7) Development of hand hold device using the applications of micro fluidics in the fields of Engineering and Technology is an important current research trend. Lab on a chip(8), droplet micro fluidics(9), micro pumps (10), microvalves (10), micro propulsion (11), micro thermal, DNA chips (12), inkjet heads (13), plant tissue culture (14) etc. are remarkable advancements of research in field of microfluidics.

II. METHODOLOGY

A. Plug Flow Reactor

It is also known as Piston Flow Reactor is a continuous flowing system of cylindrical geometry where the chemical reaction is about to take place. (15) It finds a

numerous advantage in various process industries like oil and gas industries, Petroleum, petrochemical, food, fertilizer industries etc. PFR works with the principle of radial perfect mixing. There is no lateral or late mixing in the PFR.

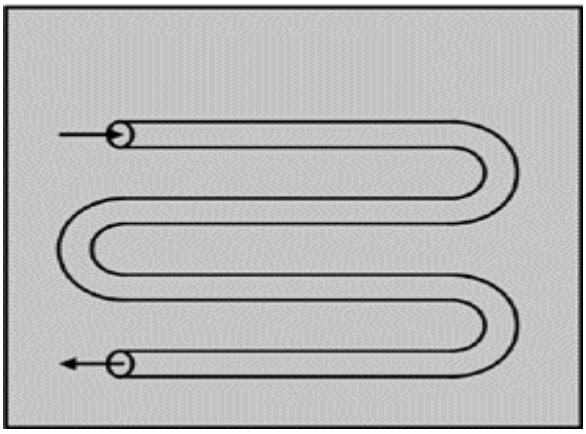

Figure 1: Typical PFR

Assumptions of PFR

1. Plug flow
2. Steady state
3. Homogenousity
4. Density remains same.

In laboratory, PFR is used to proceed conversion and Residence Time Distribution studies by the students.

B. Procedure for Conversion study in PFR

The setup consists of 2 overhead tanks containing ethyl acetate and solutions of sodium hydroxide. The two solutions are allowed to flow through the respective miniature rotameter at constant flow rate. Sufficient time is allowed for steady flow rate to be attained. 5 ml of the reaction mixture is collected and to it 5 ml of HCl is added to arrest the reaction. The above mixture is titrated with NaOH to estimate the amount of NaOH originally reacted. Experiment is repeated with another steady flow rate. (15)

C. Procedure for RTD studies in PFR

Water is allowed to enter the PFR at constant flow rate. 5ml sodium hydroxide (0.1N) solution is injected into the fluid stream as pulse input. The solution from the outlet of plug flow reactor is collected in a interval of every 30 seconds. The concentration of NaOH in the solution is determined by titrating against hydrochloric acid solution using phenolphthalein indicator. Dispersion number and number of tanks were calculated. A graph between E(t) and t is plotted and the area under the curve is obtained. (15)

III. RESULTS

A design of Fist hold Piston Flow Reactor is created for performing lab scale experiments as shown in Figure 2.

Table 1: Dimensions of Microfluidic Fist Piston Flow Reactor

SPECIFICATION	DIMENSION IN MM
LENGTH	80
WIDTH	110
INLET TUBE DIAMETER	0.35
OUTLET TUBE DIAMETER	0.50
INLET CONVERGENCE	40

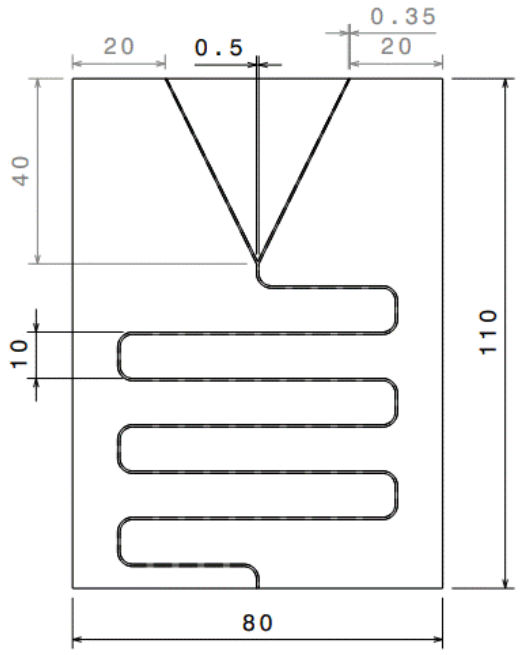

Figure 2: Microfluidic Fist Piston Flow Reactor

Lab Experiments

1. Less space
2. Less chemicals usage
3. Cost effective
4. Low equipment cost
5. Easy to handle
6. Simple cleaning and maintenance

Inculcate students to perform experiments with more interest

IV.CONCLUSION

This study is made to design a new Fist hold Plug Flow Reactor using the applications of microfluidics in it to

perform conversion and residence time distribution studies in PFR at chemical engineering laboratory.

V.ACKNOWLEDGMENT

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