Koya University
Faculty of Engineering
Chemical Engineering department

(Reactor lab)

(tubular flow reactor)

PREPARED BY:

Mohammed Kazim
Ali hewa
Twana

SUPERVISOR:

MR. blnd zrar

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Aim of experiment

To determine the conversion of sodium hydroxide in tubular flow reactor.

Introduction

Tubular flow reactors (TFRs), also known as plug flow reactors (PFRs), are widely used in chemical and industrial processes for continuous reaction systems. These reactors operate with a steady-state flow, where reactants are continuously introduced at one end and products exit at the other, ensuring efficient conversion over a defined residence time. Unlike batch reactors, TFRs provide uniform reaction conditions along the reactor length, minimizing back-mixing and allowing for precise control over reaction kinetics.

This experiment aims to investigate the performance of a tubular flow reactor by analyzing the conversion of reactants under different flow rates and concentrations. By applying fundamental principles of chemical reaction engineering, such as the design equation for PFRs and the interpretation of experimental data, the study will assess reaction kinetics and efficiency. The findings from this experiment are crucial for optimizing industrial processes, where TFRs play a key role in applications such as polymerization, hydrogenation, and wastewater treatment.

Tools and Apparatus:

This devices and Apparatus are used experiment:

Figure1:reactor service unit.

Figure2:Control unit

Figure3: Conductivity Unit

Figure4Plug flow Reactor

Figure5:NaOH base-Ethyl Acetate Acid
Reaction containers

Procedure:

1. Prepare 1 L and 0.05 M of NaOH (solution). after it, we need to prepare second reactant for reaction occur prepare 1 L and 0.05 M of CH3COOHC2H5 (solution) .

2. First of all, in the service units close all valve if open. After that put the bottles in specific places in service unit. And be careful to that the pipes and valves are connected as well.

3. Turn on the switch control box (power supply).

4. In this experiment we don't use water bath because it operates under room temperature (20 oC in this experiment).

5. Set the limited flow rate of the reagents before run the steps
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6. Switch on pumps of reactants.

7. Take the reactants from their containers to the Plug Flow Reactor (PFR).

8. Send both of reactants at same time by both reactant hose and reactants enter the reactor by long tube (inside tube).

9. The reactants react together, and the tube flow as laminar through the Packaging and then after a specific time give us a product.

10. Product will out from the top
.

11. To estimate the conductivity, we use the conductivity meter after output of the PFR. Also, join end of the hose of product with the sensor then the value of conductivity can be read on the display of the sensor.

12. At the end of the experiment, turn off the pumps.

13. Turn off the power of control interface box.

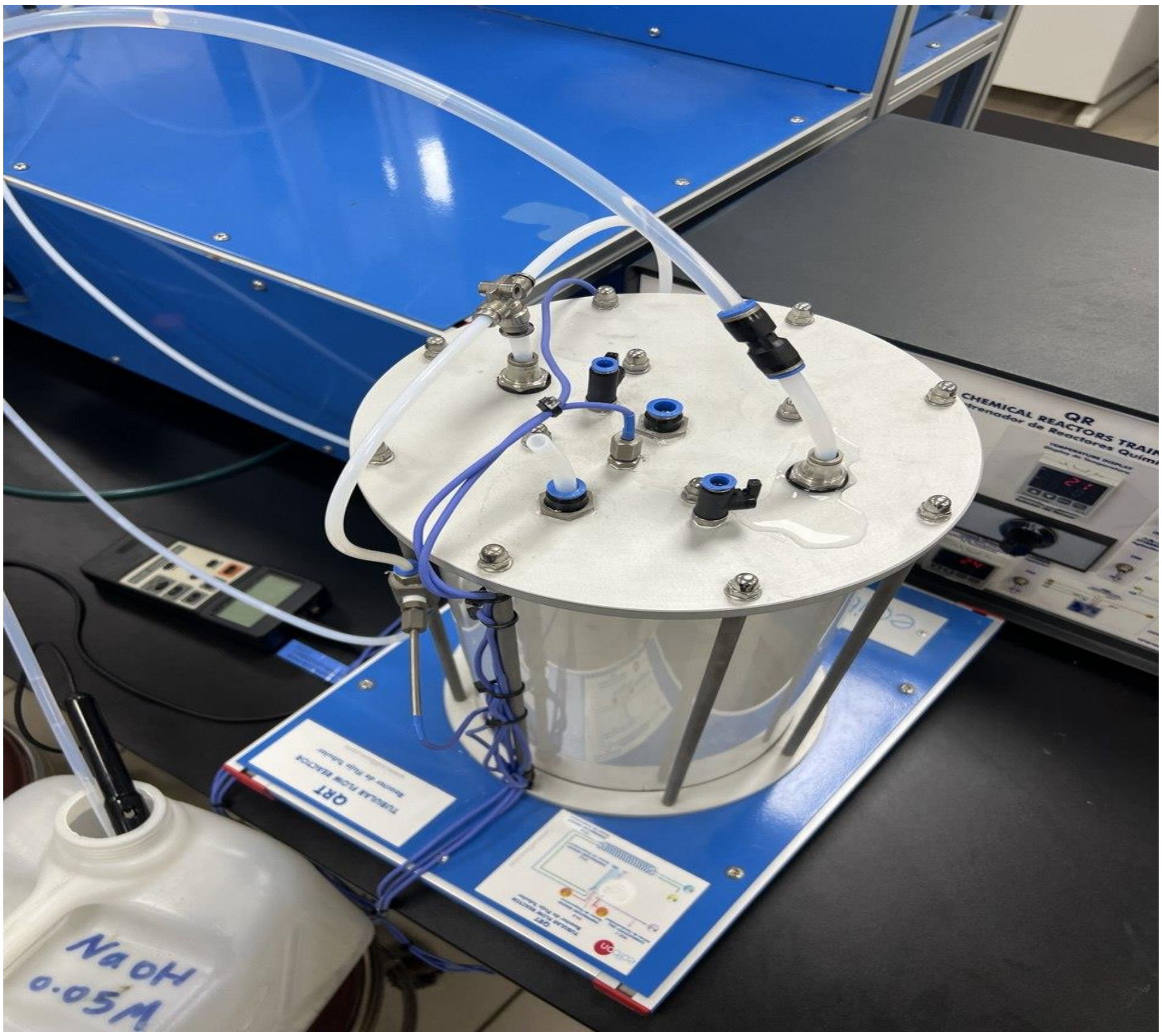
14. Reactants should be removed from both (1 and 2) reactant bottle container. Then, the liquids must be kept for following test.

Plug Flow reactor parts:

1. Tube: feeds (reactants) inter the reactor by two of hoses and flow through this tube and react together.

2. Packaging: These Packaging are used for increase the surface area and it cause to fast the reaction or to make more collision number between reactants.

3. Temperature Sensor: it used for record temperature



Conclusion

In this experiment, the performance of a tubular flow reactor was analyzed by determining the conversion of sodium hydroxide under different flow conditions. The results demonstrated that conversion efficiency is influenced by factors such as flow rate, reactant concentration, and reactor design. The experimental data aligned with the theoretical predictions of plug flow reactor behavior, highlighting the reactor's ability to maintain steady-state conditions with minimal back-mixing.

Overall, the study confirmed that tubular flow reactors are effective for continuous chemical processing, providing consistent conversion rates and efficient utilization of reactants. The findings emphasize the importance of optimizing flow parameters to enhance reaction efficiency in industrial applications. Further studies with varied reaction conditions and advanced monitoring techniques could provide deeper insights into reactor performance and scalability.

Discussion:

(Mohamed kazim)

1- What is a plug flow reactor?
Plug Flow Reactor. PFR is an idealized flow reactor such that along the direction of the flow all the reaction mixture are moving along at the same speed; there is no mixing or back flow. The contents in the PFR flow like plugs, from inlet to outlet.

2- What does a flow plug do?
A plug valve is a quarter-turn rotary motion manual valve. It uses a cylindrical or tapered plug (plug-shaped disk) to permit or prevent straight-through flow through the body. Plug valves offer a straightway passage through the ports so that fluid can flow through the opening plug with a minimum of turbulence.

3- What is the plug flow of fluid?
Fluid going through a Plug Flow Reactor may be modelled as flowing through the reactor as a series of infinitely thin coherent 'plugs', each with a uniform composition, travelling in the axial direction of the reactor, with each plug having a different composition from the ones before and after.

4- What is the process of PFR?
In a PFR, the reactants enter one end of the reactor and are transformed into products as they flow, in a "plug-like" fashion, towards the outlet. Key features of a (idealized) PFR include: Unidirectional Flow: The reactants and products move in one direction along the length of the reactor, with no back-mixing.

5- How does PFR work?
Plug flow reactors, also known as tubular reactors, consist of a cylindrical pipe with openings on each end for reactants and products to flow through. Plug flow reactors are usually operated at steady-state. Reactants are continually consumed as they flow down the length of the reactor.