
Faculty of engineering

Chemical Engineering Department

Third Stage (2024-2025)

Rector Design Laboratory

# (Batch Reactor)

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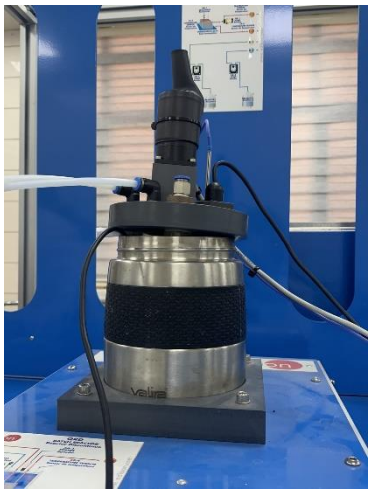
## Aim of experiment

To determine the conductivity and conversion of batch reactor.

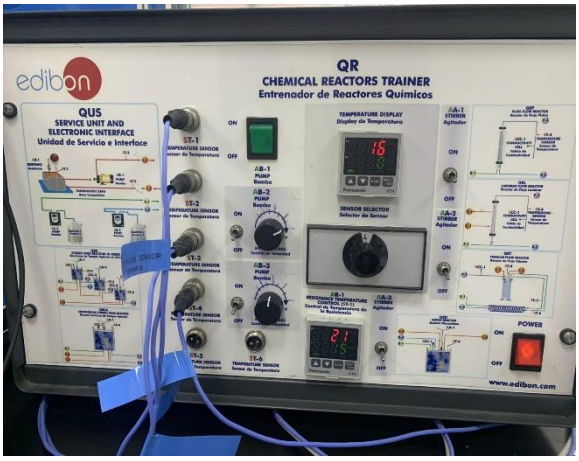
## Introduction

The batch reactor is one of the simplest types of reactors used in chemical and industrial processes. It consists of a tank where chemical reactions take place, typically equipped with an agitator and an internal or external heating or cooling system. Tank sizes range from as small as one liter to as large as 15,000 liters and are often made from materials such as steel, stainless steel, or glass-lined alloys. Reactants, in liquid or solid form, are introduced through connections in the top cover, while vapors or gases produced during the process are vented through other top connections. Liquid products or residues are discharged from outlets at the bottom of the reactor. One of the key advantages of batch reactors is their versatility. They can handle multiple operations within the same vessel without breaking containment, making them ideal for processing toxic or sensitive compounds. These reactors are widely used across various industries, particularly for processes requiring long reaction times or operations under high pressure and temperature. Advanced technologies, such as magnetic stirrers, pressure sensors, and temperature controls, further enhance the safety and efficiency of batch reactors, making them a critical component in modern industrial processes.

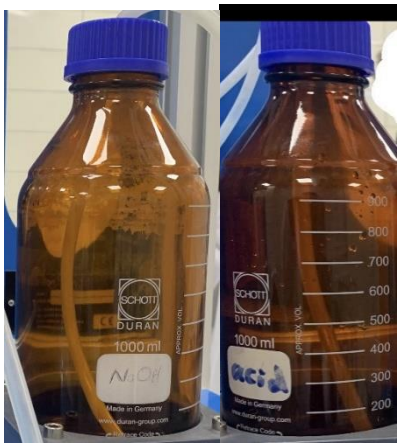
# Tools and Apparatus:



**Batch reactor**




**control unit**




**Reaction containers**

**Service unit**


**Conductivity meter**

## Batch reactor parts:

- ✓ **Coil:** for control the temperature of the reaction.
- ✓ **Conductivity Sensor:** for record the conductivity.
- ✓ **Stirrer:** for mix the reactants and make a collision for reactants.

## Service Unit, control unit and its parts:

- ✓ **Water Bath:** is the tank which contain water it used for control temperature of reactants.
- ✓ **Water Bath temperature:** switch button and controllers.
- ✓ **Reactant Container 1:** For storage reactant 1.
- ✓ **Reactant Container 2:** For storage reactant 2.
- ✓ **Water Pump AB-1:** it used for pumping water.
- ✓ **Pump AB-2:** It used for pump the reactor 1.
- ✓ **Pump AB-3:** It used for pump the reactor 2.
- ✓ **Pump AB-1 on/off button:** It used for switch on or switch of pump AB-1.
- ✓ **Power Button:** Used to turn on control unit.
- ✓ **Temperature Display:** For displaying the temperatures
- ✓ **Temperature Sensor**: for record temperature.
- ✓ **Speed Controller:** For control the velocity of reactant.
- ✓ **Sensor Selector:** it used for select the temperature sensor that you want.

## Procedure:

- 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 CH3COOC2H5 solution) .
- 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.
- Turn on the switch control box (power supply).
- This experiment operates in the room temperature (at 28 °C in this experiment).
- Set the limited flow rate of the reagents before run the steps.
- Switch on the valves and pumps of reactants.
- Take the reactants from their containers (bottles to the first).
- We fill the reactor by both reactant liquids and the flow rate would be limited at both flow meters in the control box.
- Switch on the stirrer from the main control box.
- Turn on the conductivity meter (which connected initially to the reactor).
- Feeds enter the reactor and out the reactor when reach the overflow valve.
- The conductivity measurements (Conductivity sensor) must be noted while change of the conductivity reach the constant value. The readings should be taken at every 15 second**.**

### Shut down procedure:

- At the end of the experiment, turn off the pumps, stirrer and the heater of the water bath.
- Turn off the power of control interface box.
- Reactants should be removed from both (1 and 2) reactant bottle container. Then, the liquids must be kept for following test.
- The product output valve must be opened to drain any liquid from the reactor through the stainless steel tube to a waste tank. Add one liter of tab water to the waste before draining.
- Turn the three way valves to the close position and Clean all the used devices with distilled water.

### West management:

Clean the vessel, Reactor and the tools from the west of the NaOH and the Ethyl estate by water.

## Theory

**Consider The chemical reaction as below:**

**aA+ bB → cC + dD**

**Possess in order to undergo a specified reaction.**

**Calculate the conversion of NaOH using :**

$$X_A = \frac{C_0 - C}{C_0 - C_\infty}$$

**Where:**

**XA=Conersion of NaOH**

**C=specific conductivity at time t**

**C0=specific conductivity at time=0**

**F(x)=XA/(1-XA)**

# Table of reading

- Table of Reading -

| time(s) | conductivity (ms) |
|---|---|
| 0 | 8.7 |
| 30 | 8.68 |
| 60 | 7.73 |
| 90 | 6.28 |
| 120 | 5.52 |
| 150 | 5.05 |
| 180 | 4.30 |
| 210 | 4.19 |
| 240 | 4.11 |
| 270 | 4.04 |
| 300 | 3.97 |
| 330 | 3.92 |
| 360 | 3.87 |
| 390 | 3.82 |
| 420 | 3.80 |
| 450 | 3.73 |
| 480 | 3.72 |
| 510 | 3.68 |
| 540 | 3.60 |
| 570 | 3.59 |
| 600 | 3.56 |
| 630 | 3.5 |
| 660 | 3.47 |

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| Time (s) | Conductivity (ms) |
|---|---|
| 690 | 3.44 |
| 720 | 3.41 |
| 750 | 3.40 |
| 780 | 3.36 |
| 810 | 3.34 |
| 840 | 3.31 |
| 870 | 3.27 |
| 900 | 3.28 |
| 930 | 3.26 |
| 960 | 3.25 |
| 990 | 3.22 |
| 1020 | 3.2 |
| 1050 | 3.17 |
| 1080 | 3.16 |
| 1110 | 3.11 |
| 1140 | 3.14 |
| 1170 | 3.10 |
| 1200 | 3.06 |
| 1230 | 3.05 |
| 1260 | 3.04 |
| 1290 | 3.04 |
| 1320 | 3.01 |
| 1350 | 3.02 |
| 1380 | 2.99 |

| Time | Conductivity |
|---|---|
| 1410 | 2.97 |
| 1440 | 2.93 |
| 1470 | 2.95 |
| 1500 | 2.91 |
| 1530 | 2.9 |
| 1560 | 2.89 |
| 1590 | 2.88 |
| 1620 | 2.87 |
| 1650 | 2.86 |
| 1680 | 2.85 |
| 1710 | 2.84 |
| 1740 | 2.83 |
| 1770 | 2.82 |
| 1800 | 2.81 |
| 1830 | 2.79 |
| 1880 | 2.79 |
| 1890 | 2.77 |
| 1920 | 2.76 |
| 1950 | 2.75 |
| 1980 | 2.75 |
| 2010 | 2.74 |

| Time | Cond |
|---|---|
| 2010 | 2.74 |
| 2040 | 2.73 |
| 2070 | 2.71 |
| 2100 | 2.7 |
| 2130 | 2.69 |
| 2160 | 2.69 |
| 2190 | 2.69 |

## Conclusion:

Batch reactor is a closed system, there is no inlet and outlet streams during the reaction Rate of reaction is expressed as a function of concentration; it is strongly dependent of temperature. It is noticed that Rate constant increases by increasing temperature. The reaction is second order reaction. In addition, Rate of reaction decreases with time due to the consumption of reactant. Batch reactor must be cleaned periodically after each run. Any deviation in the result is due to the experimental and personal errors.

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