

```

clc;
clear;
% Given Data

mass_NaOH = 40; % g/mol
mass_ETAC = 88.11; % g/mol
mass_HCL = 36.46; % g/mol
rho_ETAC = 0.902; % g/ml
rho_HCL = 1.16; % g/ml

Co_NaOH = 0.05; % gmol/lit
k = 0.19; % l/mol.s

NaOH_flow = [200, 150, 120]; % ml/min
ETAC_flow = [200, 150, 120]; % ml/min

% PFR
% time in matrix form , each row is for a particular flow rate of NaOH
t_PFR = [101 202 303 404;
        133 266 399 532;
        166 332 498 664
        ]; % s

V_PFR=[7.2 , 7 , 7.3 , 7.4;
        7.6 , 7.4 , 7.8 , 7.3;
        8 , 7.8 , 8 , 7.9]; % titre value of NaOH (ml)

V_reactor_PFR = 675; % ml
V_HCl_PFR= 0.44; % ml

% CSTR
% time in matrix form , each row is for a particular flow rate of NaOH
t_CSTR = [310 620 930 1240;
        420 840 1260 1680;
        501 1002 1503 2004]; %s

V_CSTR=[7.2    7.5    7.4    7.8;
        7.6    7.9    7.5    8;
        8.2    7.9    8    8.1]; % titre value of NaOH (ml)

V_reactor_CSTR = 2050; % ml
V_HCl_CSTR= 0.51; % ml

%%% Calculations PFR %%%
HCl_o_PFR = 1 %mmole

```

```

HCl_o_PFR = 1

```

```

HCl_R_PFR = HCl_o_PFR - (mean(V_PFR,2)*0.1)

```

```

HCl_R_PFR = 3×1

```

```
0.2775
0.2475
0.2075
```

```
C_NaOH_PFR = HCl_R_PFR/10 % V sample = 10 ml
```

```
C_NaOH_PFR = 3×1
0.0277
0.0247
0.0207
```

```
X_exp_PFR = (Co_NaOH-C_NaOH_PFR)/Co_NaOH
```

```
X_exp_PFR = 3×1
0.4450
0.5050
0.5850
```

```
% for theoretical
```

```
tau_PFR = (V_reactor_PFR./(NaOH_flow+ETAC_flow)).*60 % in s
```

```
tau_PFR = 1×3
101.2500 135.0000 168.7500
```

```
X_th_PFR = (k*Co_NaOH.*tau_PFR)./(1 + k*Co_NaOH.*tau_PFR)
```

```
X_th_PFR = 1×3
0.4903 0.5619 0.6158
```

```
% for equilibrium
```

```
Ceq_NaOH_PFR = V_HCl_PFR*(0.1/10) % in mol/l
```

```
Ceq_NaOH_PFR = 0.0044
```

```
Xeq_PFR = (Co_NaOH-Ceq_NaOH_PFR)/Co_NaOH
```

```
Xeq_PFR = 0.9120
```

```
%% Calculation CSTR %%
```

```
HCl_o_CSTR = 1 %mmole
```

```
HCl_o_CSTR = 1
```

```
HCl_R_CSTR = HCl_o_CSTR - (mean(V_CSTR,2)*0.1);
C_NaOH_CSTR = HCl_R_CSTR/10 % V sample = 10 ml
```

```
C_NaOH_CSTR = 3×1
0.0252
0.0225
0.0195
```

```
X_exp_CSTR = (Co_NaOH-C_NaOH_CSTR)/Co_NaOH
```

```
X_exp_CSTR = 3×1
0.4950
0.5500
```

0.6100

```
% for theoretical
```

```
tau_CSTR = (V_reactor_CSTR./(NaOH_flow+ETAC_flow)).*60 % in s
```

```
tau_CSTR = 1x3  
307.5000 410.0000 512.5000
```

```
const1 = k*tau_CSTR*Co_NaOH
```

```
const1 = 1x3  
2.9213 3.8950 4.8688
```

```
X_th_CSTR = ((2+(1./const1)) - sqrt((1+4*const1)./(const1.*const1)))/2
```

```
X_th_CSTR = 1x3  
0.5616 0.6057 0.6380
```

```
% for equilibrium
```

```
Ceq_NaOH_CSTR = V_HCl_CSTR*(0.1/10) % in mol/l
```

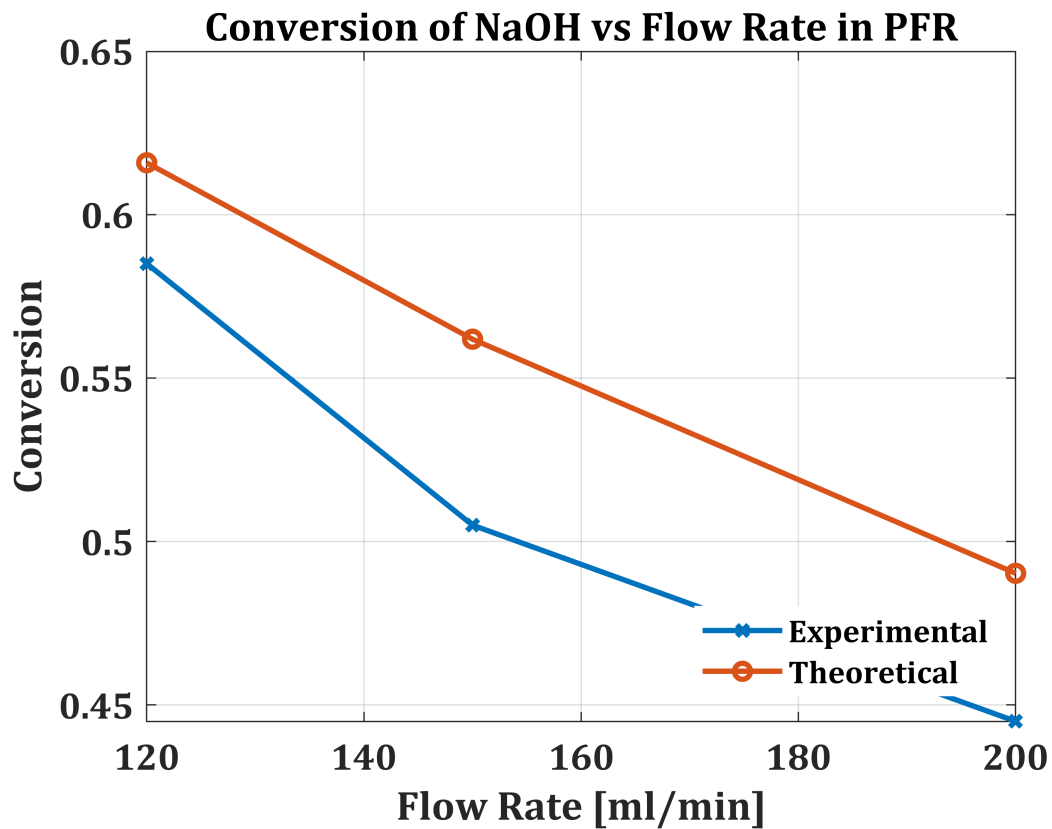
```
Ceq_NaOH_CSTR = 0.0051
```

```
Xeq_CSTR = (Co_NaOH-Ceq_NaOH_CSTR)/Co_NaOH
```

```
Xeq_CSTR = 0.8980
```

Plots for PFR

```
plot(NaOH_flow,X_exp_PFR,'-x',LineWidth=2);hold on;  
title('Conversion of NaOH vs Flow Rate in PFR')  
ylabel('Conversion')  
xlabel('Flow Rate [ml/min]')  
grid on;  
plot(NaOH_flow,X_th_PFR,'-o',LineWidth=2);  
set(gca,'FontSize',14,'FontWeight','bold','FontName','Cambria')  
legend({'Experimental',"Theoretical"},'Location','southeast','FontSize',12,'FontWeight','bold',  
hold off;
```

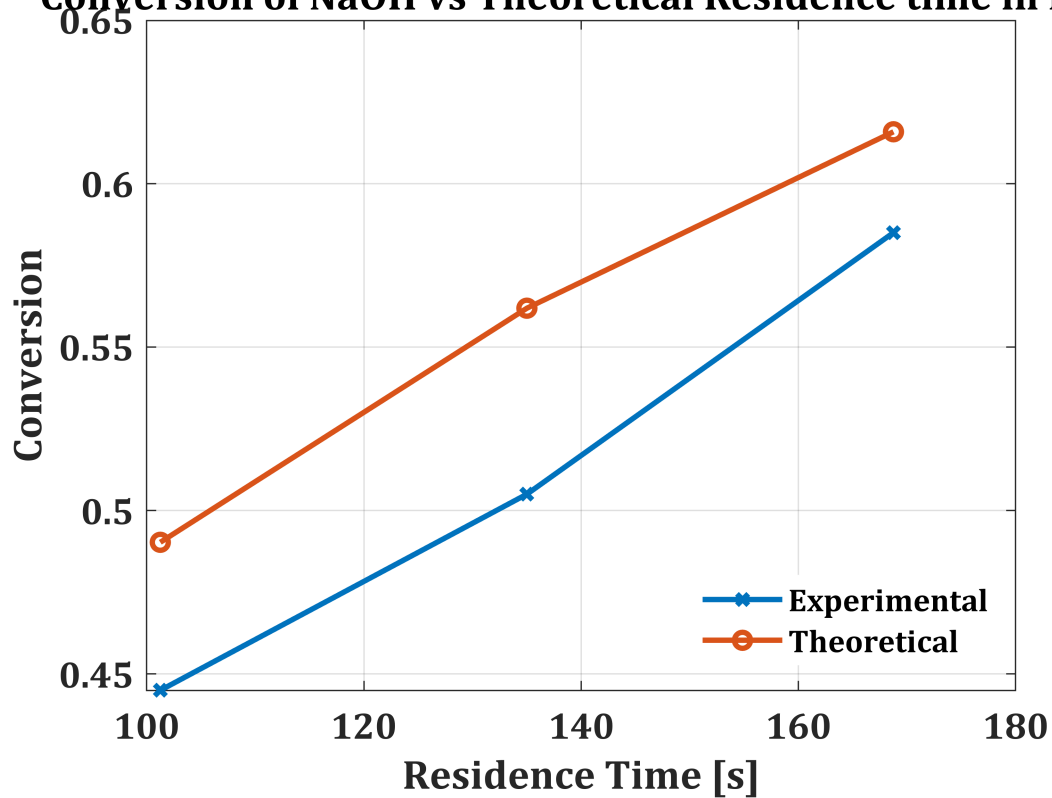


```

plot(tau_PFR,X_exp_PFR,'-x',LineWidth=2);hold on;
title('Conversion of NaOH vs Theoretical Residence time in PFR')
ylabel('Conversion')
xlabel('Residence Time [s]')
grid on;
plot(tau_PFR,X_th_PFR,'-o',LineWidth=2);
set(gca,'FontSize',14,'FontWeight','bold','FontName','Cambria')
legend({'Experimental',"Theoretical"},'Location','southeast','FontSize',12,'FontWeight','bold',
hold off;

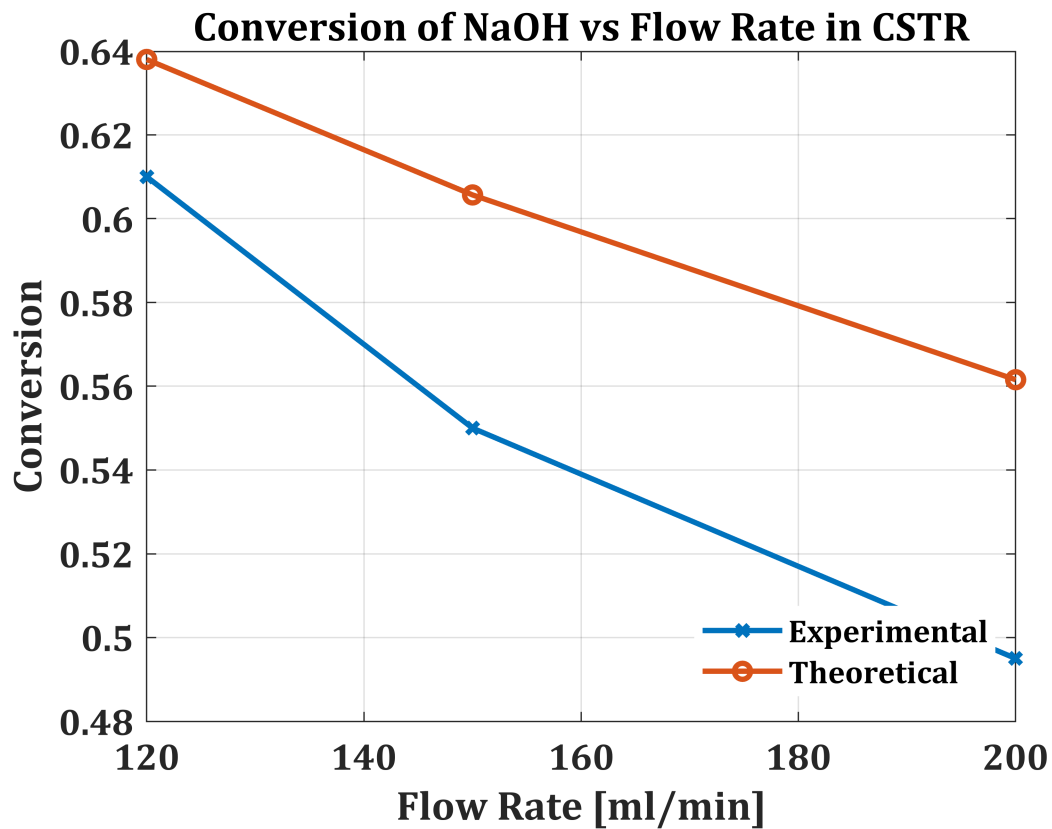
```

## Conversion of NaOH vs Theoretical Residence time in PFR



Plots for CSTR

```
plot(NaOH_flow,X_exp_CSTR,'-x',LineWidth=2);hold on;
title('Conversion of NaOH vs Flow Rate in CSTR')
ylabel('Conversion')
xlabel('Flow Rate [ml/min]')
grid on;
plot(NaOH_flow,X_th_CSTR,'-o',LineWidth=2);
set(gca, 'FontSize',14, 'FontWeight', 'bold', 'FontName', 'Cambria')
legend({'Experimental',"Theoretical"},'Location','southeast','FontSize',12,'FontWeight','bold',
hold off;
```

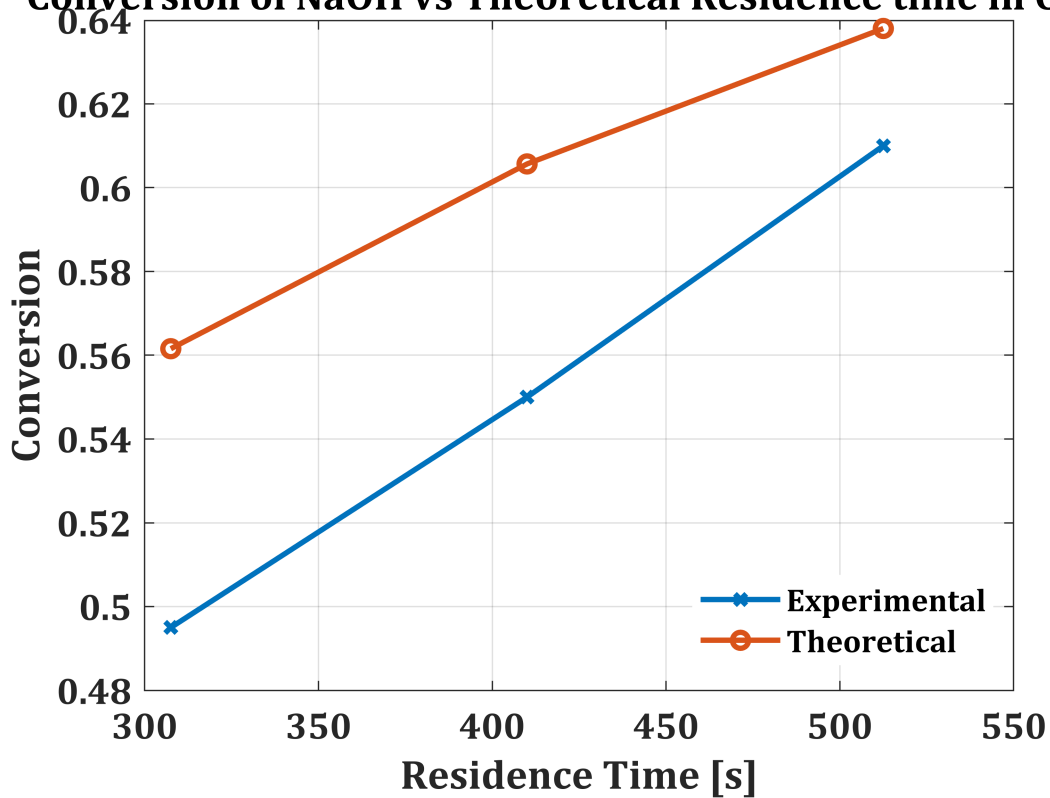


```

plot(tau_CSTR,X_exp_CSTR,'-x',LineWidth=2);hold on;
title('Conversion of NaOH vs Theoretical Residence time in CSTR')
ylabel('Conversion')
xlabel('Residence Time [s]')
grid on;
plot(tau_CSTR,X_th_CSTR,'-o',LineWidth=2);
set(gca,'FontSize',14,'FontWeight','bold','FontName','Cambria')
legend({'Experimental',"Theoretical"},'Location','southeast','FontSize',12,'FontWeight','bold',
hold off;

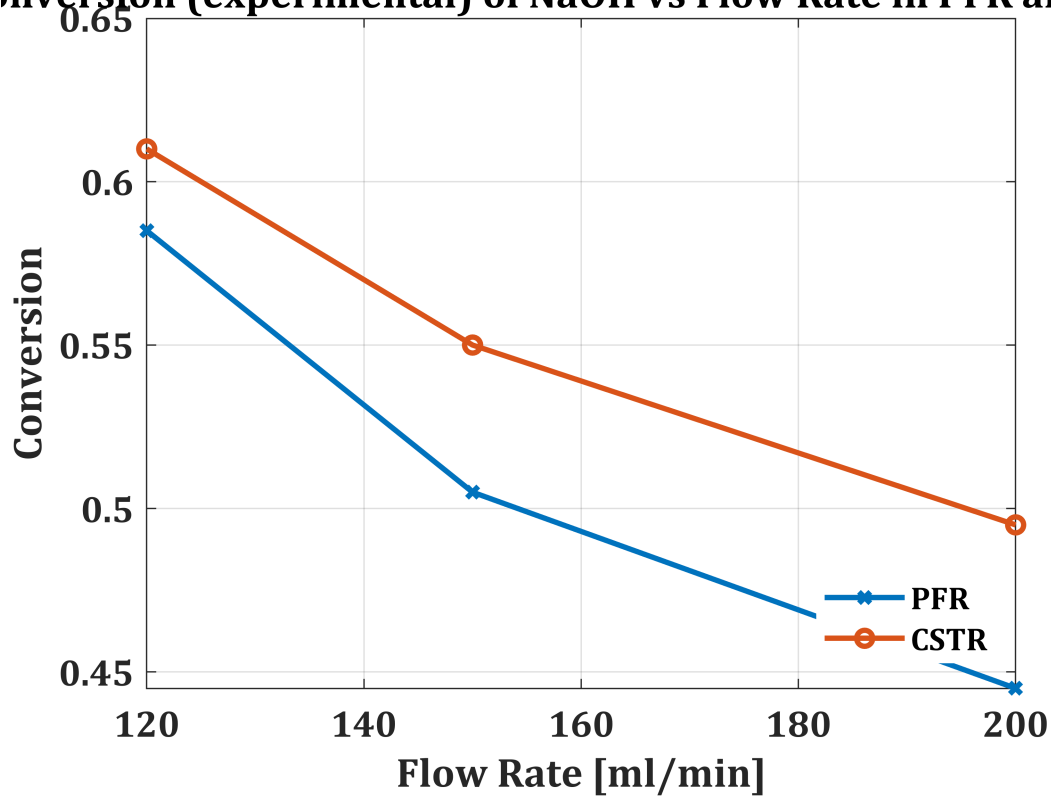
```

## Conversion of NaOH vs Theoretical Residence time in CSTF



```
% MIX PLOT
plot(NaOH_flow,X_exp_PFR,'-x',LineWidth=2);hold on;
title('Conversion (experimental) of NaOH vs Flow Rate in PFR and CSTR')
ylabel('Conversion')
xlabel('Flow Rate [ml/min]')
grid on;
plot(NaOH_flow,X_exp_CSTR,'-o',LineWidth=2);
set(gca, 'FontSize',14, 'FontWeight', 'bold', 'FontName', 'Cambria')
legend({'PFR', "CSTR"}, 'Location', 'southeast', 'FontSize',12, 'FontWeight', 'bold', 'EdgeColor', [1 1 1])
hold off;
```

## Conversion (experimental) of NaOH vs Flow Rate in PFR and CSTR



```

plot(NaOH_flow,X_th_PFR,'-x',LineWidth=2);hold on;
title('Conversion (theoretical) of NaOH vs Flow Rate in PFR and CSTR')
ylabel('Conversion')
xlabel('Flow Rate [ml/min]')
grid on;
plot(NaOH_flow,X_th_CSTR,'-o',LineWidth=2);
set(gca, 'FontSize',14, 'FontWeight', 'bold', 'FontName', 'Cambria')
legend({'PFR', "CSTR"}, 'Location', 'southeast', 'FontSize',12, 'FontWeight', 'bold', 'EdgeColor', [1 1 1])
hold off;
    
```



Conversion (theoretical) of NaOH vs Flow Rate in PFR and CS

