#Q1

A=3.249;

B=0.422E-3;

C=0;

D=0.083E+5;

T0=283.15; %K

R = 8.314;

P1=1;

P2=33.3706;

% iteration for Ta

Tg=1.01\*T0;

CpsR=A+(B+(C+D/(Tg^2\*T0^2))\*((Tg+T0)/2))\*(Tg-T0)/(log(Tg/T0));

a=log(P2/P1);;

T1=T0\*exp(a/CpsR);

CpsR1=A+(B+(C+D/(T1^2\*T0^2))\*((T1+T0)/2))\*(T1-T0)/(log(T1/T0));

T2=T0\*exp(a/CpsR1);

CpsR2=A+(B+(C+D/(T2^2\*T0^2))\*((T2+T0)/2))\*(T2-T0)/(log(T2/T0));

T3=T0\*exp(a/CpsR2);

Ta=T3;

dHigR=A\*(Ta-T0)+B/2\*(Ta^2-T0^2)+D\*((Ta-T0)/(Ta\*T0));

dHig=dHigR\*8.314;

dHigreal=dHig/0.8;

% find work

work=dHigreal\*44.4312676;

work\_in\_kw = work / 1000; %KW

% work\_in\_kw= 791.4405

%%

% find real T, iterate again

Ta = 283.15; %K

Tg1=Ta;

CpHR=A+B/2\*(Tg1+Ta)+D/(Tg1\*Ta);

dHigrealR=dHigreal/R;

Tf1=dHigrealR/CpHR+Ta;

CpHR1=A+B/2\*(Tf1+Ta)+D/(Tf1\*Ta);

Tf2=dHigrealR/CpHR1+Ta;

CpHR2=A+B/2\*(Tf2+Ta)+D/(Tf2\*Ta);

Tf3=dHigrealR/CpHR2+Ta;

disp("Tf3 " + Tf3 + " K")

%Tf3 890.1836K

%%Q1\_EC

A=3.249;

B=0.422E-3;

C=0;

D=0.083E+5;

T0=283.15; %K

R = 8.314;

P1=9;

P2=27;

% iteration for Ta

Tg=1.01\*T0;

CpsR=A+(B+(C+D/(Tg^2\*T0^2))\*((Tg+T0)/2))\*(Tg-T0)/(log(Tg/T0));

a=log(P2/P1);

T1=T0\*exp(a/CpsR);

CpsR1=A+(B+(C+D/(T1^2\*T0^2))\*((T1+T0)/2))\*(T1-T0)/(log(T1/T0));

T2=T0\*exp(a/CpsR1);

CpsR2=A+(B+(C+D/(T2^2\*T0^2))\*((T2+T0)/2))\*(T2-T0)/(log(T2/T0));

T3=T0\*exp(a/CpsR2);

Ta=T3;

dHigR=A\*(Ta-T0)+B/2\*(Ta^2-T0^2)+D\*((Ta-T0)/(Ta\*T0));

dHig=dHigR\*8.314;

dHigreal=dHig/0.8;

% find work

work=dHigreal\*44.4312676;

work\_in\_kw = work / 1000; %KW

% work\_in\_kw= 791.4405

%%

% find real T, iterate again

Tg1=Ta;

CpHR=A+B/2\*(Tg1+T0)+D/(Tg1\*T0);

dHigrealR=dHigreal/R;

Tf1=dHigrealR/CpHR+T0;

CpHR1=A+B/2\*(Tf1+T0)+D/(Tf1\*T0);

Tf2=dHigrealR/CpHR1+T0;

CpHR2=A+B/2\*(Tf2+T0)+D/(Tf2\*T0);

Tf3=dHigrealR/CpHR2+T0;

disp("Tf3 " + Tf3 + " K")

disp("Work: " + work\_in\_kw + "kW")

%Tf3 890.1836K

#Q1\_EC

A=3.249;

B=0.422E-3;

C=0;

D=0.083E+5;

T0=283.15; %K

R = 8.314;

P1=9;

P2=27;

% iteration for Ta

Tg=1.01\*T0;

CpsR=A+(B+(C+D/(Tg^2\*T0^2))\*((Tg+T0)/2))\*(Tg-T0)/(log(Tg/T0));

a=log(P2/P1);

T1=T0\*exp(a/CpsR);

CpsR1=A+(B+(C+D/(T1^2\*T0^2))\*((T1+T0)/2))\*(T1-T0)/(log(T1/T0));

T2=T0\*exp(a/CpsR1);

CpsR2=A+(B+(C+D/(T2^2\*T0^2))\*((T2+T0)/2))\*(T2-T0)/(log(T2/T0));

T3=T0\*exp(a/CpsR2);

Ta=T3;

dHigR=A\*(Ta-T0)+B/2\*(Ta^2-T0^2)+D\*((Ta-T0)/(Ta\*T0));

dHig=dHigR\*8.314;

dHigreal=dHig/0.8;

% find work

work=dHigreal\*44.4312676;

work\_in\_kw = work / 1000; %KW

% work\_in\_kw= 791.4405

%%

% find real T, iterate again

Ta = 283.15; %K

Tg1=Ta;

CpHR=A+B/2\*(Tg1+Ta)+D/(Tg1\*Ta);

dHigrealR=dHigreal/R;

Tf1=dHigrealR/CpHR+Ta;

CpHR1=A+B/2\*(Tf1+Ta)+D/(Tf1\*Ta);

Tf2=dHigrealR/CpHR1+Ta;

CpHR2=A+B/2\*(Tf2+Ta)+D/(Tf2\*Ta);

Tf3=dHigrealR/CpHR2+Ta;

disp("Tf3 " + Tf3 + " K")

disp("Work: " + work\_in\_kw + "kW")

%Tf3 890.1836K

#Q2

A=3.249;

B=0.422E-3;

C=0;

D=0.083E+5;

T0=283.15; %K

R = 8.314;

P1=1;

P2=33.3706;

% iteration for Ta

Tg=1.01\*T0;

CpsR=A+(B+(C+D/(Tg^2\*T0^2))\*((Tg+T0)/2))\*(Tg-T0)/(log(Tg/T0));

a=log(P2/P1);;

T1=T0\*exp(a/CpsR);

CpsR1=A+(B+(C+D/(T1^2\*T0^2))\*((T1+T0)/2))\*(T1-T0)/(log(T1/T0));

T2=T0\*exp(a/CpsR1);

CpsR2=A+(B+(C+D/(T2^2\*T0^2))\*((T2+T0)/2))\*(T2-T0)/(log(T2/T0));

T3=T0\*exp(a/CpsR2);

Ta=T3;

dHigR=A\*(Ta-T0)+B/2\*(Ta^2-T0^2)+D\*((Ta-T0)/(Ta\*T0));

dHig=dHigR\*8.314;

dHigreal=dHig/0.8;

% find work

work=dHigreal\*44.4312676;

work\_in\_kw = work / 1000; %KW

% work\_in\_kw= 791.4405

%%

% find real T, iterate again

Ta = 283.15; %K

Tg1=Ta;

CpHR=A+B/2\*(Tg1+Ta)+D/(Tg1\*Ta);

dHigrealR=dHigreal/R;

Tf1=dHigrealR/CpHR+Ta;

CpHR1=A+B/2\*(Tf1+Ta)+D/(Tf1\*Ta);

Tf2=dHigrealR/CpHR1+Ta;

CpHR2=A+B/2\*(Tf2+Ta)+D/(Tf2\*Ta);

Tf3=dHigrealR/CpHR2+Ta;

disp("Tf3 " + Tf3 + " K")

%Tf3 890.1836K

#Q3

Ato=0.29;

Bto=47.052E-3;

Cto=-15.716E-6;

Dto=0;

Tnto=383.8;

Tini=283.15;

Tfi=600;

Tcto=591.8;

Pc=41.06;

nto=33.96020457;

dHR1=Ato\*(Tnto-Tini)+Bto/2\*(Tnto^2-Tini^2)+Cto\*(Tnto^3-Tini^3)/3;

dH1=dHR1\*R\*nto;

Trnto=Tnto/Tcto;

dHnRTn=1.092\*(log(Pc-1.013))/(0.930-Trnto);

dH2=dHnRTn\*R\*Tnto\*nto;

dHR3=Ato\*(Tfi-Tnto)+Bto/2\*(Tfi^2-Tnto^2)+Cto\*(Tfi^3-Tnto^3)/3;

dH3=dHR3\*R\*nto;

dHtotal=dH1+dH2+dH3;

dHtotal\_in\_kw=dHtotal/1000;

disp(dHtotal\_in\_kw)

%total heat required is 3150.1 KW.

#Q4

%%For toluene

A = 0.29;

B = 47.052E-3;

C = -15.716E-6;

D = 0;

T0= 600; %K

R = 8.314;

P1 = 1; %Bar

P2 = 33.3706; %Bar = 484 psia

% iteration for Ta

Tg=1.01\*T0;

CpsR=A+(B+(C+D/(Tg^2\*T0^2))\*((Tg+T0)/2))\*(Tg-T0)/(log(Tg/T0));

a=log(P2/P1);

T1=T0\*exp(a/CpsR);

CpsR1=A+(B+(C+D/(T1^2\*T0^2))\*((T1+T0)/2))\*(T1-T0)/(log(T1/T0));

T2=T0\*exp(a/CpsR1);

CpsR2=A+(B+(C+D/(T2^2\*T0^2))\*((T2+T0)/2))\*(T2-T0)/(log(T2/T0));

T3=T0\*exp(a/CpsR2);

Ta=T3;

dHigR=A\*(Ta-T0)+B/2\*(Ta^2-T0^2)+D\*((Ta-T0)/(Ta\*T0)) + (C/3)\*(Ta^3 - T0^3);

dHig=dHigR\*8.314;

dHigreal=dHig/0.75;

% find work

work=dHigreal\*33.9602046;

work\_in\_kw = work / 1000; %KW

%%

% find real T, iterate again

Ta = 600;

Tg1=Ta;

CpHR=A+B/2\*(Tg1+Ta)+D/(Tg1\*Ta);

dHigrealR=dHigreal/R;

Tf1=dHigrealR/CpHR+Ta;

CpHR1=A+B/2\*(Tf1+Ta)+D/(Tf1\*Ta);

Tf2=dHigrealR/CpHR1+Ta;

CpHR2=A+B/2\*(Tf2+Ta)+D/(Tf2\*Ta);

Tf3=dHigrealR/CpHR2+Ta;

CpHR2=A+B/2\*(Tf3+Ta)+D/(Tf3\*Ta);

Tf4=dHigrealR/CpHR2+Ta;

disp("Tf " + Tf4 + " K")

disp("Work: " + work\_in\_kw + "kW")

%

%>>Q4

% Tf 698.1111 K

% Work: 854.0413kW

%

#Q9

Ar=3.7212;

Br=0.0149;

Cr=-4.3013E-6;

Dr=-1.0542E5;

T1=922.0389;

T2=960.9278;

T0=298.15;

R=8.314;

nRF=952.583738;nE=nRF;

Hfto=50170; Hfme=-74520; Hfbe=82930; Hfbi=1.8E5;

H0rxn1=Hfbe+Hfme-Hfto;

H0rxn2=Hfbi-2\*Hfbe;

si1=33.9602046;

si2=0.84900511;

Htrxn1=H0rxn1\*si1;

Htrxn2=H0rxn2\*si2;

dHigR1=Ar\*(T0-T1)+Br\*(T0^2-T1^2)/2+Cr\*(T0^3-T1^3)/3+Dr\*((T0-T1)/(T0\*T1));

dHig1=dHigR1\*R\*nRF;

yEto=0.011883541;

yEh=0.202911468;

yEbe=0.033868093;

yEme=0.608734403;

yEbi=0.142602496;

Ato=0.290;Bto=47.052E-3;Cto=-15.716E-6;Dto=0;

Abi=13.83;Bbi=51.7E-3;Cbi=-16.33E-6;Dbi=-7.578E5;

Ah=3.249;Bh=0.422E-3;Ch=0;Dh=0.083E5;

Ame=1.702;Bme=9.081E-3;Cme=-2.164E-6;Dme=0;

Abe=-0.206;Bbe=39.064E-3;Cbe=-13.301E-6;Dbe=0;

AE=yEto\*Ato+yEh\*Ah+yEbe\*Abe+yEme\*Ame+yEbi\*Abi;

BE=yEto\*Bto+yEh\*Bh+yEbe\*Bbe+yEme\*Bme+yEbi\*Bbi;

CE=yEto\*Cto+yEh\*Ch+yEbe\*Cbe+yEme\*Cme+yEbi\*Cbi;

DE=yEto\*Dto+yEh\*Dh+yEbe\*Dbe+yEme\*Dme+yEbi\*Dbi;

dHigR2=AE\*(T2-T0)+BE\*(T2^2-T0^2)/2+CE\*(T2^3-T0^3)/3+DE\*((T2-T0)/(T2\*T0));

dHig2=dHigR2\*R\*nE;

dHtotal=dHig1+dHig2+Htrxn1+Htrxn2;

dHtotal\_in\_kw=dHtotal/1000;

disp(dHtotal\_in\_kw)

% dHtotal\_in\_kw=2466.7 KW

#Q10

T0=298.15;

dHig2a=-dHig1-Htrxn1-Htrxn2;

dHig2pm=dHig2a/nE;

Tg1=T0;

CpHR=AE+BE/2\*(Tg1+T0)+CE/3\*(Tg1^2+Tg1\*T0+T0^2)+DE/(Tg1\*T0);

dHig2pmR=dHig2pm/R;

Tf1=dHig2pmR/CpHR+T0;

CpHR1=AE+BE/2\*(Tf1+T0)+CE/3\*(Tf1^2+Tf1\*T0+T0^2)+DE/(Tf1\*T0);

Tf2=dHig2pmR/CpHR1+T0;

CpHR2=AE+BE/2\*(Tf2+T0)+CE/3\*(Tf2^2+Tf2\*T0+T0^2)+DE/(Tf2\*T0);

Tf3=dHig2pmR/CpHR2+T0;

CpHR3=AE+BE/2\*(Tf3+T0)+CE/3\*(Tf3^2+Tf3\*T0+T0^2)+DE/(Tf3\*T0);

Tf4=dHig2pmR/CpHR3+T0;

CpHR4=AE+BE/2\*(Tf4+T0)+CE/3\*(Tf4^2+Tf4\*T0+T0^2)+DE/(Tf4\*T0);

Tf5=dHig2pmR/CpHR4+T0;

CpHR5=AE+BE/2\*(Tf5+T0)+CE/3\*(Tf5^2+Tf5\*T0+T0^2)+DE/(Tf5\*T0);

Tf6=dHig2pmR/CpHR5+T0;

disp(Tf6)

%Tf6=937.7692 K

#Q12

%%Q12\_A

AE=3.664; BE=0.0149; CE=-4.2832E-6; DE=-1.0638E5;

PE=39.3001;

PS=33.3706;

yEto=0.011883541;

yEh=0.202911468;

yEbe=0.033868093;

yEme=0.608734403;

yEbi=0.142602496;

TE=960.9278;

Tcto=591.8; Pcto=41.06; wto=0.262;

Tcbe=562.2; Pcbe=48.98; wbe=0.21;

Tcme=190.6; Pcme=45.99; wme=0.012;

Tcbi=772.16; Pcbi=34.74; wbi=0.423;

Tch=43.6/(1+(21.8/(2.016\*TE)));

Pch=20.5/(1+(44.2/(2.016\*TE)));

wh=0;

Tcmix=yEto\*Tcto+yEh\*Tch+yEbe\*Tcbe+yEme\*Tcme+yEbi\*Tcbi;

Pcmix=yEto\*Pcto+yEh\*Pch+yEbe\*Pcbe+yEme\*Pcme+yEbi\*Pcbi;

wmix=yEto\*wto+yEh\*wh+yEbe\*wbe+yEme\*wme+yEbi\*wbi;

TrE=TE/Tcmix;

PrE=PE/Pcmix;

PrS=PS/Pcmix;

% from interpolation of tables

HR0RTc1=-0.0589692975;

HR1RTc1=0.1547014805;

HR0RTc2=-0.0505258085;

HR1RTc2=0.1317329783;

HRRTC1=HR0RTc1+wmix\*HR1RTc1;

HRRTC2=HR0RTc2+wmix\*HR1RTc2;

HR1=HRRTC1\*R\*Tcmix;

HR2=HRRTC2\*R\*Tcmix;

dHig11=HR1-HR2;

%assume temperature Tgu=TE(exhaust temperature)

Tgu=TE;

CpHR=AE+BE/2\*(Tgu+TE)+CE/3\*(Tgu^2+Tgu\*TE+TE^2)+DE/(Tgu\*TE);

dHig11R=dHig11/R;

TS1=dHig11/CpHR+TE;

disp(TS1)

%%Q12\_B

%%Part B

AE=3.664;

BE=0.0149;

CE=-4.2832E-6;

DE=-1.0638E5;

nE=952.583738;

PE=39.3001;

PS=33.3706;

TE=960.9278;

Tgue=1.01\*TE;

R=8.314

CpsR=AE+(BE+(CE+DE/(Tgue^2\*TE^2))\*((Tgue+TE)/2))\*(Tgue-TE)/(log(Tgue/TE));

a=log(PS/PE);

Tturb1=TE\*exp(a/CpsR);

CpsR1=AE+(BE+(CE+DE/(Tturb1^2\*TE^2))\*((Tturb1+TE)/2))\*(Tturb1-TE)/(log(Tturb1/TE));

Tturb2=TE\*exp(a/CpsR1);

Tturb=Tturb2;

dHigturbR=AE\*(Tturb-TE)+BE/2\*(Tturb^2-TE^2)+CE\*(Tturb^3-TE^3)/3+DE\*((Tturb-TE)/(Tturb\*TE));

dHigturb=dHigturbR\*8.314;

dHrealturb=dHigturb\*0.8;

workturb=dHrealturb\*nE;

work\_in\_kw=workturb/1000;

disp(work\_in\_kw)

%work extracted is the absolute value of work\_in\_kw, which is 989.8919 KW.

% find real T, iterate again

Tturba = TE;

Tgues=Tturba;

CpHturbR=AE+BE/2\*(Tgues+TE)+CE/3\*(Tgues^2+Tgues\*TE+TE^2)+DE/(Tgues\*TE);

dHrealturbR=dHrealturb/R;

Tl1=dHrealturbR/CpHturbR+TE;

CpHturbR1=AE+BE/2\*(Tl1+TE)+CE/3\*(Tl1^2+Tl1\*TE+TE^2)+DE/(Tl1\*TE);

Tl2=dHrealturbR/CpHturbR1+TE;

CpHturbR2=AE+BE/2\*(Tl2+TE)+CE/3\*(Tl2^2+Tl2\*TE+TE^2)+DE/(Tl2\*TE);

Tl3=dHrealturbR/CpHturbR2+TE;

disp(Tl3)

%Final Temperature is 951.923 K

#Q13

clear

%%part b

K1=0.00211577;

K2=433.816504;

K3=0.00651267;

K4=12.8652437;

K5=3.25e-06;

z1=0.011883541;

z2=0.202911468;

z3=0.033868093;

z4=0.608734403;

z5=0.142602496;

q=0.801279;

V=763.285345;

L=189.298393;

F=952.583738;

x1=z1/(1+q\*(K1-1));

x2=z2/(1+q\*(K2-1));

x3=z3/(1+q\*(K3-1));

x4=z4/(1+q\*(K4-1));

x5=z5/(1+q\*(K5-1));

y1=K1\*x1;

y2=K2\*x2;

y3=K3\*x3;

y4=K4\*x4;

y5=K5\*x5;

%% part c

Rh2=y2\*V/(F\*z2);

Rme=y4\*V/(F\*z4);

disp("Rh2: " + Rh2)

disp("Rme: " + Rme)

%% part d

Rto=x1\*L/(F\*z1);

Rbe=x3\*L/(F\*z3);

Rbi=x5\*L/(F\*z5);

disp("Rto: " + Rto)

disp("Rbe: " + Rbe)

disp("Rbi: " + Rbi)

#Q14

clear

%%part b

K1=0.018101196;

K2=433.473936;

K3=0.044197071;

K4=21.9651996;

K5=0.000115013;

z1=0.059294277418480;

z2=5.834028612676449e-04;

z3=0.166069342600917;

z4=0.057934037523364;

z5=0.717592138111170;

q=0.0156422;

F=189.298393;

V=F\*q;

L=F-V;

x1=z1/(1+q\*(K1-1));

x2=z2/(1+q\*(K2-1));

x3=z3/(1+q\*(K3-1));

x4=z4/(1+q\*(K4-1));

x5=z5/(1+q\*(K5-1));

y1=K1\*x1;

y2=K2\*x2;

y3=K3\*x3;

y4=K4\*x4;

y5=K5\*x5;

#Q15

%part a and b

A\_to=13.932; B\_to=3056.96; C\_to=217.625;

A\_bi=14.6372; B\_bi=4576.67; C\_bi=201.594;

T=260;

Psat\_to=exp(A\_to-B\_to/(C\_to+T));

Psat\_bi=exp(A\_bi-B\_bi/(C\_bi+T));

P=200;

x\_to=(P-Psat\_bi)/(Psat\_to-Psat\_bi);

x\_bi=1-x\_to;

y\_to=x\_to\*Psat\_to/P;

y\_bi=1-y\_to;

z\_to=0.08;

z\_bi=0.92;

k=(z\_to-x\_to)/(y\_to-x\_to);

F=140;

V=k\*F;

L=(1-k)\*F;

% x of toluene is 0.0499; x of biphneyl is 0.9501

% y of tulenee is 0.4660; y of biphneyl is 0.5340

% total vapor molar flow rate is 10.1175 mol/s

% total liquid molar flow rate is 129.8825 mol/s

%Part C

xbi=0.99;

xto=1-xbi;

A\_to=13.932; B\_to=3056.96; C\_to=217.625;

A\_bi=14.6372; B\_bi=4576.67; C\_bi=201.594;

T=260;

Psat\_to=exp(A\_to-B\_to/(C\_to+T));

Psat\_bi=exp(A\_bi-B\_bi/(C\_bi+T));

P\_rqd=xto\*Psat\_to+xbi\*Psat\_bi;

yto=xto\*Psat\_to/P\_rqd;

ybi=1-yto;

zto=0.08;

zbi=0.92;

k\_b=(zbi-xbi)/(ybi-xbi);

F=140;

V\_b=k\_b\*F;

L\_b=(1-k\_b)\*F;

% Pressure required is 1.3 bar

% Vapor fraction of toluene 0.1436

% Vapor fraction of biphneyl is 0.8564

% Total liquid flow rate is 66.6451 mol/s

% Total vapor flow rate is 73.3549 mol/s