%property calculator, ME343

clear all;

%Stored reference values

M=[4.003 39.948 31.999 28.013 18.015 44.010]; %In same order as Cp

R=[2.077 .208 .26 .297 .462 .189];

Sref=[31.5375 3.876 6.6999 6.8045 10.423 4.8585];

Uref=[928.419 92.976 194.2 221.44 412.05 156.57];

Href=[1547.365 154.96 271.72 309.99 549.75 212.93];

%Tabulated Cp and Cv values from table 5s

Cp5s=[1.0041 1.0107 1.0249 1.0452 1.0687 1.0927 1.1154 1.1360 1.1544 1.1706 1.1848 1.1973 1.2083 1.2180 1.2267 1.2345 1.2416 1.2480 1.2539 1.2593 1.2644];

Cv5s=[.7169 .7235 .7376 .758 .7815 .8054 .8281 .8488 .8672 .8834 .8976 .9101 .9210 .9308 .9395 .9473 .9544 .9608 .9667 .9721 .9771];

Pref=10^2;%in kPa

Tref=298;%in Kelvin

COEFF=[0 0 0 0;%Coefficients of Cp equations

0 0 0 0;

0.7963 4.7501e-004 -2.2360e-007 4.1001e-011;

1.0317 -5.6081e-005 2.8847e-007 -1.0256e-010;

1.7896 1.0674e-004 5.8562e-007 -1.9956e-010;

0.5058 0.0014 7.9550e-007 1.6971e-010];

CvCOEFF=COEFF;%Coefficients of Cv equations where Cv=Cp-R

CvCOEFF(3,1)=COEFF(3,1)-R(3);

CvCOEFF(4,1)=COEFF(4,1)-R(3);

CvCOEFF(5,1)=COEFF(5,1)-R(3);

CvCOEFF(6,1)=COEFF(6,1)-R(3);

sintCOEFF(:,1)=COEFF(:,1);%Divide each coefficient by its respective power for integration to find entropy

sintCOEFF(:,2)=COEFF(:,2);

sintCOEFF(:,3)=COEFF(:,3)/2;

sintCOEFF(:,4)=COEFF(:,4)/3;

intCOEFF(:,1)=COEFF(:,1);%Divide each coefficient by its respective power for integration to find h

intCOEFF(:,2)=COEFF(:,2)/2;

intCOEFF(:,3)=COEFF(:,3)/3;

intCOEFF(:,4)=COEFF(:,4)/4;

intCvCOEFF(:,1)=CvCOEFF(:,1);%Divide each coefficient by its respective power for integration to find u

intCvCOEFF(:,2)=CvCOEFF(:,2)/2;

intCvCOEFF(:,3)=CvCOEFF(:,3)/3;

intCvCOEFF(:,4)=CvCOEFF(:,4)/4;

Y=[0 0 0.18 0.51 0.18 0.14];%mole fraction values

MMIX=M\*Y';%Calculate other mixture values

X=Y.\*M./MMIX;

RMIX=8.3145/MMIX;

hrefMIX=Href\*X';

urefMIX=Uref\*X';

srefMIX=Sref\*X';

%get values of mixture pressure and temperature

%disp 'Input the mixture Pressure(kPa) and Temperature(C):';

press=100;%input('Pressure(kPa): ');

tempC=1000;%input('Temperature(C): ');

temp1=1500;%tempC+273.15;

temp2=520;

tempA=[temp1 temp2];%put temperatures of interest into an array of size 2 to run for loop

intCpMIXref=303.6432;%Constant integrated value of Cp at reference temperature (298K)

intCvMIXref=226.1387;%Constant integrated value of Cv at reference temperature (298K)

sMIXref=0.0271;%Constant integrated value of Cpdt/T at reference temperature (298K)

%calculate values of Cp and Cv, integrals of Cp and Cv, h, u and s

for i=0:1

TEMP=[1 tempA(i+1) tempA(i+1)^2 tempA(i+1)^3];

sTEMP=[log(tempA(i+1)/298) tempA(i+1) tempA(i+1)^2 tempA(i+1)^3];

Cp=COEFF\*TEMP';

Cp(1)=5/2\*R(1);

Cp(2)=5/2\*R(2);

Cp=COEFF\*TEMP';

s=sintCOEFF\*sTEMP';

s(1)=5/2\*R(1)\*log(tempA(i+1)/298);

s(2)=5/2\*R(2)\*log(tempA(i+1)/298);

intTEMP=tempA(i+1)\*TEMP;%Add a power to each temp

intCp=intCOEFF\*intTEMP';%Calculate integral values for 4 polynomial functions

intCp(1)=5/2\*R(1)\*tempA(i+1);%Assign integrated values of constant 5/2\*R values = 5/2\*R\*temp

intCp(2)=5/2\*R(2)\*tempA(i+1);

intCv=intCvCOEFF\*intTEMP';

intCv(1)=3/2\*R(1)\*tempA(i+1);

intCv(2)=3/2\*R(2)\*tempA(i+1);

CpMIXA(i+1)=X\*Cp;%multiply matrices to calculate values

intCpMIXA(i+1)=X\*intCp;

intCvMIXA(i+1)=X\*intCv;

CvMIXA(i+1)=CpMIXA(i+1)-RMIX;

sMIX(i+1)=X\*s;

h(i+1)=intCpMIXA(i+1)-intCpMIXref+hrefMIX;

u(i+1)=intCvMIXA(i+1)-intCvMIXref+urefMIX;

S(i+1)=sMIX(i+1)-sMIXref+srefMIX;

end

%Calculate other values

CpMIX=X\*Cp;

CvMIX=RMIX-CpMIX;

K=CpMIX/CvMIX;

work=h(1)-h(2)

**PART B.**

clear all

%Stored reference values

M=[4.003 39.948 31.999 28.013 18.015 44.010]; %All arrays in same order as Cp

R=[2.077 .208 .26 .297 .462 .189];

Sref=[31.5375 3.876 6.6999 6.8045 10.423 4.8585];

Uref=[928.419 92.976 194.2 221.44 412.05 156.57];

Href=[1547.365 154.96 271.72 309.99 549.75 212.93];

%Tabulated Cp and Cv values from table 5s

Cp5s=[1.0041 1.0107 1.0249 1.0452 1.0687 1.0927 1.1154 1.1360 1.1544 1.1706 1.1848 1.1973 1.2083 1.2180 1.2267 1.2345 1.2416 1.2480 1.2539 1.2593 1.2644];

Cv5s=[.7169 .7235 .7376 .758 .7815 .8054 .8281 .8488 .8672 .8834 .8976 .9101 .9210 .9308 .9395 .9473 .9544 .9608 .9667 .9721 .9771];

h5s=[273.92 374.6 476.32 579.79 685.48 793.56 903.98 1016.6 1131.1 1274.4 1365.2 1483.0 1604.6 1726 1848.2 1971.3 2095.1 2219.6 2344.7 2470.4 2596.6];

u5s=[195.46 267.42 340.42 415.17 492.13 571.49 653.19 737.07 822.89 910.45 999.52 1088.6 1181.5 1274.1 1367.7 1462 1557.1 1652.9 1749.3 1846.2 1943.7];

s5s=[6.6119 6.9259 7.1673 7.3656 7.5356 7.6852 7.8195 7.9415 8.0536 8.1571 8.2535 8.3436 8.4281 8.5078 8.5831 8.6546 8.7225 8.7872 8.8491 8.9083 8.965];

Y=[0 0 0.18 0.51 0.18 0.14];%mole fraction values

%Calculate other mixture values

Y=[yHe yAr yO2 yN2 yH2O yCO2];

MMIX=M\*Y';%molar mass of mixture

RMIX=8.3145/MMIX;%R value of mixture

X=Y.\*M./MMIX;%mass fraction

hrefMIX=Href\*X';%href of mixture

urefMIX=Uref\*X';%uref of mixture

srefMIX=Sref\*X';%sref of mixture

TMIN=0;

TMAX=2000;

int=100;

tempC=[TMIN:int:TMAX];%temperature array in degrees celsius

tempA=tempC+273.15;%temperature array in degrees kelvin for calculations

tempB=[0:100:2000];%temperature array to use for graphing tabulated values

COEFF=[0 0 0 0;

0 0 0 0;

0.7963 4.7501e-004 -2.2360e-007 4.1001e-011;

1.0317 -5.6081e-005 2.8847e-007 -1.0256e-010;

1.7896 1.0674e-004 5.8562e-007 -1.9956e-010;

0.5058 0.0014 7.9550e-007 1.6971e-010];

CvCOEFF=COEFF;

CvCOEFF(3,1)=COEFF(3,1)-R(3);

CvCOEFF(4,1)=COEFF(4,1)-R(3);

CvCOEFF(5,1)=COEFF(5,1)-R(3);

CvCOEFF(6,1)=COEFF(6,1)-R(3);

sintCOEFF(:,1)=COEFF(:,1);%Divide each coefficient by its respective power for interation

sintCOEFF(:,2)=COEFF(:,2);

sintCOEFF(:,3)=COEFF(:,3)/2;

sintCOEFF(:,4)=COEFF(:,4)/3;

intCOEFF(:,1)=COEFF(:,1);%Divide each coefficient by its respective power for interation

intCOEFF(:,2)=COEFF(:,2)/2;

intCOEFF(:,3)=COEFF(:,3)/3;

intCOEFF(:,4)=COEFF(:,4)/4;

intCvCOEFF(:,1)=CvCOEFF(:,1);

intCvCOEFF(:,2)=CvCOEFF(:,2)/2;

intCvCOEFF(:,3)=CvCOEFF(:,3)/3;

intCvCOEFF(:,4)=CvCOEFF(:,4)/4;

intCpMIXref=303.6432;%Constant integrated value of Cp at reference temperature (298K)

intCvMIXref=226.1387;%Constant integrated value of Cv at reference temperature (298K)

sMIXref=0.0271;%Constant integrated value of Cpdt/T at reference temperature (298K)

for i=0:1:(TMAX-TMIN)/int

TEMP=[1 tempA(i+1) tempA(i+1)^2 tempA(i+1)^3];

sTEMP=[log(tempA(i+1)/298) tempA(i+1) tempA(i+1)^2 tempA(i+1)^3];

Cp=COEFF\*TEMP';

Cp(1)=5/2\*R(1);

Cp(2)=5/2\*R(2);

Cp=COEFF\*TEMP';

s=sintCOEFF\*sTEMP';

s(1)=5/2\*R(1)\*log(tempA(i+1)/298);

s(2)=5/2\*R(2)\*log(tempA(i+1)/298);

intTEMP=tempA(i+1)\*TEMP;%Add a power to each temp

intCp=intCOEFF\*intTEMP';%Calculate integral values for 4 polynomial functions

intCp(1)=5/2\*R(1)\*tempA(i+1);%Assign integrated values of constant 5/2\*R values = 5/2\*R\*temp

intCp(2)=5/2\*R(2)\*tempA(i+1);

intCv=intCvCOEFF\*intTEMP';

intCv(1)=3/2\*R(1)\*tempA(i+1);

intCv(2)=3/2\*R(2)\*tempA(i+1);

CpMIXA(i+1)=X\*Cp;

intCpMIXA(i+1)=X\*intCp;

intCvMIXA(i+1)=X\*intCv;

CvMIXA(i+1)=CpMIXA(i+1)-RMIX;

sMIX(i+1)=X\*s;

h(i+1)=intCpMIXA(i+1)-intCpMIXref+hrefMIX;

u(i+1)=intCvMIXA(i+1)-intCvMIXref+urefMIX;

S(i+1)=sMIX(i+1)-sMIXref+srefMIX;

hErr(i+1)=abs((h5s(i+1)-h(i+1))/h5s(i+1))\*100;

uErr(i+1)=abs((u5s(i+1)-u(i+1))/u5s(i+1))\*100;

sErr(i+1)=abs((s5s(i+1)-S(i+1))/s5s(i+1))\*100;

end

TABLE=[h' h5s' hErr' u' u5s' uErr' S' s5s' sErr'];%variable to combine all calculated values, tabulated values, and percent errors

plot(tempC,CpMIXA,'o');

hold on

plot(tempB,Cp5s,'r');

TITLE('Cp vs. Temperature')

XLABEL('Temperature [C]')

YLABEL('Cp [KJ/(Kg\*K)')

Legend('Calculated values','Tabulated (Table 5s)')