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/*
Example on Unsteady-State System with Variable Density - Question 9
*/

#include<stdio.h>
#include<math.h>

#define QEIn 12000.
#define rhoEin 0.7893
#define D 75.
#define d 1.0
#define C 0.58
#define g 3531600.
#define PI 3.1415927

float OverallMassBalance(float,float,float);
float EthanolMassBalance(float,float,float,float,float);
float EthanolDensity(float);

float OverallMassBalance(float h, float dens, float delt)
{
    float answer;

    answer=((4*QEIn*rhoEin)/(PI*D*D)-(d*d*C*dens*sqrt(2*g*h))/(D*D))*delt+dens*h;
    return(answer);
}

float EthanolMassBalance(float h,float dens,float wE,float densE,float delt)
{
    float answer;

    answer=((4*QEIn*rhoEin)/(PI*D*D)-(d*d*C*dens*wE*sqrt(2*g*h))/(D*D))*delt+densE*h;
    return(answer);
}

float EthanolDensity(float wE)
{
    float density;

    density=0.9982+wE*(-0.1979+wE*(0.4728+wE*(-1.314+0.9690*wE)));
    return(density);
}

main()
{
    FILE *fptr;

    float olddens,oldh,olddensE,oldmassfractE;
    float newdens,newh,newdensE,newmassfractE;
    float deltatime,Volume;
    float MaxVolume=883.5;

    float rhoh,rhoEh;
    int count;

    float limitmassfractE=0.50;
    float Time=0;

    /*    Input    */

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printf("Enter Time Step (min): ");
scanf("%f",&deltatime);

/*    Initial Values    */

olddens=0.9982;
oldh=113.18;
olddensE=0;
oldmassfractE=0;

/*    Open File for output    */

fptr = fopen("a:ethtank.dat","w");

/*    Print out a Heading    */

printf("Time (min)  Mass Fraction Ethanol  Volume (L)  Density (g/mL)\n");
printf("-----\n");
count=0;

do
{
    Time=Time+deltatime;
    rhoh=OverallMassBalance(oldh,olddens,deltatime);
    rhoEh=EthanolMassBalance(oldh,olddens,oldmassfractE,olddensE,deltatime);
    newmassfractE=rhoEh/rhoh;
    newdens=EthanolDensity(newmassfractE);
    newdensE=newdens*newmassfractE;
    newh=rhoh/newdens;
    Volume=PI*D*D*newh/4000.; /* Convert Units to Liters to compare with maximum Volume */
    count++;

/*    Print out only every 60 intervals    */

    if(count==60)
    {
        count=0;
        printf("%7.2f          %6.4f          %7.1f          %6.4f\n",Time,newmassfractE,Volume,
newdens);
        fprintf(fptr,"%7.2f          %6.4f          %7.1f          %6.4f\n",Time,newmassfractE,Volume,
newdens);
    }
    olddens=newdens;
    oldh=newh;
    olddensE=newdensE;
    oldmassfractE=newmassfractE;
}
while((newmassfractE<limitmassfractE)&&(Volume<MaxVolume));
printf("\n");
if(Volume>MaxVolume)
{
    printf("The capacity of the tank was exceeded!\n");
    printf("This condition occurred at a time of %7.2f minutes\n",Time);
}
else
{
    printf("The final mass fraction is : %6.4f\n",newmassfractE);
    printf("This solution's density is : %6.4f\n",newdens);
    printf("The final volume is : %7.1f L\n",Volume);
    printf("The time required is : %7.2f minutes\n",Time);
}
fclose(fptr);
}

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