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Calculation of Terminal Velocity

Contents

Constants :

Defining the constants used :

```
g = 9.80665;  % m/s^2, acceleration due to gravity
rhop = 1800;   % kg/m^3 , Particle Density
rhof = 994.6; % kg/m^3, Fluid Density
mu = 8.931e-4; % kg/m-s, Fluid Viscosity
Dp = 0.208e-3;  % m, Particle Diametere
T = 298.15;      %  Kelvin, Temperature
const = rhof*Dp/mu; % Constant used to calculate Re, Re = const*v
const1 = (4*g*(rhop-rhof)*Dp/3/rhof)^0.5 ;
vt = 1 ;   % m/s, Terminal velocity guess value
e = 1e-6   ;       % Error Margin
```

Functions Used :

Below I have defined the Functions that I have used

```
Re = @(v) const*v ; % Reynolds Number
Cd_1 = @(v) 24/(const*v) ; % Drag Coefficient for Re < 0.1 ;
Cd_2 = @(v) (24/(const*v))*(1 + 0.14*((const*v)^0.7)); % Drag Coefficient for 0.1 =< Re =< 1000 ;
Cd_3 = @(v) 0.44; % Drag Coefficient for 1000 =< Re =< 350,000 ;
Cd_4 = @(v) 0.19 - (8e4)/(const*v); % Drag Coefficient for Re > 350,000 ;
v_t = @(Cd) const1*(Cd^-0.5) ; % Terminal Velocity in terms of Drag Coefficient
```

Solving the First Part :

Here I have shown how to solve the first part :

I will run a loop where first we calculate the Reynolds Number with a guess value of vt. Using this we obtain a new value of vt and check if the guess value matches. If not, we take the obtained vt as the guess value in the next loop.

The program will print the guess and obtained guess as the loop runs so that we can observe the convergance.

```
i = 0; disp_vt = [vt]; disp_vtt = [0];
while true
    Re_g = Re(vt) ;
    if Re_g < 0.1
            Cd = Cd_1(vt) ;

    elseif (Re_g >= 0.1)||(Re_g <= 1000)
            Cd = Cd_2(vt) ;

    elseif (Re_g <= 350000)||(Re_g > 1000)
            Cd = Cd_3(vt) ;
```

```
    elseif Re_g > 350000
            Cd = Cd_4(vt) ;
    end
    vt_t = v_t(Cd);
    disp_vt = [disp_vt;vt]; disp_vtt = [disp_vtt;vt_t];

    if abs(vt - vt_t) < e
        break
    else
        vt = vt_t;
        i = i + 1;
    end
end
ind = [0:i+1];
T1 = table(ind',disp_vt,disp_vtt,'VariableNames',{'Iteration Number','Guess Value','Obtained Guess'});
disp(T1);
disp(['The Terminal velocity is : ',num2str(vt_t ),' m/s'])
disp(['The Reynolds Number is : ',num2str(vt*const)])
disp(['The Drag Coefficient is : ',num2str(Cd)]);
```

```
    Iteration Number    Guess Value    Obtained Guess
    ________________    ___________    ______________

            0                   1               0
            1                   1         0.053846
            2            0.053846         0.025084
            3            0.025084         0.018982
            4            0.018982         0.017008
            5            0.017008         0.016271
            6            0.016271          0.01598
            7             0.01598         0.015863
            8            0.015863         0.015815
            9            0.015815         0.015795
           10            0.015795         0.015787
           11            0.015787         0.015784
           12            0.015784         0.015783
           13            0.015783         0.015782

The Terminal velocity is : 0.015782 m/s
The Reynolds Number is : 3.6559
The Drag Coefficient is : 8.8422
```

Solving for the Second Part :

Here we need to make a small change.

Instead of accelration due to gravity, our g changes from g to what is given i.e 30*g.

Redefining the functions to include the changes

```
g_new = 30*g ;
const2 = (4*g_new*(rhop-rhof)*Dp/3/rhof)^0.5 ;
v_t_c = @(Cd) const2*(Cd^-0.5) ; % Terminal Velocity in terms of Drag Coefficient with different g
% Again solving as done before:
% First Redefine the initial value of vt !!IMPORTANT!!
vt_c = 1;
j = 0; disp_vtc = [vt_c]; disp_vttc = [0];
while true
    Re_g = Re(vt_c) ;
    if Re_g < 0.1
```

```
            Cd = Cd_1(vt_c) ;

    elseif (Re_g >= 0.1)||(Re_g <= 1000)
            Cd = Cd_2(vt_c) ;

    elseif (Re_g <= 350000)||(Re_g > 1000)
            Cd = Cd_3(vt_c) ;

    elseif Re_g > 350000
            Cd = Cd_4(vt_c) ;
    end
    vt_t_c = v_t_c(Cd);
    disp_vtc = [disp_vtc;vt_c]; disp_vttc = [disp_vttc;vt_t_c];

    if abs(vt_c - vt_t_c) < e
        break
    else
        vt_c = vt_t_c;
        j = j + 1;
    end
end
ind = [0:j+1];
T2 = table(ind',disp_vtc,disp_vttc,'VariableNames',{'Iteration Number','Guess Value','Obtained Guess'});
disp(T2);
disp(['The Terminal velocity in Centrifugal Separator is : ',num2str(vt_t_c ),' m/s'])
disp(['The Reynolds Number is : ',num2str(vt_c*const)])
disp(['The Drag Coefficient is : ',num2str(Cd)])
```

Iteration Number	Guess Value	Obtained Guess
0	1	0
1	1	0.29493
2	0.29493	0.22566
3	0.22566	0.21097
4	0.21097	0.20731
5	0.20731	0.20636
6	0.20636	0.20611
7	0.20611	0.20604
8	0.20604	0.20603
9	0.20603	0.20602
10	0.20602	0.20602
11	0.20602	0.20602

```
The Terminal velocity in Centrifugal Separator is : 0.20602 m/s
The Reynolds Number is : 47.7227
The Drag Coefficient is : 1.5566
```

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