Injector Design Tool

Table of Contents

The following is a comprehensive injector calculation tool. Make sure that all relevant functions are in the same path/folder as this script. Do NOT change the names of any functions.

```
clear all
clc
format short g

%Injector Design Tool
    %Vignesh Sella
    %12/03/2018
    %The following is a comprehensive injector calculation tool.
    %Make sure that all relevant functions are in the same path/folder
 as this
    %script. Do NOT change the names of any functions.
%Handy Equations:
%   p1+1/2*rho*v1^2=p2+1/2*rho*v2^2 // Bernoulli's Equation
%   mdot=rho*s1*v1 // Mass Flow Rate
```

GIVENS/ASSUMPTIONS

```
    global p0, p0=7.5*10^6; %Pa // Pressure in the oxidizer tank
    global v0, v0=0; %m/s // Initial velocity in the oxidizer tank
    global rho, rho=769.9; %kg/m^3 // Density of NOS at room
 temperature
    global mdot, mdot=1.53; %kg/s // Mass flow rate in steady state
    global d1, d1=0.0127; %m // Diamater of feed pipe, directly after
 oxidizer tank
    global d2, d2=0.030; %m // Diamater of manifold, directly before
 injector plate
    global p3, p3=4*10^6; %Pa // Expected combustion chamber pressure
 during steady state
    global d, d=1*10^-3; %m // Diameter of an individual orifice
    global k, k=2; %dimensionless // Head loss coefficient for radial
 inlet
    pseudo_p = 35;
    units = {'kg/m^3';'kg.s';'m';'Bars'};
T1 = table({'Rho';'Desired Mdot';'Orf D';'DeltaP'},
[rho;mdot;d;pseudo_p],[units]);
```

```
T1.Properties.VariableNames = {'Specification','Value','Units'}


T1 =

  4×3 table

    Specification      Value      Units
    ______________     _____    ________

    'Rho'              769.9    'kg/m^3'
    'Desired Mdot'      1.53    'kg.s'
    'Orf D'            0.001    'm'
    'DeltaP'              35    'Bars'
```

PV CALC

```
    [p1, v1] = PVCalc(d1,p0,v0);
    [p2, v2] = PVCalc(d2,p1,v1);
    deltap= p2-p3; %Pa // Pressure differential of manifold and
 combustion chamber
```

ORIFICE GEOMETRY

```
   %-------------------------
    Ao = pi*(d^2/4); %m^2 // Area of an individual orifice
    Vinj = sqrt((2*deltap)/(k*rho)); %m/s // Velocity of fluid through
 injector **ALSO EQUAL TO v3/sqrt(k)**
    n_tot = mdot/(rho*Vinj*Ao); %# // Number of orifices in injector
 plate
    INT_n_tot = ceil(n_tot);
%-------------------------
    Ao_tot = Ao*INT_n_tot; %m^2 // Area of all orifices combined
    Ao_tot_mm = Ao_tot*10^6; %mm^2 // Area of all orifices combined
%-------------------------
    d_tot = d*INT_n_tot; %m // Total diameter of all orifices combined
    d_tot_mm = d*INT_n_tot*1000; %mm // Total diamter of all orifices
 combined
    length = 7*d;
unitz = {'#';'m/s';'mm^2';'m'};
T2 = table({'#ofOrf';'Velocity';'A2';'Length'},
[INT_n_tot;Vinj;Ao_tot_mm;length],[unitz]);
T2.Properties.VariableNames = {'Specficiation', 'Value','Units'}


T2 =

  4×3 table

    Specficiation    Value     Units
    _____________    ______    ______
```

```
'#ofOrf'            38     '#'
'Velocity'      67.395     'm/s'
'A2'            29.845     'mm^2'
'Length'         0.007     'm'
```

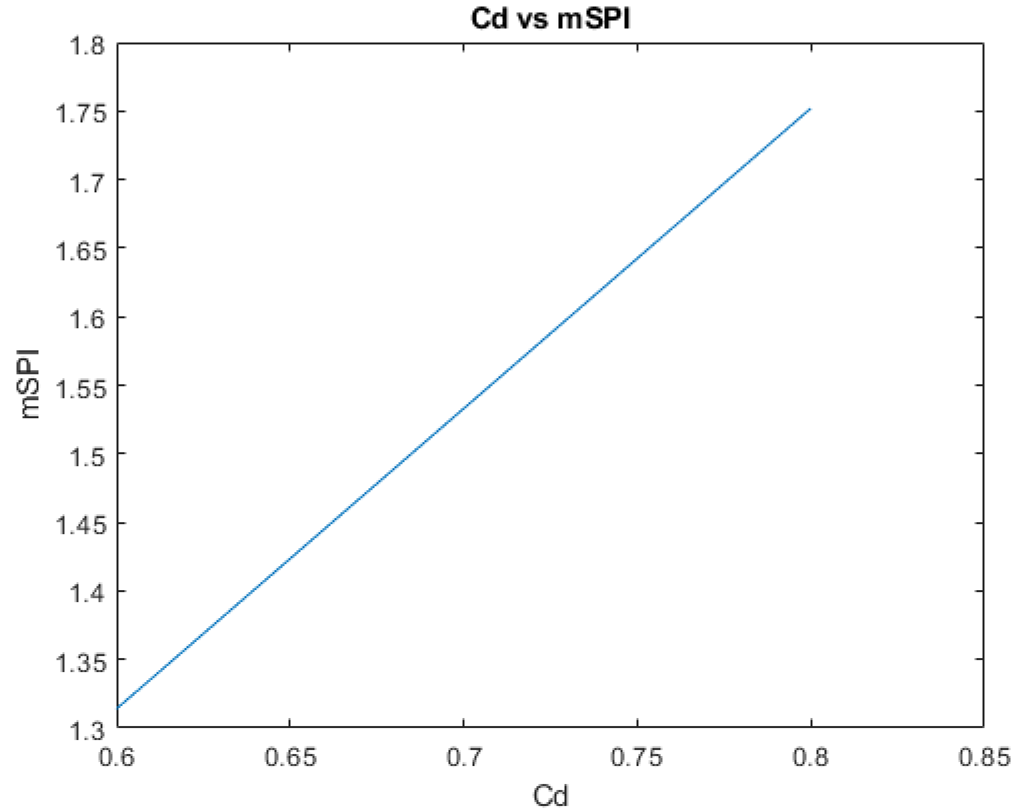
FLOW MODELING

```
%Cd=0.7; %dimensionless // Ratio of actual flow to theoretical
%-------------------------
%SINGLE PHASE INCOMPRESSIBLE
%Equation: mSPI = Cd*Ao_tot*sqrt(2*rho*deltap); %kg/s
%Anonymous function which takes in various Cd values, and then exports
%various mSPI values.
    mSPI = @(Cd) (Cd*Ao_tot*sqrt(2*rho*deltap));
    Cd_range = linspace(.6,.8,10); %Range of values given to Cd
    mSPI_range = mSPI(Cd_range);
    mSPI_range_AVG = mean(mSPI_range)
    plot(Cd_range,mSPI_range)

title('Cd vs mSPI')
xlabel('Cd')
ylabel('mSPI')
%-------------------------
%INSERT mHEM, mDYER
%-------------------------
%INSERT mHEM, mDYER
```

```
mSPI_range_AVG =

        1.533
```



ATOMIZATION

```
%NITROUS OXIDE CHARACTERISITICS (at 10 degC)
    dyn=0.007146; %Pa // dynamic viscosity of NOS
    kin = 8.39712e-8; %m^2/s (converted from cSt) // kinematic
 viscosity
    st=.003948; %N/m // surface tension of NOS
%-------------------------
%REYNOLDS NUMBER
    Re=(Vinj*d)/kin;
%-------------------------
%OHNESORGE NUMBER
    Oh=dyn/sqrt(rho*st*d);
%-------------------------
%WEBER NUMBER
    We=rho*Vinj^2*d/st ;
%-------------------------
T2 = table({'Reynolds';'Ohnesorge';'Weber'},[Re;Oh;We]);
T2.Properties.VariableNames = {'Specficiation', 'Value'}
```

```
T2 =

  3×2 table

    Specficiation       Value
```

'Reynolds'	8.026e+05
'Ohnesorge'	0.12962
'Weber'	8.8575e+05

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