COE-C2003 Basic course on fluid mechanics, S2021

Round 6: Pipe flows (return at the latest by Thu 28.10. at 13:00 o'clock)

Each problem (1-4) will be assessed on a scale of 0-3. Remember to explain the different stages in the solution. More detailed information can be found from MyCourses.

1. Water flows from the container shown in the Fig. 1. Determine the loss coefficient needed in the valve if the water is to 'bubble up' 7.6 cm above the outlet pipe.

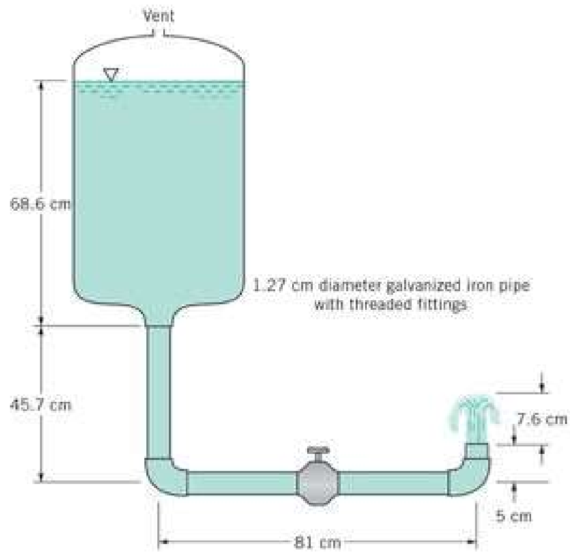

Figure 1. Problem 1.

2 The exhaust from a car's engine flows through a complex pipe system as shown in Fig. 2. Assume that the pressure drop through this system is Δp_1 when the engine is idling at 1000 rpm. Estimate the pressure drop (in terms of Δp_1) with the engine at 3000 rpm when driving on a highway. List all the assumptions that you made to arrive at your answer.

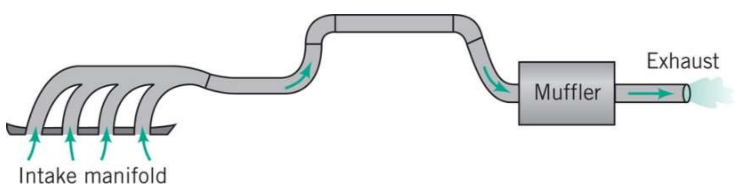

Figure 2. Problem 2.

Flow around immersed bodies

3 A golf ball has dimples on its surface, Fig. 3. Explain why they are used, what is their effect, and what is the physics behind this.

Figure 3. The surface of a golf ball.

4 We continue from Round 5 Matlab exercise where we calculated the injection velocity with the Bernoulli equation. Now, make a 2D contour plot of the injection velocity as a function of injection pressure and backpressure. Use the contour –command (google ‘Matlab contourf’). Injection pressure is between 300 – 2300 bar and the backpressure is between 22 – 220 bar. The fuel density is 800 kg/m^3.

The basic idea is now that **two for *-loops are made in Matlab*.** One for the injection pressure and one for the backpressure (google ‘Matlab for loop’). From this we get the injection velocity as a function of the injection pressure and backpressure ($V(j, i)$). Plot the figure so that the injection pressure is in the x-axis and the backpressure is in the y-axis (vertical axis). Plot also the axis texts (xlabel, ylabel). In the answer, give the code and the figure (in a single pdf file).

Some Matlab hints:

```
clear all;
set(0,'DefaultAxesFontWeight','default')
set(0,'DefaultAxesFontSize',[14])
set(0,'DefaultTextFontSize',[14])

rhoo_l=   ; % liquid density

% Make a loop over the injection pressure. Make the loop from e.g.
% 1 - 100

for i=…

% Make another loop for the backpressure. Make this loop also from
% 1 - 100

for j=...
```

```matlab
% In the loop, define the injection pressure (320 - 2300bar with
% 20bar steps)

% Define the backpressure (22 - 220 bar with 2 bar intervals)

v(j,i)=... % Calculate the injection velocity based on injection
           % pressure and backpressure

    end
end

[x,y]=meshgrid(320:20:2300,22:2:220) % Lets make a mesh into which we
% plot the result. This is ready as it is above.

Contourf(...) % Plot the figure

colormap jet(20) % you can use e.g. this color map if you like

% Axis texts
xlabel(...)
ylabel(...)

% Add color map scale to the plot and axis text

c = colorbar;
c.Label.String = 'Injection velocity [m/s]';
c.Label.FontSize = 14;
```