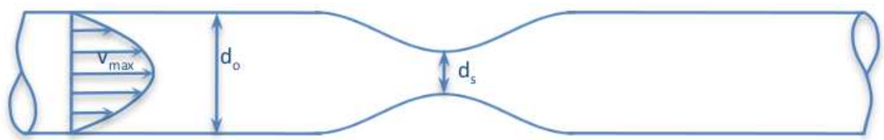
Stenotic Vessel Simulations

Description

In this lab exercise the COMSOL package will be used to study incompressible flow fields inside axisymmetric stenoses. The geometry files for two different stenotic vessels are provided (`stenosis_75.dxf` and `stenosis_90.dxf`). These vessels present 75% and 90% area constrictions, respectively.



The overall vessel length is $L = 0.15$ m for the 90% and $L = 0.04$ m for the 75% stenosis, respectively, while the inlet and outlet radii are $r_0 = 0.0015$ m for both vessels. The filling fluid is considered to be blood with density $\rho = 1050$ kg/m^3 and dynamic viscosity $\eta = 0.004$ Pa $\cdot$ s. The exit pressure is equal to 80 mmHg. The normal inlet velocity profile has the following form

$$v = V_{max}\left[1 - \left(\frac{r}{r_0}\right)^2\right],$$

where:

$$V_{max} = \frac{2Q}{\pi r_0^2},$$

with Q denoting the flow rate.

Solve the incompressible flow field inside the 90% area stenosis for the flow rate values of 0.5 ml/s, 1.0 ml/s, 1.5 ml/s, 2.0 ml/s, and:

- Make surface plots of the velocity components, the velocity magnitude and pressure. Plot also the streamlines and comment on the extent of the recirculation zones downstream of th constriction.
- Construct axial pressure distribution graphs for each flow rate.
- Compare the computed pressure value at the neck of the constriction to the value predicted by the Bernoulli theory. Plot these values against the flow rates.

Repeat the above procedure for the 75% constricted vessel only for the case of 1.0 ml/s flow rate and compare results with the 90% case for the same flow rate.

The geometry files contain data in SI units, so all units in COMSOL must be providec same unit system.
