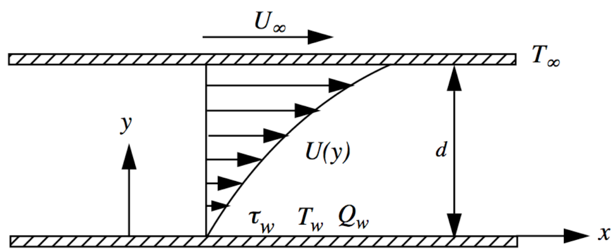
AA210A Homework 5 2020 -2021 B. Cantwell Fall 2020
Due Wednesday October 21

Read Chapter 8 Sections 8.4 to 8.11. In Chapter 8 do Problem 4.

Problem 1 - The figure below depicts compressible Couette flow between two parallel walls. The upper wall is at a temperature $T_\infty = 300K$ and moves to the right at a speed $U_\infty = 800\ m/\sec$ while the lower wall is at rest. The gas is helium with $P_r = 0.67$ and atomic weight = 4. Normally we consider the case where the lower wall is adiabatic and there is heat flow through the upper wall. In this problem I would like you to consider the opposite case where the upper wall is adiabatic and the lower wall is not adiabatic. In this case the power put into the flow by the upper wall all passes through the lower wall and $Q_w < 0$.



For this case:

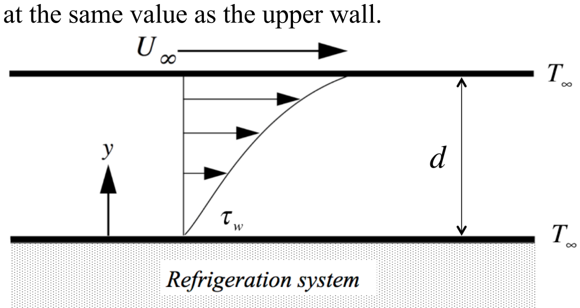
1) Determine M_∞.

2) Use the energy equation to relate U_∞, τ_w and Q_w.

3) Determine the temperature of the lower wall, T_w / T_∞.

4) Assuming $\mu/\mu_\infty = T/T_\infty$, determine $(\tau_w d)/(\mu_\infty U_\infty)$.

Problem 2 – In the Couette flow problem shown below a refrigeration system is used to maintain the temperature of the lower wall at the same value as the upper wall.



1) Show that $Q_w / \tau_w = -U_\infty / 2$

2) Use the following data to evaluate R_e, M_∞, and P_r. What gas is this?

$U_\infty = 400 m/\sec,\ d = 0.001m,\ T_\infty = 300K,\ \rho_\infty = 1.177 kg/m^3,\ R = 287 m^2/\left(\sec^2 - K\right),\ \gamma = 1.4$

$\mu_\infty = 1.846\times10^{-5} kg/\left(m-\sec\right),\ C_p = 1005 m^2/(\sec^2 - K),\ \kappa_\infty = 2.624\times10^{-2} kg\text{-}m/\left(\sec^3 - K\right)$

3) Assume $\mu/\mu_\infty = T/T_\infty$. Determine the friction coefficient, C_f, on the lower wall.