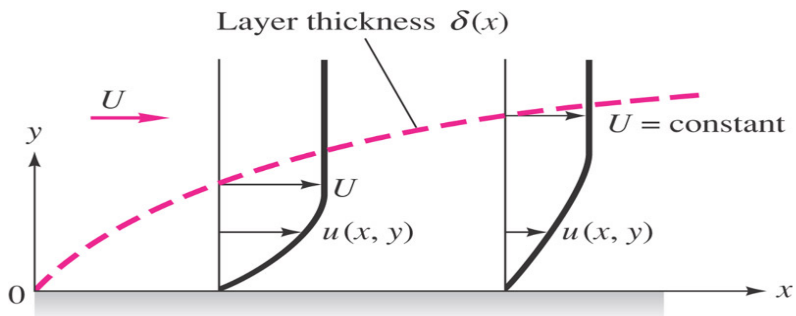
MASSACHUSETTS INSTITUTE OF TECHNOLOGY
DEPARTMENT OF MECHANICAL ENGINEERING
2.06 Fluid Dynamics

RECITATION #5, Spring Term 2013

Topics: Continuity (Mass Conservation) and Navier-Stokes Equation

Problem 1.

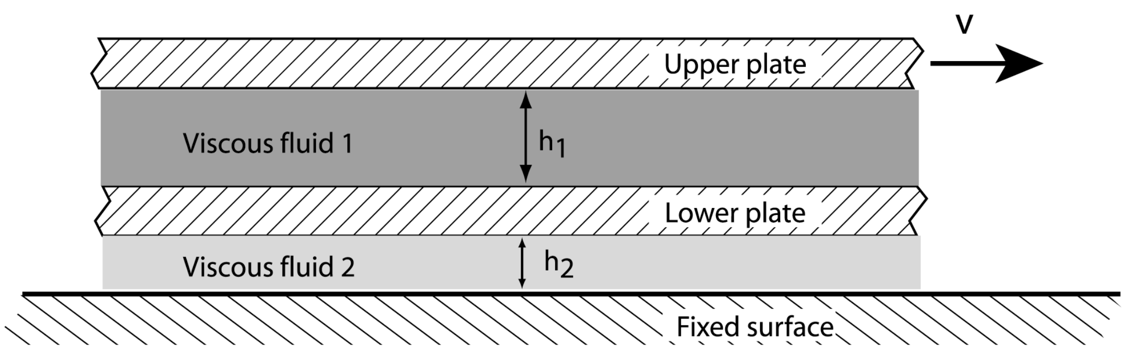


A reasonable approximation for the two-dimensional incompressible laminar boundary layer on the flat surface is

$$u(x,y) = U\left(\frac{2y}{\delta} - \frac{y^2}{\delta^2}\right) \text{ for } y \le \delta \text{ where } \delta = Cx^{1/2}, \text{ C=const}$$

a) Assuming a no-slip condition at the wall, find an expression for the velocity component v(x,y) for y≤δ.
b) Then find the maximum value for v at the station x=1m, for the particular case of airflow, when U=3 m/s and δ=1.1cm.

Problem 2.



Two plates and a fixed surface sandwich two viscous fluid films as shown above. The top plate moves with a velocity v of 1.5 m/s and the lower plate is free to move under the influence of the viscous forces applied to it. The contact areas for the lower surface of the upper plate is the same as the upper surface of the lower plate as well as the lower surface of the lower plate and that of the fixed surface. h_1=2.0 mm, μ_1=0.2 Pa-s, h_2= 1 mm and μ_2= 0.5 Pa-s. The density of both fluids is 850 kg/m^3.

a) After steady state conditions have been reached, what is the velocity of the lower plate?
b) What is the force per unit area imposed on the upper plate to maintain its velocity?

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