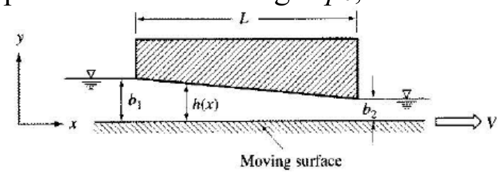
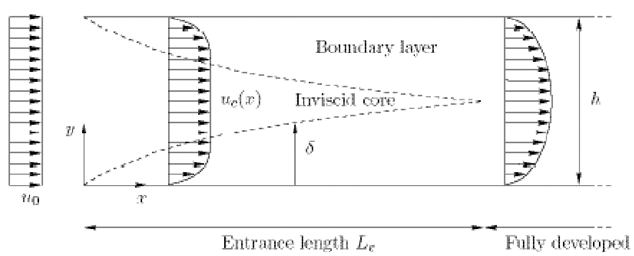
تمرین سری هفتم درس جریان لزج

تاریخ تحویل:۹۴/۹/۲۸

1. A simple slider bearing has a uniform taper from the inlet, where the gap is b_1, to the exit, where the gap is b_2. The bottom surface moves at a steady speed V a shown. The local channel height is h.
   (a) Show that the pressure gradient along the slider can be written as
   $$\frac{dp}{dx} = \frac{12\mu V}{h^3}\left(\frac{h}{2} - \frac{b_1 b_2}{b_1 + b_2}\right)$$
   (b) If the pressure at each open end of the bearing is p_0, sketch the pressure.



2. Derive an expression for pressure variations in Hiemenz plane flow and show that
   $$\frac{\partial p}{\partial x} = -\rho a^2 x = -\rho U_{inv.} \frac{dU_{inv.}}{dx}$$
   $$\frac{\partial p}{\partial y} = -\rho a\sqrt{\nu a}\left(F'' + FF'\right) = O\left(\sqrt{\nu}\right)$$
   It shows that the pressure variation in the y-direction is an order $1/Re$. Is the true stagnation pressure equal to the inviscid stagnation pressure?
3. Consider the planar incompressible laminar flow in the entrance region between two infinitely thin flat plates a distance h apart, as depicted schematically in the figure below. In the entrance region, i.e., $0 \le x \le L_e$ where L_e is the so-called entrance length, the boundary layers growing on the two plates are separated by the inviscid core. The flow becomes fully developed when the boundary layers merge at the center line. Upstream of the plates, the velocity is u_0.



   Assume that the velocity in the inviscid core is ue(x) and that the velocity in the boundary layer can be approximated by the parabolic profile $u(x,y)/u_e(x) = y/\delta(2 - y/\delta)$ where $\delta(x)$ denotes the boundary-layer thickness.
   (a) Use conservation of mass to show that the boundary-layer thickness $\delta(x)$ increases according to $\delta / h = 3/2(1 - u_0/u_e)$ and then find δ^* / δ and θ / δ.
   (b) Use the results you derived in (a) and the momentum- integral equation to show that the non-dimensional velocity in the inviscid core, defined as $\bar{u}_e = u_e / u_0$ satisfies

$$(9 - \frac{16}{\overline{u}_e} - \frac{7}{\overline{u}_e^{\,2}})\frac{d\overline{u}_e}{d\overline{x}} - \frac{40}{3\,\mathrm{Re}}$$

where $\overline{x} = x/h$ and $Re = u_0 h/\nu$.

(c) Show that the entrance length is given by

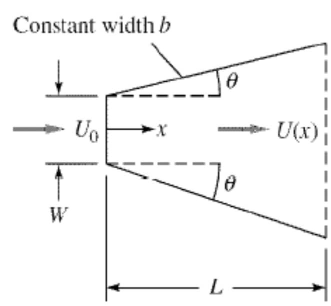
$$\frac{L_e}{h} = 0.0259\, u_o h/\nu = 0.0259\, Re$$

Discuss, from a physical point of view, whether the dependence of L_e on u_0, h and ν makes sense. Compare the formula obtained with available results in the literature.

4. Consider a two-dimensional flat-walled diffuser in the figure below, with constant width b. If x is measured from the inlet and the wall boundary layers are thin, show that the core velocity $U(x)$ in the diffuser is given approximately by

$$U = \frac{U_o}{1 + (2x \tan\theta)/W}$$

where W is the inlet height. Use this velocity distribution with Thwaites method to find an expression for the wall angle θ at which laminar separation will occur in the exit plane $x = l$. What is the value of θ if diffuser length $L = 1.5W$? Note that the result is independent of the Reynolds number.



تمرینات تحویلی باید شامل موارد ذیل باشد.

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تاریخ تحویل

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