5.16 PROBLEM ~~4.61~~ 5.16

GIVEN Fig. P~~4.61~~. Molten plastic at 510°F, extruder inside diameter = D = 8 in., inside length = L = 16 ft, adapter internal volume = die internal volume = 0.48 ft^3, plastic sheet width = b = 4 ft, thickness = t = 0.187 in., and V_2 = 30 fps. Constant plastic density. Screw volume = 3/5 extruder internal volume.

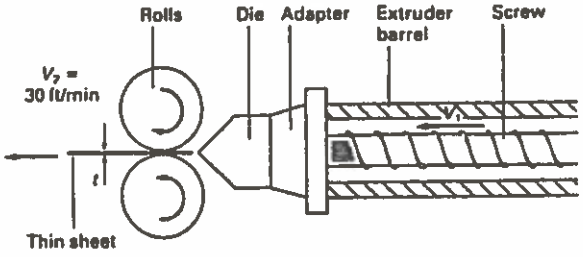
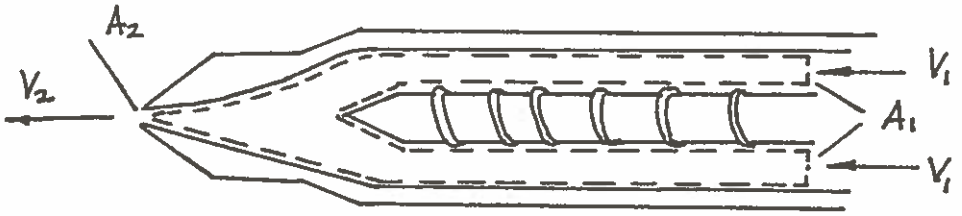


Fig. P~~4.61~~ 5.16

FIND Axial velocity V_1 of molten plastic in extruder.

SOLUTION Apply conservation of mass (i.e. continuity equation) to a control volume enclosing the plastic. Assume steady state.



For constant density (and steady state)

$$A_1 V_1 = A_2 V_2$$

Now

$$A_1 = \frac{2}{5}\frac{\pi}{4}D^2 = \frac{2}{5}\frac{\pi}{4}(8\text{ in.})^2\left(\frac{\text{ft}}{12\text{ in.}}\right)^2 = 0.1396\text{ ft}^2,$$

$$A_2 = bt = (4\text{ ft})\left(\frac{0.187}{12}\text{ ft}\right) = 0.0623\text{ ft}^2,$$

and

$$V_1 = \frac{A_2 V_2}{A_1} = \frac{(0.0623\text{ ft}^2)(30\text{ ft/sec})}{(0.1396\text{ ft}^2)}$$

$$\boxed{V_1 = 13.4\text{ ft/sec}}$$