

**4.27** A nozzle is designed to accelerate the fluid from  $V_1$  to  $V_2$  in a linear fashion. That is, V = ax + b, where a and b are constants. If the flow is constant with  $V_1 = 10$  m/s at  $x_1 = 0$  and  $V_2 = 25$  m/s at  $x_2 = 1$  m, determine the local acceleration, the convective acceleration, and the acceleration of the fluid at points (1) and (2).

With u = ax + b, v = 0, and w = 0 the acceleration  $\vec{a} = \frac{\partial \vec{V}}{\partial t} + \vec{V} \cdot \nabla \vec{V}$  can be written as  $\vec{a} = a_x \hat{c}$  where  $a_x = u \frac{\partial u}{\partial x}$ . (1)

Since  $u = V_1 = 10 \frac{m}{s}$  at x = 0 and  $u = V_2 = 25 \frac{m}{s}$  at x = 1 we obtain 10 = 0 + b

25 = a + b so that a = 15 and b = 10

That is,  $u = (15x+10) \frac{m}{s}$ , where  $x \sim m$ , so that from Eq.(1)

 $a_X = (15X+10)\frac{m}{s}(15\frac{1}{s}) = (225X+150)\frac{m}{s^2}$ 

Note: The local acceleration is  $\overline{zero}$ ,  $\frac{\partial \vec{V}}{\partial t} = 0$ , and the convective acceleration is  $u\frac{\partial u}{\partial x} \hat{i} = (225x+150)\hat{i} \frac{m}{s^2}$ 

At x = 0,  $\vec{a} = 150 \hat{i} \frac{m}{S^2}$ ; at x = /m,  $\vec{a} = 375 \hat{i} \frac{m}{S^2}$