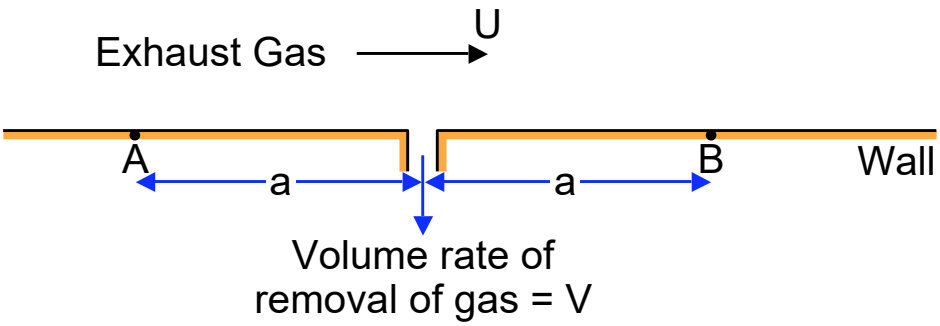
Solution to Problem 120M:



The volume rate of removal of gas, V, is simulated by placing a sink of strength $2V$ at the location of the vent hole. Then the potential flow generated by the superposition of a uniform stream, U, and the sink of strength, $2V$, leads to a velocity, u, given by

$$u = U - \frac{Va}{2\pi(x^2+y^2+z^2)^{3/2}} \tag{1}$$

where the origin of the (x, y, z) coordinate system is chosen to be the location of the vent hole. Then the velocities at locations A and B are

$$u_A = U + \frac{V}{2\pi a^2} \quad ; \quad u_B = U - \frac{V}{2\pi a^2} \tag{2}$$

Then by Bernoulli's theorem, the pressure difference $(p_B - p_A)$ is given by

$$\frac{2(p_B - p_A)}{\rho} = \left[U + \frac{V}{2\pi a^2}\right]^2 - \left[U - \frac{V}{2\pi a^2}\right]^2 \tag{3}$$

and therefore

$$V = \frac{(p_B - p_A)\pi a^2}{\rho U} \tag{4}$$

so that measurements of the pressure at A and B can be used to measure the volume flow rate, V.