Problem 2C.1

Performance of an electric dust collector (see Fig. 2C.1)[5].

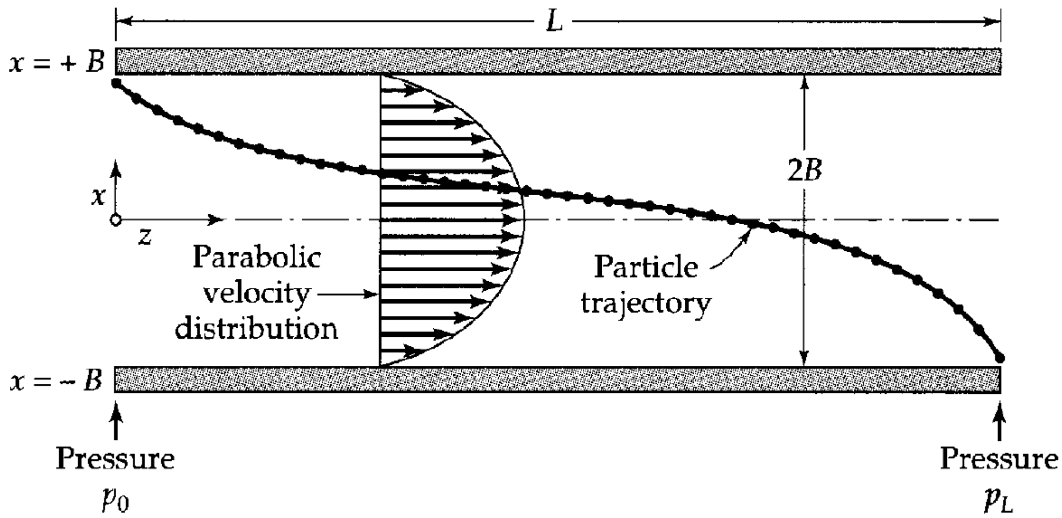

Figure 1: This is Fig. 2C.1 in the text. A possible particle trajectory. The particle that begins at $z = 0$, $x = B$ and ends at $x = -B$ may not necessarily travel the longest distance in the z direction.

(a) A dust precipitator consists of a pair of oppositely charged plates between which dust-laden gases flow. It is desired to establish a criterion for the minimum length of the precipitator in terms of the charge on the particle e, the electric field strength $\mathscr{E}$, the pressure difference $(p_0 - p_L)$, the particle mass m, and the gas viscosity μ. That is, for what length L will the smallest particle present (mass m) reach the bottom just before it has a chance to be swept out of the channel? Assume that the flow between the plates is laminar so that the velocity distribution is described by Eq. 2B.3-2. Assume also that the particle velocity in the z direction is the same as the fluid velocity in the z direction. Assume further that the Stokes drag on the sphere as well as the gravity force acting on the sphere as it is accelerated in the negative x direction can be neglected.

(b) Rework the problem neglecting acceleration in the x direction, but including the Stokes drag.

(c) Compare the usefulness of the solutions in (a) and (b), considering that stable aerosol particles have effective diameters of about 1-10 microns and densities of about 1 g/cm^3.

Answer: **(a)** $L_{\text{min}} = [12(p_0 - p_L)^2 B^5 m / 25\mu^2 e\mathscr{E}]^{1/4}$

[5] The answer given in the first edition of this book was incorrect, as pointed out to us in 1970 by Nau Gab Lee of Seoul National University.