Fluidized Bed

As a second example of the use of the drift flux method, we explore a simple model of a fluidized bed. The

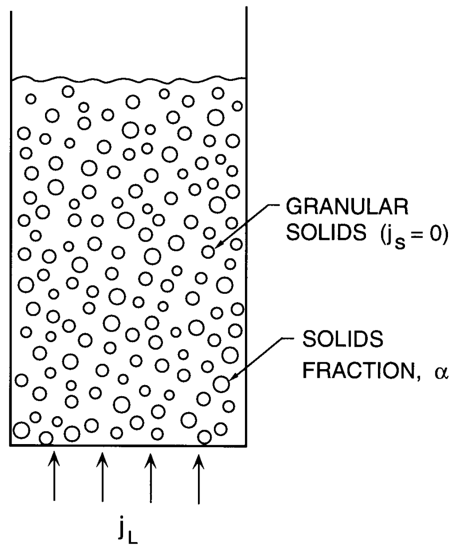

Figure 1: Schematic of a fluidized bed.

circumstances are depicted in figure 1. An initially packed bed of solid, granular material (component, $A = S$) is trapped in a vertical pipe or container. An upward liquid or gas flow (component, $B = L$) that is less dense than the solid is introduced through the porous base on which the solid material initially rests. We explore the sequence of events as the upward volume flow rate of the gas or liquid is gradually increased from zero. To do so it is first necessary to establish the drift flux chart that would pertain if the particles were freely suspended in the fluid. An example was given earlier in section (Nqb) and a typical graph of $j_{SL}(\alpha)$ is shown in figure 2 where upward fluxes and velocities are defined as positive so that j_{SL} is negative. In the case of suspensions of solids, the curve must terminate at the maximum packing solids fraction, α_m.

At zero fluid flow rate, the operating point is OPA, figure 2. At very small fluid flow rates, j_L, we may construct the dashed line labeled CASE B; since this does not intersect the drift flux curve, the bed remains in its packed state and the operating point remains at $\alpha = \alpha_m$, point OPB of figure 2. On the other hand, at higher flow rates such as that represented by CASE D the flow is sufficient to fluidize and expand the bed so that the volume fraction is smaller than α_m. The critical condition, CASE C, at which the bed is just on the verge of fluidization is created when the liquid flux takes the first critical fluidization value, $(j_L)_{C1}$, where

$$(j_L)_{C1} = j_{SL}(\alpha_m)/(1 - \alpha_m) \quad \text{(Nqd1)}$$

As the liquid flux is increased beyond $(j_L)_{C1}$ the bed continues to expand as the volume fraction, α, decreases. However, the process terminates when $\alpha \to 0$, shown as the CASE E in figure 2. This occurs at a second critical liquid flux, $(j_L)_{C2}$, given by

$$(j_L)_{C2} = \left(-\frac{dj_{SL}}{d\alpha} \right)_{\alpha=0} \quad \text{(Nqd2)}$$

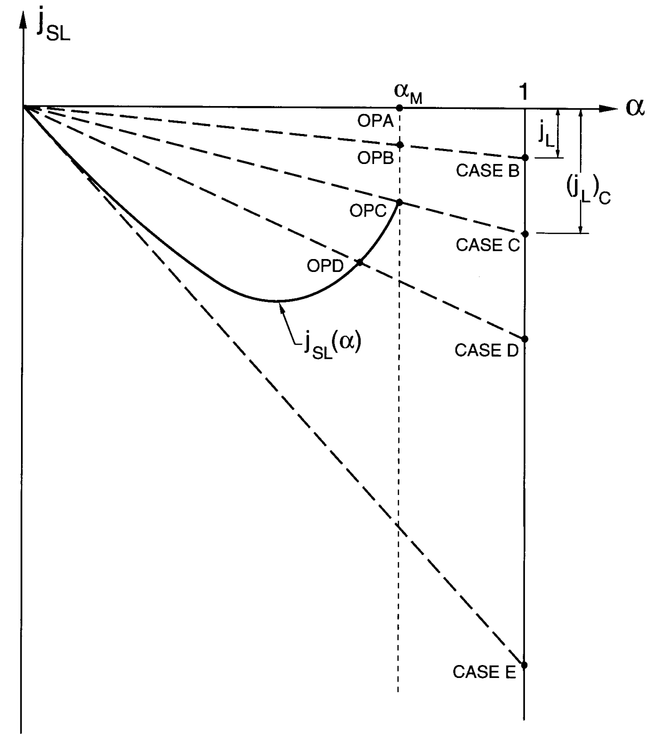

Figure 2: Drift flux chart for a fluidized bed.

At this critical condition the velocity of the particles relative to the fluid cannot maintain the position of the particles and they will be blown away. This is known as the *limit of fluidization*.

Consequently we see that the drift flux chart provides a convenient device for visualizing the overall properties of a fluidized bed. However, it should be noted that there are many details of the particle motions in a fluidized bed that have not been included in the present description and require much more detailed study. Many of these detailed processes directly affect the form of the drift flux curve and therefore the overall behavior of the bed.