# 9 Conveying

This chapter covers the transportation of particles by fluids. It considers hydraulic, pneumatic and mechanical conveying means. The former uses liquids the second gases and an example of the latter is a conveyer belt. A basic course in fluid mechanics will equip the reader with sufficient knowledge to calculate the pressure drop for a given flow rate of a uniform, or homogeneous, fluid. When considering particles suspended in flow, however, it is possible for the particle to *slip* in the fluid; i.e. the fluid travels faster than the solid particle. It is also possible for two distinct regions to be visible: a dilute, or emulsion, region with few particles and a dense region below it. This is illustrated in Figure 9.1. In the case of homogeneous flow, where there is no slip and the particles merely add to the effective liquid viscosity and density the methods of analyses covered already in Sections 6.6 and 6.7 are appropriate.

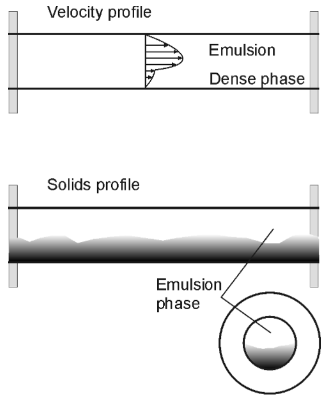


**Fig. 9.1** Heterogeneous flow showing only the particles within the dense region

An example of a *positive pressure* pneumatic conveying flowsheet is provided in Figure 9.2. The process is straightforward and requires a blower to provide the motive force, feed silo for solids, a means of controllably passing solids into the conveying line and a destination vessel with particle-gas separation equipment. If the blower was to be positioned after the gas cleaning equipment and the particles sucked through the system it would be *negative pressure* pneumatic conveying. Systems with mixed positive and negative pressures are also possible, such as might occur when there are two conveying lines: one operating under suction on the blower inlet, the other from the blower outlet.

## 9.1 Heterogeneous flow in liquids

Most of the work in this subject was due to the requirement to move coal, and other minerals, over significant distances as slurries. A resurgence of interest occurred when clean-up of nuclear solids deposited in ponds started. There are two key mathematical analyses required for the flow of solids in a liquid filled pipe: identification of the flow velocity which is insufficient to prevent solids depositing on the bottom of the pipe and the calculation of the pressure drop, or gradient, during the heterogeneous flow. Homogeneous flow is dealt with elsewhere. If the slurry velocity is reduced from a high value which entrains all the solids a point will be reached when solids will be observed to become stationary on the pipe surface. This is the limit deposit-velocity ($u_{LDV}$) of the heterogeneous suspension. In order to hydraulically convey material efficiently this velocity should be exceeded. An analysis based on boundary layer theory suggests that a correlation of the following form is appropriate