CHAPTER 1

GENERAL INTRODUCTION

Pneumatic conveyor, as the name suggest is basically a means of conveying solids by means of air. It is better to call it a fluid power system rather than just a mechanical handling system as fluid forces instead of mechanical force are involved in it.

Pneumatic conveyor forms one of the most efficient and important mechanical handling equipments for handling grains and materials alike. Pneumatic conveyors are widely used in ports for unloading grains from ships, agricultural farms and also in many industries in different forms such as handling of ash, cement, coal, dust, alumina, cotton, crushed coal, saw dust, crystals for cracking plants, feeding coal to burner etc. Its traditional advantages may be summarised as conveying over long distances and varied path, safety, dust tight enclosures, cleanliness, versatality, little or no material loss, low maintenance cost, easy control from one point to another, easy removal from one place to other and reduced labour.

When compared with other means of mechanical handling equipments, the power consumption per ton of material conveyed is a little high, but if initial cost also is considered pneumatic conveyor compares most favourably for the fluidisable materials.

The problem of pneumatic conveying is a complex science. The number of variables are so many and are of so varying nature that a hundred percent accurate result is perhaps impossible. The fundamental step is to calculate the pressure drop along the pipe length. The second but equally important part is to find out the amount of air necessary for conveying the materials without clogging and with maximum economy. Considerable uncertainty exists as to the right value of the different parameters even for one phase flow. When grains are also introduced, the uneven shape of grains at different flow conditions make the already difficult problem still complicated to solve. Recent studies have recognised the importance of particle velocity, density and rheological behaviour of solid system; however the difficulty of accurately measuring these quantities has precluded the establishment of a clear picture of the mutual relation in solid-gas flow phenomena. Because of change in physical properties of different solid particles, they behave quite differently. Therefore, the problem does not remain a problem of two phase flow but it can be called a "mutiphase flow problem".

The physical properties of materials, conveyance pipe and the conveying media which are responsible for the flow pattern of solid-gas system are:-

A) Properties of pipe:

i) length, ii) diameter, iii) roughness, iv) position (whether horizontal, vertical, or bend)

B) Materials to be conveyed:

i) diameter, ii) shape, iii) size, iv) concentration, v) density, vi) temperature, vii) conductivity, viii) surface roughness, ix) the tolerable degradation, x) coefficient of friction between particles, xi) coefficient of restitution between particles.

C) Conveying media:

i) density, ii) pressure, iii) temperature, iv) specific heats.

D) Pipe and materials:

i) coefficient of friction, ii) coefficient of restitution.

E) Pipe and conveying media:

i) Coefficient of friction.

F) Material and conveying media:

i) drag coefficient.

It has been observed by several research workers that fine solid particles when mixed with air behave quite differently in comparison to their behaviours when the size of the particles are large. There is evidence that the fluid turbulence is substantially affected by the presence of the solids under certain conditions and that the flow depends markedly on the size of the particles.

An experimental report from Sproull that the viscosity of mixture of fine particles and gas was less than that for air alone and another report from Boothroyd stating that the frictional pressure drop in one inch pipe was always below that for air alone if fine particles were allowed to flow in the pipe line made the author interested in the problems of flow of solid-gas mixture under different conditions of flow. With these phenomena in mind, the author has tried to give explanations for the following behaviours of solid-gas flow.

a) Reduction in the apparant viscosity of dusty gases and the factors influencing such reduction.

b) Hetrogeneous and homogeneous flow of solids in tubes of circular cross-sections.

c) Effect of compressibility and heat conductivity of air on the flow behaviours.

Generalized nature of the equations developed could be easily felt as they have been shown to be valid for hydraulic conveyance and also for flow through fixed beds of spherical and non-spherical particles.
