PREFACE

Pneumatic conveying of solids has gained importance in the light of current social and economic situations in a developing country like India, mainly because of two reasons; transportation of iron ore fines and coal dust, and a safe guard against air pollution. The present method of handling these things are very much labour oriented and many times, inadequate. The Department of Mechanical Engineering has done considerable work in the field of pneumatic conveying of solids. Several aspects of the problem have been taken. In the present report, an attempt is made to study the various aspects of cyclone separator, an extremely important part of pneumatic conveying system, and used in various industries.

Among the different types of cyclones normally used, the classical reverse flow cyclone with tangential inlet and axial dust discharge has been chosen for the studies to be presented in this dissertation. The whole work has been divided into six chapters.

Chapter 1 presents a general introduction to cyclone along with an outline of different aspects of the problem of cyclone flow and separation.

In Chapter 2, an analytical and experimental investigation of turbulent air flow in cyclone is presented. The momentum integral method has been used to predict theoretically the axial variations of the tangential and the axial velocity profiles. Experiments were conducted to measure these velocity components and the results show good agreement with theory. The details of experimental set up and instrumentation are also discussed in this chapter.

Chapter 3 deals with a theoretical analysis of a single particle motion in cyclone. The radial, tangential and axial components of the velocity of particles and the particle trajectories are predicted reflecting the effect of fluid flow rate, particle size and particle initial position.

In Chapter 4, the influence of particles on velocity distribution is investigated from the stand-point of multi-particle flow. The tangential velocities of fluid and particle phases are studied analytically and significant changes in them with changing particle size and concentration are predicted. The agreement of the theory with the experiments is quite reasonable here. The axial fluid velocity measured experimentally and the radial fluid velocity computed from continuity condition, also reveal remarkable influence of particles on them.

Chapter 5 presents an investigation on energy losses in cyclone. The centrifugal head is evaluated theoretically from tangential velocity distribution at different solid concentrations. Comparision with experimental values shows good agreement. An improved method is proposed for computing the energy losses in cyclone. The decrease in the energy loss with increasing dust concentration is found to be due to alteration of rotational flow.

In Chapter 6, the separation performance of cyclone is analysed considering the effects of backmixing, particle concentration and diffusion. Based on some recent findings on turbulent boundary layers, models for deposition and backmixing of particles at the cyclone boundary are constructed. The 'cloud effect' which is responsible for faster settling of particles, is extended to explain the higher collection efficiency observed at denser particle concentrations. The effect of diffusion of particles on their concentration profiles in cyclone is also analysed. A generalised efficiency equation taking care of the above effects, is proposed.

All Chapters, besides being parts of the whole study, are complete in themselves. Leaving aside Chapter 1, each of the Chapters 2-6 contains sections such as Abstract, Introduction, Theoretical analysis, Experiments (if any), Discussions, Conclusions, Nomenclature and References for the respective chapter.

The problems were solved on IBM 370 and EC-1030 (Reyad) computers. The important computer programs are presented in Appendix A-E, so that they can be referred to, if necessary.

Ashutosh Parida

(Ashutosh Parida)