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Some comments on: the flow behaviour of solids from silos; wear in pneumatic conveying systems; ancillary equipment

11.1 INTRODUCTION

There are a number of additional facets in the design of pneumatic conveying systems which in their own right could form the basis of a separate handbook. An awareness of the intricacies of silo and hopper design, wear in pneumatic conveying systems and the type and characteristics of a number of essential hardware components are deemed to be important information for the system designer.

In many instances, a lack of appreciation of efficient silo design or the dos and don’ts for designing systems for abrasive products have resulted in the condemnation of total systems. This chapter has been written with the specific objective of providing the reader with some insight into the additional factors relevant to the design of pneumatic conveying systems. The reader is cautioned to obtain specialist assistance for those systems which are being designed for products which are highly abrasive or have very poor flow characteristics.

The chapter is concluded with some discussion related to those essential components which, together with feeding devices discussed in Chapter 7 and gas–solids separation devices discussed in Chapter 10, make up a total conveying system.

11.2 THE FLOW OF SOLIDS FROM BINS

11.2.1 Introduction

An essential element in the successful operation of any pneumatic conveying system is the flow of solids from storage bins into the feeding device. The ability to ensure reliable and continuous flow from any storage device is fundamental to ensuring that a system will meet design criteria.

R. D. Marcus et al., Pneumatic Conveying of Solids
The 'correct' design of a storage bin requires the full appreciation of techniques such as those developed by Jenike [1] and others [2]. In this text the authors intend to alert the reader only to those essential elements which, when combined with an accepted design technique, will provide a successful bin design. It is not the intention of this text to provide the reader with all the information relating to the design of such storage systems.

11.2.2 Common flow problems from a silo bin

Essentially, there are two common flow problems associated with the incorrect design of a silo: (a) bridging; (b) ratholing.

(a) Bridging

The bridging phenomenon results in an arch or a bridge forming across the opening of a hopper. The strength of the bridge is such that it supports the total load of solids above it. Bridging occurs when the outlet of the silo $D < D_{\text{min}}$; where $D_{\text{min}}$ is the calculated minimum diameter required to effect uninterrupted solids flow. (Bridging can occur even though the cone angle $\theta$ might be of the same magnitude as that obtained from accepted silo design theory.)

(b) Ratholing

The ratholing phenomenon is characterized by the formation of a channel throughout the solid mass. In this case the phenomenon is dependent upon the correct selection of the cone angle $\theta$. Ratholing will occur even though the hopper opening conforms to $D \geq D_{\text{min}}$.

![Figure 11.1 Flow problems in silos.]