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Selection of Solids Handling Equipment

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Die Auswahl von Schüttgut-Fördereinrichtungen
Choix du matériel de manutention des solides
Selección de equipo de manejo de sólidos
粉体処理装置の選択
固体处理设备的选样
اختيار معدات مناولة المواد الصلبة (غير السائلة). بقلم آر فولر.

Summary

An introduction to solids handling and storage equipment selection is given and the general and basic practical considerations which are involved are highlighted with particular reference to plastic raw materials.

1. Introduction

The subject of material handling is vast and ranges from simple hopper loading units up to complex fully programmed automatic systems.

In the majority of cases, if a company wishes to install a large system working from silos and utilising bulk deliveries, then a specialist is called in. Therefore, the subject of this paper is to assist the engineer/production supervisor to evaluate suitable material handling equipment for small individual applications.

2. Materials to be Handled

The form in which the material is purchased, i.e., granules, powder, reground chip, possibly liquid, obviously has a great bearing on the type of equipment to be purchased.

Plastics materials presented in this form are usually the easiest to handle. Generally they are clean and free flowing. However, fibre filled material can cause difficulties, as the granules sometimes tends to be *hairy* and thus *bridges*. Also dense, heavily filled materials can limit conveying quantities and distances.

Most processors wish to recycle waste material and will granulate scrap. The efficiency of this depends largely on the type of material, granules shape and size, content of fines etc. Therefore, the correct selection of granulator, and the condition of the cutting knives is important. Problems encountered with material in this form are mainly due to "bridging" and sometimes blockage of filters in certain types of conveying equipment, due to the fines.

Granulated film can be extremely difficult to handle, due to bridging and its tendency to cling to surfaces, owing to its static charge.

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Most material powders are above 75 microns and can, therefore, by conveyed without problems in vacuum conveyors, as long as the material is of a free flowing nature.

For powder material and powder additives of less than 50 microns, a number of problems exist relative to vacuum conveying.

— Inability of the filter to prevent powder escaping into the atmosphere.
— Frequent changing of filters becomes essential.
— Tendency of powder additives (blowing agent, pigment etc.) to be separated from base materials and, therefore, vary concentration in processed material.

3. Methods of Transport

The requirement of a transport system is to convey material from some form of reservoir to the hopper of the processing equipment. Different methods have advantages and disadvantages relating to:

— Initial cost
— Running cost
— Efficiency
— Effectiveness
— Reliability
— Ease of use
— Suitability for the process
— Cleanliness and prevention of contamination to the material.

Most equipment suppliers will supply graphs giving details of conveying distances and heights for various materials in their various forms, relative to throughput.

3.1 Manual

The reason for automatic conveying of material is to overcome the inefficiencies and inconveniences of manually feeding material into the machine hopper.

If the machine is small (hopper at working height) and throughput very low, then the fitting of automatic conveying equipment may be unnecessary, but, on the other hand, a fully automatic shop with few operators may demand the use of automatic hopper loading.

Large machines with high outputs may not only prove to be exhausting to the operator, but also physically dangerous. Some moulding machine hoppers are more than fifteen feet

from the ground and this represents a physical hazard for an elderly operator to fill. Therefore, the consideration for automatic hopper loading may be not only economics, but more one of safety.

Another consideration is one of cleanliness — it is a good operator who manages to climb a ladder with a 25 kg bag of material and tip it into the hopper without spilling at least a few granules.

3.2 Vacuum Operated Conveyors

This is, perhaps, the most common method of conveying material. Although the basic cost of the equipment is fairly high, running costs are comparatively low. They are compact, self contained units, and are easily fitted to machine hoppers. The probe on the flexible suction hose can be located to suit the material reservoir.

All types of materials can be conveyed, down to fine powders (75 microns and possibly less). The price of the unit purchased will vary with the conveying capacity (weight and distance) and the amount of filtration. Obviously, a unit designed for fine powders will have a more elaborate filtration and blow-back system. Unless completely dust free materials are to be conveyed, it is essential that a vacuum conveyor is fitted with a filter and automatic blow-back system. The blow-back feature is to reverse the air flow and clear the filter. The unit should be fully automatic, having a cut out control which cuts the motor when the hopper is full.

3.3 Pneumatic Powered Conveyors

These are extremely simple and, therefore, relatively cheap. It must not be forgotten that a source of compressed air is required and the provision of this can sometimes be expensive, thus making the final cost higher than alternative conveying methods.

Unless the compressed air supply is perfectly dry and clean, contamination of the material can occur. Filtration needs to be good to prevent airborne dust escaping into the surrounding atmosphere.

3.4 Screw Conveyors

This means of conveying is not as flexible as either vacuum or pneumatic methods, and is limited by length/torque characteristics of the screw. However, there are advantages regarding the conveying of powders and granules coated with fine powder additives. The powders are not airborne and therefore there is less chance of atmospheric contamination.

Also, materials that have been mixed prior to conveying are less likely to separate during transport by this method.

The possibility of contamination of the material being conveyed due to abrasive wear of the screw against the conveying tube must not be overlooked.

4. Equipment Ancillary to Material Handling

Once a decision has been made to install plant for automatic hopper loading, then it follows that ancillary plant, to further streamline the production, should be considered. It may be, however, that certain requirements of the process demand ancillary plant, e.g. drying.

4.1 Drying and Preheating

These compact units can be obtained in a range of sizes to cope with various throughputs and different material requirements. The moulding of hygroscopic materials, such as nylon, can be improved by using hopper drying units. Also a material such as polycarbonate, whose impact strength is seriously impaired by moisture content can show great benefits and result in reliably consistent mouldings.

In cases where the plasticizing capacity of a machine is a limiting factor, a hopper dryer used as a preheater can increase throughput and with some materials reduce screw power requirements.

4.2 Blending and Mixing

There are many advantages in blending and mixing materials immediately above or in the machine hopper.

- Less chance of contamination
- No possibility to feed wrong premixed material in the machine
- Only sufficient material for a particular "run" is mixed therefore, no waste of expensive masterbatches, pigments, additives etc.
- No separation of mixed materials due to transporting
- Less floor space required (no mixing department)
- Smaller labour force required.

The cost of equipment will depend upon the degree of accuracy required and the materials to be mixed.

In the case of blending virgin with reground chip in approximate proportions, then a simple two way valve can suffice. This enables a hopper loader to alternatively load materials from two separate reservoirs (either bins placed alongside the machines or silos at some distance from the machine).

The layering effect of materials in the hopper can be minimised by selecting appropriate time intervals on the changeover valve.

Where material proportioning is important, i.e., blending of granules with pigments or powders, then units incorporating mixing chambers can be selected. Some units can offer liquid dispensing systems for pigmentation or blowing agents.

If it is felt that mixing above the machine hopper is either too costly (basic cost of equipment) or that it does not fit in with the overall organisation of the processing shop, then mixing equipment can be used for batch mixing.

These mixers can be of a variety of types:

- Vertical screw
- Tumble
- Paddle.

The advantage of the paddle or screw type mixers is that they do give positive mixing, whereas with a tumble mixer, unless the mixing chamber is of a special shape to promote mixing, and precautions are taken to prevent overfilling, then adequate mixing by tumbling does not take place.

5. Cost Analysis

It is always difficult to analyse the cost saving by installing automatic hopper loading. The majority of companies probably install such equipment from a convenience point of view, rather than as a result of a cost saving analysis. Small companies tend to put forward arguments against installing hopper loading equipment, stating that operators/labourers have spare time and this can be utilised in handling material. However, it should be pointed out that more efficient deployment of staff could result in cost savings and the use of people just because they are there is not an answer or justification in itself.