bulk solids handling Volume 1 Number 3, September 1981

Recent Advances in Sack-Emptying Technology

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Neuere Entwicklungen bei der Sackentleerung
Evolution récente de la technologie du vidage des sacs
Recientes avances en la tecnología de vaciado de sacos
サック内容物をあけ出すテクノロジーにおける最近の進歩
近来装袋卸料工艺的成就
التطورات الحديثة في مجال تقنية تفريغ الحوالات . بقلم آر . دي . بير .

Summary

Sacks are widely used as a method of storing powdered, granular and fibrous materials. The major drawback associated with this method of storage is discharging material from the sack in a clean and efficient manner.

This paper traces the design and development of a Fully Automatic Sack Emptying Machine. The design criteria and considerations are outlined from the initial concept stage through to the production of a highly efficient and versatile machine.

1. Introduction

There are three methods generally used for the storage and transportation of powdered, granular and fibrous materials, these being:

a) Bulk tankers plus silos
b) Intermediate bulk containers
c) Sacks

Of the three methods, sacks are by far the most versatile, because of the availability of supply, ease of handling and initial plant costs. Even so, there is one major drawback to handling materials in sacked form — the emptying of the product from the sack in a clean and efficient manner, whilst keeping labour requirements to the minimum.

Many sack emptying machines have been produced over the years, ranging from high-speed, fully automatics to low speed and throughput semi-automatics. Each machine type is capable of handling certain products and sack types, but none have been able to overcome all the problems of sack emptying with its wide range of sack/product combinations. The market has long required the simple, compact machine which will provide all these requirements.

In setting out to design a machine to fulfil these requirements, JSK (Materials Handling) Ltd. analysed all the problems of emptying the various sack/product combinations as well as the requirements of the many industries handling products in sacks.

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2. Parameters of Effective Sack Emptying

These requirements can be split into four main sections.

2.1 Efficient Discharge of Product

The cost of material being handled naturally has a great effect on the importance of the percentage discharged from the sack, and hence the cost of lost product. Where whitings and fillers were concerned, the cost per tonne is relatively low, therefore if 2% of 3% is left within the sack the cost in wastage terms is not unduly high. Where pigments or expensive chemicals are concerned even 1% of material left in the sack can represent large sums of money.

The throughputs being handled can clearly affect the importance of discharge efficiency. Ideally 100% of the material should be released from the sack, in cases where plastic granules or similar materials are handled, this is possible. In the case of most other materials which do not exhibit free-flowing properties, this figure is not attainable.

With manual sack-emptying, optimum emptying can be achieved, but only if sufficient time is allowed for slitting the sack to obtain complete opening and then shaking or even brushing the inside clean.

2.2 Total Sack/Product Separation

Contamination of product by pieces of sack material is of prime importance in most processes. If the sack is torn and shreds of paper, plastic, jute etc. enter the product, then serious problems can occur. In the food and pharmaceutical industry this sort of contamination is a health hazard. In many sack-emptying operations the product is being fed into mixing or slurry tanks and any sack materials will soon cause problems in the form of blocked pumps, filters or jets. In many industries the product passes into a baking process and any sack material would become conspicuous as burnt specks in the finished product and this would usually be unacceptable.

The ideal sack-emptying operation should therefore minimize the chance of sacks being torn or shredded, hence minimizing product contamination.

2.3 Dust Emission Control

Where granular materials are being handled, dust emission is not usually a problem area, but where fine powders and fibrous materials are being dealt with the problem can be on a large scale often becoming a health hazard.

Dust control, at the emptying hopper, is generally accepted as being necessary, but a problem area which is often overlooked is when the empty sack is being disposed of. Most sacks still contain a small amount of material so that when the sack is being removed from the hopper some product is released into the atmosphere.

An effective dust control system both at the tipping hopper and also at the sack disposal end of the process should be an integral part of the sack emptying machine.

2.4 Low Labour Costs

The task of sack emptying is time consuming, physically tiring and in some cases injurious to health.

In order to keep costs to the minimum, the operation should be simplified as much as possible. Lifting devices to present the sack at the correct level to the operator can both reduce the time taken for the emptying operation and also reduce the physical effort required, possibly reducing strains and periods of illness.

Effective Dust Control around the tipping area provides better working conditions keeping labour costs down.

3. Requirements of an Ideal Machine

A machine that is both effective in its operation and acceptable to industry must satisfy the four requirements listed previously. The machine must also satisfy physical and mechanical requirements ensuring versatility without becoming too large and expensive to be practical.

The factors listed below have been considered throughout the design and development of the machine, each does not carry equal importance but all must be taken into account if a totally acceptable machine is to be produced.

a) High discharge efficiency
b) Minimum product contamination
c) Minimum dust emission
d) Able to handle all products
e) Able to handle all sack types
f) Integral disposal of empty sack
g) Minimum operator effort
h) Simple operation and controls
i) Maintenance simple and infrequent
j) Smooth inside surfaces for minimum hold-up of product
k) Easy clean down
l) Simple conversion for food quality applications
m) Compact and easy to install

4. Existing Machines

Several Sack Slitters are manufactured throughout the world, some capable of handling few types of product, and sacks, and a few capable of handling a wide variety of sacks and products. Each type of Sack Slitter has its advantages and drawbacks, and we therefore considered each type of machine, analysing the steps involved in the splitting and emptying operation. The good features of the existing machines could possibly be used as a basis for the new JSK design.

The machine types can be split into three main groupings:

1. Tumble action machines
2. Chain support machines
3. Discreet half sack machine.

There are, of course, variations within these groups, the basic operation of the machines are analysed below:

4.1 Tumble Action Machines

The principle of these machines is to cut or shred the sack, the product being separated from the sack pieces in a rotating mesh drum.

Infeed

— Usually the individual sacks are fed in on a conveyor belt, and there is the possibility of tipping many sacks together. This method, however, has proved unsuitable with many products.

Splitting action

— The rotating blades or screw auger cut the sack.

Discharge

— The sack is in many pieces and the product discharges as the sack pieces pass along the rotating mesh drum. Free-flowing products are handled well, but sticky or lumpy products can get carried over with the waste sacks, resulting in low discharge efficiency. This method is not suitable for most pressure-packed or fibrous products. Screening is required to minimise the product/sack contamination.

4.2 Chain Support Machines

A chain system, fitted with pins or spikes, carries the sack from the infeed, through the splitting blades to the sack disposal area.

Infeed

— Sacks are placed individually onto the infeed conveyor, which transfers the sack onto a spiked chain which in turn grips and supports the sack. The chain positions need to be altered for different sack sizes.

Splitting action

— Single or double rotating blades cut the sack along its entire length. On some machines the blade height is adjusted for different sack sizes.

Discharge

— As the sack has been split, the product discharges under gravity. The sack can be beaten to assist discharge or agitation applied to the chains to shake product out. Free-flowing products are handled well, but pockets within the sack retain some product, particularly with lumpy materials. This method is not suitable for pressure-packed or long fibre materials.

4.3 Discreet Half Sack Machines

The sacks are split into two discreet halves, the product discharging as the halves are pulled apart.

Infeed

— The bags are placed individually onto the infeed conveyor and fed into the machine. Due to the vertical positioning of the sacks and gravity discharge, the infeed point is usually high and requires a long infeed conveyor or elevator.

Splitting action

— Reciprocating blade cuts through the sack and product. The blade life is limited due to contact with the product and general action. There is a low throughput rate when handling fibrous or hard materials.

Discharge

— Gravity discharge, sacks being fully split, therefore no pockets of material should occur in theory. At high throughputs there is a limited time for discharge, resulting in carry-over with the waste sack, hence product loss. Screening is also required as the knife-action can produce small sack pieces in with the product.

From the analysis of the existing machines, it became apparent that the following features would be desirable in any new machine to split sacks:

1. The infeed should accept any sack size without requiring adjustment.
2. The sack should be carried through the splitting process, the product discharged and delivered to a disposal point whilst being continuously gripped and supported.
3. The splitting action should be attained using rotating blades, ensuring infrequent sharpening and a clean, shred-free cut.
4. The sack should be fully opened (eliminating pockets) to allow all product to be discharged whilst cutting the sack as little as possible, preferably keeping it in one piece.

5. Principle of the JSK Machine

The basic principles of the JSK machine were now laid out. The machine would include the following features:

1. Infeed system to take discreet sacks, not pallet loads tipped into a hopper.
2. The conveyor to the machine would run intermittently but the machine drives for the rest of the machine would run continuously.
3. The sacks would be carried through the opening process, positively and continuously gripped from the infeed to the disposal point.
4. Rotating blades would cut the sacks, the cuts being as few as possible, and no adjustment being necessary for differing sack sizes or types.
5. The product would be able to discharge fully, whether it be free-flowing, lumpy or fibrous.
6. The empty sack would be compressed into a dust tight container within the machine.
7. The machine would include an integral Dust Extraction unit, with automatic feedback of filtered product.
8. The machine would have a minimum of hang-up points, all faces being inclined between 60° and vertical.
9. Access would be easy and maintenance and control simple.

6. Final Design of JSK Machine

The principles of the machine had been agreed upon so the next task was to produce a design which incorporated these principles. Many hours were spent discussing schemes, throwing them out and trying new ideas. Eventually, a design was put together as shown in Fig. 1, which incorporated all the stipulated features and met the majority of the requirements of an ideal machine.

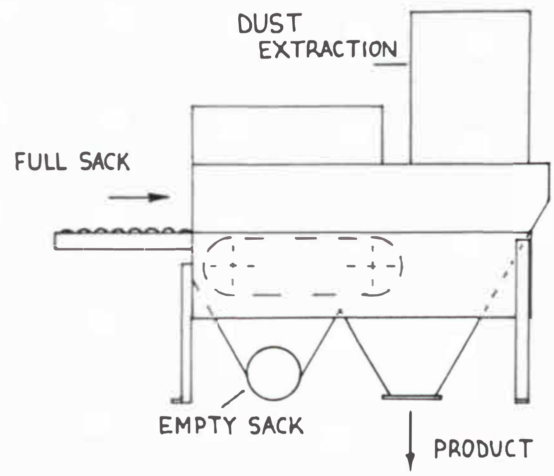

Fig. 1: General machine arrangement

With the aid of Fig. 1 the basic operation of the machine can be described as follows:

1. A sack is placed on the infeed rollers and feeds onto the gripper conveyor. This conveyor grips the sack, the size, weight and sack material not effecting the system.
2. The sack is drawn through the spiltting arrangement which cuts the sack on three sides using rotary blades.
3. At the discharge point, the sack is fully opened allowing product to discharge under gravity. When running at high throughput rates, the discharge is further assisted by centrifugal force.
4. A rotating brush is mounted adjacent to the gripper conveyor, this positively sweeps the entire inside surface of the sack. The sack, having been swept, is released from the gripper conveyor and dropped into a waste sack compaction unit.

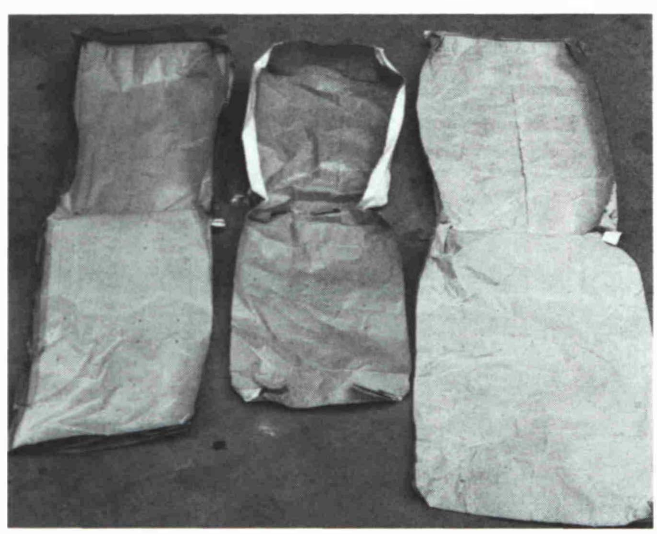

Fig. 2: Sacks having passed through the sack splitter

The effectiveness of the machine is indicated by the sacks in Fig. 2. These sacks were fed through the machine without adjustments being made. The larger two sacks contained flour, the smaller ones contained high density polythylene crumb. The throughput rates for both products being approximately 22 t/h.

The clean cut produced by the rotary blades can be clearly seen in Fig. 2, one particular point to notice is the absence of any loose tails on the sack, which might cause contamination of the product.

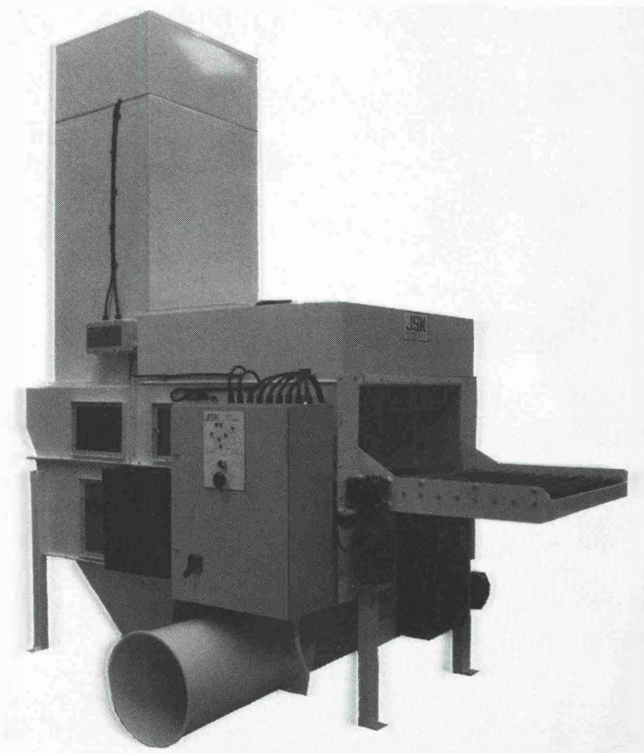

Fig. 3: JSK sack splitting machine

The machine, as finally produced, is shown in Fig. 3 complete with the optional Dust Extraction/Filter unit and exhaust air silencer. From the photograph, the following important features can be seen.

1. The machine is compact in build and has a low infeed conveyor for easy feeding.
2. Motors and drivers are external for simple maintenance.
3. Viewing windows give good access to all parts of the machine.
4. All flanges are external, thus there are no hang-up points for free-flowing of material and minimum cross-contamination.
5. Integral Electrical Control Panel is completely wired, including safety limit switches on access doors, and includes all starters, overloads fuses and machine mimic.

7. Final Comment

Only minor alterations have been required to the original design to produce a machine capable of fulfilling all of the initial aims. The machine has undergone extensive trials, handling many products and sack types, and now handles a wide variety of both.

The success of the JSK Sack Splitter can be mainly attributed to a logical approach to design, a true understanding of the problems involved in sack handling and a great deal of creative design flair.