Selection of Conveyor for Weigh Batching System

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ABSTRACT
An automatic weigh batching system to mix flux powders, was developed for a welding electrode manufacturer small scale industry. The requirement of the system was to mix 10 different powdered materials to make accurate batches of 6 different selectable recipes of electrode coating fluxes. This had been a very crucial issue in quality control (QC) as human errors in cumulative weighing of flux ingredients caused great losses. This paper highlights the features of Flexible spring conveyors as they were found most suitable, fulfilling the requirements of this automatic weigh-batching system for a small scale industry.

General Terms
Automation. Automatic weigh batching.

Keywords
Weigh-batching, spring conveyor, welding-electrode, flux-recipe, powder-handling, flexible conveyor.

1. INTRODUCTION
An automatic weigh batching system [1] was developed for a small scale welding electrode manufacturing industry to give accurate composition of flux coating mixtures. Earlier the ingredient powders were cumulatively weighed manually by adding to a tray on an electronic weighing scale. This method was very vulnerable to human errors causing losses to the industry.

The control unit for this weigh batching system has been designed and assembled using a Programmable Logic Controller (PLC) [2] to read real-time weight on the weighing scale and accordingly control conveyor motors and their speeds, in sequence, through a Variable Frequency Drive (VFD) [3] as per the programmed logic.

This paper critically discusses different conveyor systems available and reports the selection criteria and the suitability of flexible spring conveyors in the above system fulfilling the desired functionality. A typical spring conveyor system which is economical in cost and floor space, dust-free, easy to install & maintain, flexible and safer is examined.

2. WELDING ELECTRODE COATING
The composition of the welding electrode coating determines its usability, as well as the composition of the deposited weld metal and the electrode specification.[4]

The flux coating gives slag cover needed to protect molten or solidifying weld metal from the atmosphere and protects the metal from damage, stabilizes the arc, and improves the weld in other ways, which include:

(1) Smooth weld metal surface with even edges.

(2) Minimum spatter adjacent to the weld.

(3) A stable welding arc.

(4) Penetration control.

(5) A strong, tough coating.

(6) Easier slag removal.

(7) Improved deposition rate.

(8) Alloying and chemical composition of the weld.

Any human error in the composition and proportions in a batch of ingredient powders in the recipe of a particular type of electrode is detectable only after the QC report or consumer's complaints, when the complete batch gets rejected causing loss of material, labor, economy, goodwill and market credibility to the industry. An automatic weigh batching system was detected as a solution.

Automatic weigh batching systems were available in the market with high capacities and costs. But they were unaffordable for a small scale industry, due to floor-space and cost limitations.

Hence an automatic, fast, accurate, reliable, space saving and cost effective weigh batching system for small scale industries was felt as dire necessity and the above mentioned solution has been realized.

Though this system was developed for flux coating of welding rods, it can be easily used by other industries for weigh-batching of 10 or more ingredients after little tailor-made modifications to suit their requirements. [1]

3. WEIGH BATCHING SYSTEM.
In this system the DC signal from the load-cell bridge of an electronic weighing scale, representing the weight, was tapped, amplified to a few volts and fed as analog input to the PLC (SIEMENS S7-224xp in this case). [2]

The S7-224xp monitors inputs and changes outputs as per the user program, which can include Boolean logic, counting, timing, complex math operations, and communications with other intelligent devices like a PC. The PLC was programmed using Micro/WIN V4.0 with ladder logic (LAD). One TD-200 [5] display unit has been used as an interface for user input data and control.

An expansion module was added to give 15 digital and one analog outputs. These outputs were used to operate 10 motor contactors and to control the VFD (SINAMICS G110, an inverter). [3] The VFD, in turn, controlled the motor speeds of individual conveyors.

Suitable conveyors were now needed to transfer different powders from hoppers to the tray kept on the weighing scale with desired flow rate control. Here a typical spring conveyor system which is economical in cost and floor-space requirements, dust-free, easy to install & maintain, flexible, safer and suitable for desired purpose was selected.

This system is an open loop system having no in-process remedial actions.

4. TYPES OF CONVEYOR SYSTEMS

There are different traditional systems available. Some of them, listed below have been examined and studied for their suitability in small scale weigh batching system.[7]

a. *Gravity conveyors*:- they were not suitable for our purpose as taking powdered material to a height and control of flow through VFD was not possible

b. *Belt conveyors*:- They were found to be cumbersome with their DE, NDE rollers, supporting rollers and structures within the floor space available for 10 numbers. They are not dust free. Maintenance also is more. The speed control (braking) response was slower.

c. *Pneumatic conveyors*:- They offered no dust free operation and to attain that, dust collectors were needed for each conveyor. Moreover the flow rate control, particularly for trickle flow desired at the end of weighing, was not possible.

d. *Vibrating conveyor system*:- This was rejected for noisy and dusty operation, more maintenance costs, length requirements and lack of accurate control on flow rates .

e. *Screw conveyors*:- These offered satisfactory flow control and dust-free operations, But had high maintenance and no flexibility, desirable for concise plant layout

f. *Flexible spring conveyor*:- This was found to be satisfying all of our requirements of place allocation and layout of hoppers, thanks to its maneuverability.[6]

Due to above reasons the selection of conveyor weighed heavily in favor of flexible spring conveyors. The features and suitability of this type of conveyors is discussed below.

5. THE FLEXIBLE SPRING CONVEYOR

A Typical flexible spring conveyors system consists of-[6]

a. A hopper to collect powder at initial work station.

b. Flexible stationary outer tube with rotating spring inside.

c. Drive arrangement to rotate the spring stirrer.

Fig 1 (a), (b), (c) shows the main components of a flexible screw conveyor. [8]

1. Electric motor: Fixed or variable speed.
2. Motor adaptor and spiral connector.
3. 45 degree or horizontal outlet assembly.
4. Dust-tight tube fitting.
5. High and low level control.
6. Abrasion resistant polymer outer tube.
7. Flexible spiral spring.
8. Inlet assembly.
9. Feed restrictor to regulate material flow.
10. Feed Hopper.

The spring coupled directly to a motor/drive, rotates within the stationary outer tube. Rotation of the spring creates an agitated (fluidized) state and positive directional displacement of the material within the outer tube, propelling the material towards the outlet. The material is conveyed in an "en masse" fashion from point of entry (inlet) to point of discharge (outlet).

This conveyor system can be used in different positions of the conveyor tube with some compromise on efficiency as shown in the Fig.2. But the flexibility is very unique compared to any other system. [8]

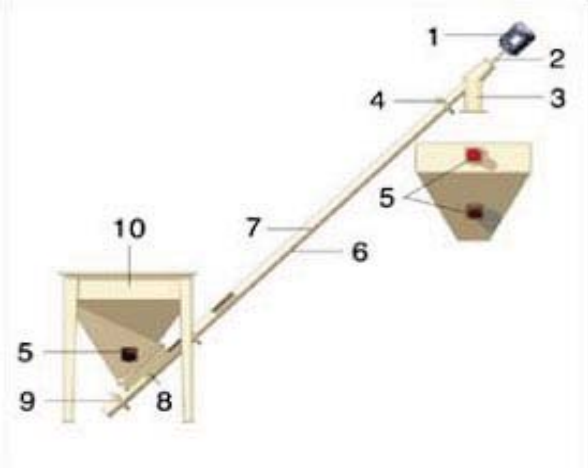
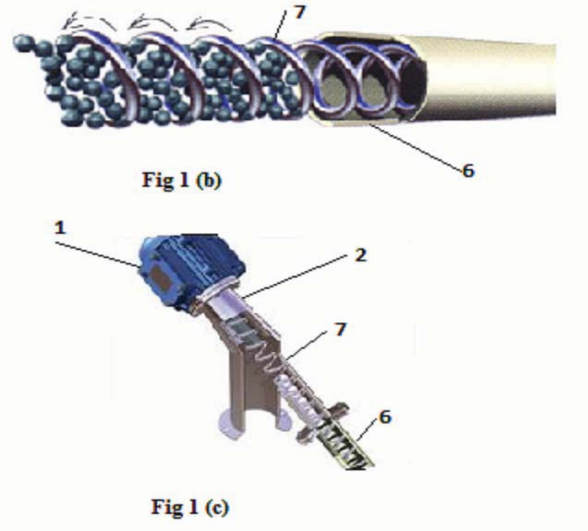


Fig 1 (a) Typical Spring Conveyor Assembly.



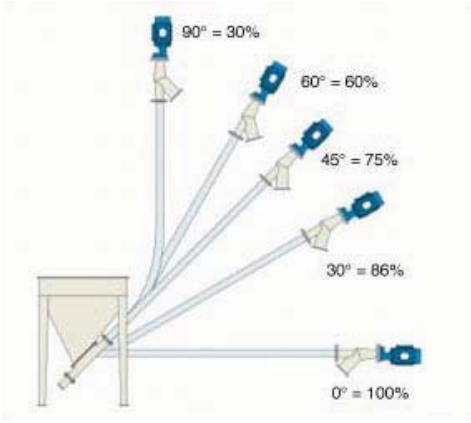


Fig. 2 Different Possible Positions

The only moving part contacting material in a flexible spring conveyor is a rugged flexible spring, which is directly driven by an electric motor. This simple design does not require the filters, cyclone separators, internal bearings, and other moving parts found on pneumatic conveyors, bucket elevators, rigid augers, drag chains, and/or aero-mechanical conveyors—parts that can add initial cost, require maintenance, wear out, breed contamination, and/or break down.

6. OBSERVATIONS

For various observations listed below the decision to choose flexible spring conveyors for the PLC based control system was reached. [8]

1. Low Cost

After critical study and examination it was found that this system is the most economical as compared to other available systems. The costing for 10 conveyors was around ` 1.5 lakhs as compared to ` 8-10 lakhs over other systems.

2. Low Maintenance

As the only moving part of a flexible spring conveyor is its robust inner spring, trouble-free operation is ensured. These springs are specially heat-treated and tempered for maximum working life.

3. Easy to handle

The rotating spring is centralized in the tube by the material and as a result there is little to no product degradation. Type and speed can be carefully chosen to ensure that material is conveyed in the optimum manner.

4. Design simplicity

Sheer simplicity of operation is the key element in the flexible spring conveying system. The electric motor driven spring, which is the only moving part, rotates within a sealed tube, moving the materials along by its Archimedean spiral action.

This design simplicity eliminates the need for any additional operating equipment such as filters or bearings - all adding up to a system that's hygienic, easy to clean, low on installation, operation and maintenance costs and high on efficiency and performance.

5. Easily Installed

Multiple conveyors linked outlet to inlet enable conveying over longer distances. Multiple inlets and/or multiple outlets are possible on a single conveyor to create a distribution system such as transferring ingredients from storage to a line of processing or packaging machines.

6. Easily Cleaned

The simplicity of the flexible spring conveying system makes cleaning a simple operation. Conveyors can be emptied of residual material by reversing the motor and then dry cleaned by brushing or, if necessary, flushed through with water or cleaning solution. Optional, interlocked, quick release connectors can facilitate rapid dismantling and reassembly where cleaning of the tube and end connections is essential

7. Dust-Tight

During the materials conveying process, even the most harmless ingredients can become a hazard when they appear as dust in the atmosphere. In addition to the resulting downtime spent cleaning floors and equipment, the presence of dust can cause airborne contamination of other products, and also pose a threat to the working environment.

The flexible spring conveying system is totally sealed during operation, and because air is not used as the conveying medium, there is no need for filtration nor is there a risk of dust contamination escaping in to the atmosphere - critical for applications involving active pharmaceuticals and hazardous chemicals.

8. Quiet

As motor is the only component in the system which is making noise this type is making less noise and thus keeps environment free from noise pollution.

9. Flexible Construction

Its flexibility allows saving lot of floor space which can be used for other production purposes.

The flexibility of flexible spring conveying systems is unlimited. They can be configured to convey in any direction and in any elevation between horizontal to vertical. They can be installed over, under and around existing plant and equipment. And they can easily be maneuvered round obstacles and through small openings in walls to maximize valuable factory space.

10. Quick Disassembly

The inlet and outlet ends are easily reachable making the System handy and easy to disassemble whenever required.

7. CONCLUSION

The plant layout, routing requirements, and space considerations are all important when comparing conveying options. Where the conveying route is straight or can be gently curved, a flexible spring conveyor will get the job done.

The preceding discussion has outlined the most common factors influencing the selection of flexible spring conveyors. While the characteristics of the material and the requirements of the process may clearly dictate one technology over the other, the flexible spring conveyors are suitable for most powder and granular bulk conveying applications.

The decision then comes down to economics, flexible spring conveyors offer lower capital and operating costs, especially over shorter distances involving lower capacities.

In the final analysis and trials it was confirmed that the flexible spring conveyors were able to transfer all flux

ingredients for welding electrodes from hoppers to the weighing scale with optimum speed and accurate flow control.

8. ACKNOWLEDGMENTS

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9. REFERENCES

[1] David Boger, (2009) "Weigh Batching: The Benefits Of An Automated System", Technical Articles, Flexicon Corp. Available:- htttp://www.flexicon.com/us/Articles/technical/v-0745.asp

[2] SIEMENS S7-200 series micro-programmable logic controllers (Micro PLCs) system manual.

[3] SIEMENS MICROMASTER 420/430/440, Getting Started Guide.

[4] "The Welding Electrode" Available: http://www.weldguru.com/index.htm

[5] SIEMENS 'SIMATIC' Text Display (TD) TD-200 User Manual.

[6] "Flexible Screw Conveyor", Technical Articles, Flexcon corp.; Available: http://www.flexicon.com/us/products/flexiblescrewconveyors/cleanliness.asp

[7] Michel Podevyn,(2008), Spiroflow Systems, Inc. "Selecting the Best Conveyor for your Application" Available:- http://www.spiroflowsystems.com/en/content/brochures

[8] "Flexible Screw Conveyors", Spiroflow Systems, Inc. Available:- http://www.spiroflowsystems.com/en/about-flexible-screw-conveyors-page2 and 3