

Ask Joe! Column

Applying Weighfeeders in Blending Operations for Bulk Solids

Guest Article by Sheldon V. Shepherd, Industry Consultant, Siemens Milltronics, Inc

Abstract



Weighfeeders are belt conveyors that are designed to control the flow rate of bulk solids by continuously weighing material on the belt and varying belt speed accordingly. In process plants, weighfeeders can be used in many locations to provide rate control for blending bulk solids such as cereals, seeds, grains and minerals. A careful evaluation of the application, proper installation and calibration, and regular maintenance are essential if operators hope to enjoy continuous and reliable service. The choice and set up of an appropriate pre-feed device is also important in conditioning the material for rate control. Weighfeeders can be used in stand-alone blending operations or they can be interfaced to a facility's process control system. They may also be connected to operate

in conjunction with other equipment such as belt scales, liquid additive pumps, and process sensors. Case histories illustrate that accurate rate control during blending can reduce material costs and help produce a more consistent, higher quality product.

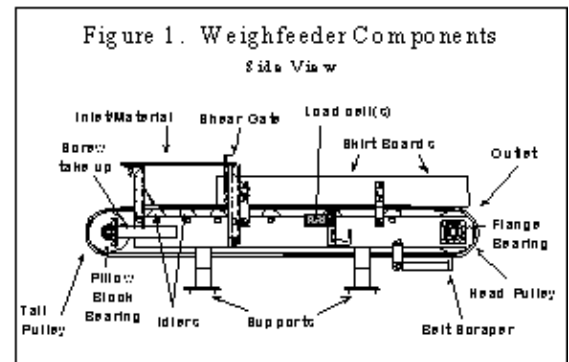
Introduction

Reducing material costs and improving product quality are of growing concern in today's global market place. Using weighfeeders to accurately control the rate of material during blending operations can help companies assure their long-term survival by improving quality and lowering costs. To accomplish this it is important to understand how to properly select, install, calibrate, and interface a weighfeeder for a particular application.

Principle of Operation

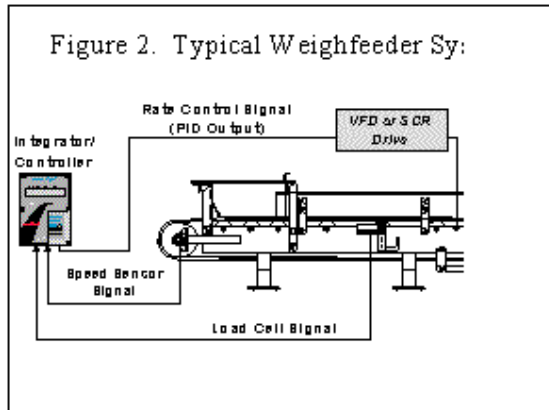
Weighfeeders are designed to deliver a designated rate of material in a process. They are used to convey, weigh, and control the flow rate of bulk materials by varying the speed of the belt. Basic components of a weighfeeder are shown in Figure 1.

A typical system supplied by a manufacturer is composed of an integrator/controller, variable frequency drive (VFD) or silicon controlled rectifier (SCR) drive. The rate of the material conveyed is computed using the equation $\text{Weight} \times \text{Speed} = \text{Rate}$. Material weight on the belt is measured by load cells, which produce a voltage signal that is sent to the integrator/controller. The integrator also receives input in the form of electronic pulses per revolution from a belt speed sensor connected to the tail pulley. Using these two points of data, the integrator/controller calculates the rate of material transferred along the belt (usually in pounds or tons per hour).



Motor speed control is derived from a proportional/integral/derivative (PID) analog signal sent from the integrator/controller to the VFD or SCR drive. This signal is calculated using actual and desired material flow rate, or

load values, modified by PID parameters that are entered by the user and stored in the integrator/controller. This is illustrated in Figure 2.



Key components include the metal frame and housing, weigh bridge, belt, reducer, motor, speed sensor, inlet with shear gate, skirt boards, and belt tensioning device. Weighfeeders are often enclosed in a housing that protects or contains the material. Clean-out devices such as a dust collection port, scavenger screw, or drag chain may be included with the housing to remove any material that falls from the belt.

Belt scrapers and return belt plows are commonly used to keep the belt clean and free of material buildup. Suppliers offer a wide variety of components and accessories to suite most any application.

Rollers, idlers or slider bars may be used as load carrying devices. Rollers or idlers require routine maintenance and can seize if they become fouled with material. For this reason, slider bars are preferred in wet environments and for use in low capacity feeding of powders.

A slider pan weighbridge is recommended for low capacity feeders. This provides for a larger sample of material to be continuously weighed. Accuracy is maintained over a wide turn-down ratio because the extended slider pan reduces belt speed influence on the weighbridge. In addition, better alignment can be maintained across the approach and retreat idlers.

Selection

Weighfeeder models are available with average flow rates in ranges from less than 100 lbs/hour to more than 1,000 tons/hour. A manufacturer selects the appropriate model size based on application data supplied by the customer. It is important that this data be accurate and account for any planned process design changes that may occur in the foreseeable future. While weighfeeders can be selected using a minimum amount of data, specialized materials or process conditions will usually require more input and forethought. Ideally, the information gathered to specify a weighfeeder includes:

- Type of material · Minimum, average, and maximum flow rate
- Bulk density · Average and maximum particle size
- Moisture content
- Material temperature
- Angle of repose and surcharge angle
- Inlet size and pre-feed device
- Space limitations and mounting constraints
- Environmental conditions: dusty, wash down, sanitary, or corrosive

(Sample data form in Appendix A)

An appropriate pre-feed device may be necessary to complete the system. A pre-feed device could include an ordinary bin, mass flow bin, belt conveyor, rotary valve, or screw conveyor. Material flow characteristics usually determine the particular type of pre-feed device. Typically, a rotary feeder or screw conveyor pre-feed is used for materials with particle sizes of less than 200 mesh.

Installation

Weighfeeders should be installed in accordance with the manufacturer's guidelines. Weighfeeders are usually tested for repeatability at the factory where belts are adjusted for proper tension and tracking. General guidelines are as follows:

- Construct the necessary support framework to provide a sturdy, rigid base. Vibration isolators are recommended if the location is subject to moderate or heavy vibration.
- Install the unit in its desired location according to the mechanical drawings supplied by the manufacturer. Make certain the unit is accessible for routine maintenance.
- Align the infeed section of the weighfeeder with the discharge of the pre-feed device.
- The unit should be fastened to a rigid, level structure. Prevent twisting or misalignment, which may induce stress on the weigh section. Use a level during installation and shim if necessary.
- Check the gear reducer oil level in accordance with the manufacturer's procedures and specifications. Follow the supplied diagram for wiring the unit.
- Remove any shipping inserts used to support the weighbridge and protect the load cells during shipment and installation.
- Make sure that the weighfeeder is free from all tools and foreign objects before it is started.
- Verify correct belt tension and tracking. For most applications, the ideal belt tension is just enough to prevent the belt from slipping on the drive pulley.
- Shear gate height is set at the factory. It should only be changed by an authorized service technician, or after consultation with the factory.

Calibration

It is important to understand that a weighfeeder is only as reliable as the standard to which it was calibrated. Weighfeeders can be calibrated using test chains, static test weights, electronic calibration, or material tests. The supplier will recommend the appropriate calibration method for a particular unit.

Material test is the most accurate calibration method because it uses known standards under actual operating conditions. With material tests, a known weight of material is transferred through the machine and compared to the total measured by the integrator. The calibration parameters in the integrator are then adjusted to compensate for any difference. It is important to note that all of the known weight of material should pass through the weighfeeder. Sometimes the test material can fall from the weighfeeder, or become stuck in the bin or infeed section.

The known weight of material can be obtained by weighing the test load in a bin supported by load cells or by a platform type scale. The material can be weighed before or after the test. It is critical that the weighing device used for the test load be accurate and calibrated to a reliable standard.

Routine Maintenance

A properly maintained weighfeeder will provide years of continuous, reliable service. Most weighfeeder manufacturers issue a recommended maintenance schedule that includes these minimum guidelines:

- Check the weighbridge weekly and remove any material buildup that could influence the deflection of the scale.
- Verify daily that the belt is tracking properly and that appropriate belt tension is maintained.
- Perform a zero calibration daily or at least weekly.
- Conduct a span calibration check once each month during initial operations. This interval can be lengthened if, over time, there is little deviation between routine span calibrations.

- Inspect, clean, and apply lubricants as needed to the chain, sprockets, bearings, and drive assemblies.
- Follow the manufacturer's recommendations for maintaining the gear reducer and motor.
- Perform extra or specific maintenance required by extraordinary climatic or environmental conditions.
- If the feeder has skirt boards, assure they are not applying pressure to the scale. Furthermore, check regularly for material lodged between the skirting and belt.

Weighfeeder Interfaces

Weighfeeders can be interfaced with other devices or with a plant's control system in a variety of ways. Multiple weighfeeders can be connected using a 4-20 mA analog signal for cascaded proportional blending. In this example, one weighfeeder integrator is set as the primary feed device. Secondary weighfeeders are then slaved to the analog output of the primary device, which is programmed to provide an analog signal that is proportional to material flow rate. All secondary weighfeeders are set to operate in proportion to the flow rate of the primary weighfeeder, using the analog remote set-point input in each of the secondary integrator/controllers.

Integrator/controllers in a blending operation do not always need to be cascaded for proportional blending, particularly in an application where the recipe does not change. Each weighfeeder can be programmed with fixed set-point values for the feed rate. The user then adjusts the feed rate set-point in each integrator/controller to modify the blend.

A blend recipe may also be set by using an interface between each of the integrator/controllers and the plant's control system. Each weighfeeder is connected to the plant's control system using two 4 - 20 mA analog signals. One signal is set up to transmit the actual rate of material fed and the other receives a remote set-point value from the plant's system. The user then adjusts the blending ratios in their control system.

While analog control systems have been used extensively in the past, digital communication networks are replacing them at a fast pace. Many users are now requiring weighfeeder integrator/controllers that are compatible with industry standard communication protocols such as Allen-Bradley Remote I/O™, DeviceNet™, Profibus™, or Modbus Plus™. These protocols offer a wide range of options for transmitting and receiving data between the weighfeeder and the plant's control system.

Typical Integrator/Controller Interfaces:

- 4 - 20 mA outputs programmable for rate, belt load, or speed
- One or more 4 - 20 mA PID control outputs
- One or more 4 - 20 mA set-point inputs
- At least one pulsed output for a remote totalizer
- Discreet inputs to initiate auxiliary functions such as batch control, routine calibration, PID modes or external alarms
- Several alarm relay outputs programmable for rate, load, speed, PID deviation and batch control
- Industry standard communication protocols

Economic Analysis

The example in Table 1 presents an economic analysis of a typical weighfeeder transferring approximately 20 tons/hour while operating 18 hours/day for 300 days of the year. If the material costs \$25/ton, a total of \$9,000 worth of material is conveyed daily. For comparison, we will examine a suitable volumetric feeding device, which can be expected to achieve accuracy around $\pm 5\%$. According to the analysis, installing a single weighfeeder in this application will provide raw material cost savings annually of \$121,500. This means the weighfeeder will pay for itself in less than 40 days.

Table 1.

System	Accuracy	Excess Material Cost		Weighfeeder System Cost	Daily Matl Savings	Payback Period (days)
		Daily	Yearly			
Volumetric	5%	\$450	\$135,000	-	-	-
Weighfeeder	0.5%	\$45	\$13,500	\$16,000	\$405	39.5

Case Studies

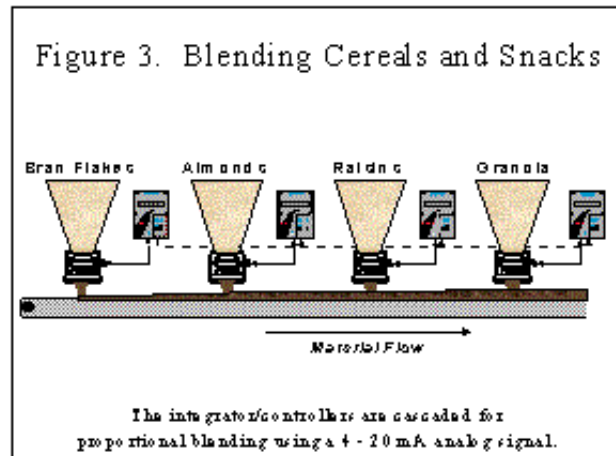
Blending Cereals and Snacks

Problem:

The customer wanted to obtain an accurate and consistent mix of bran flakes, almonds, raisins and granola in a recipe for breakfast cereal. The company had previously tried using volumetric devices to provide the proper ratios, but this led to significant variations in blend consistency. In addition, it was difficult to totalize the amount of raw products blended and it made the process set-up unsuitable for blending snack foods like trail mix, a secondary function that the company valued highly.

Solution:

Low-capacity enclosed weighfeeders were mounted underneath the raw material feed bins. The integrator/controllers were slaved together using an analog signal to provide cascaded proportional blending (Figure 3).



Description:

The raw materials used to make breakfast cereals can be relatively expensive. It is important for the user to optimize the utilization of bran flakes, almonds, raisins, and granola. Cereal makers need process control machinery that senses when to recharge material feed bins and they also need to track inventory usage. Furthermore, in a consumer product environment it is critical for producers to make a consistent product. Each finished package of cereal must contain the same blend of cereal products.

A system was provided that allowed one weighfeeder to act as the primary rate controller and the other three to act as secondaries. The manufacturer adjusted the primary (bran flakes) weighfeeder to the desired flow-rate set point. The three secondaries (almonds, raisins, and granola) were connected to the primary and set up for proportional blending. The proportions were entered individually into the each of the secondary weighfeeder control systems. Food-grade belting was provided to meet cleanliness and material compatibility requirements.

Within months, the cereal maker saved enough in raw materials to recoup the investment in the weighfeeder system. The company was also able to reassign personnel, who were previously needed for continuous monitoring of the volumetric blending equipment. In addition to saving on production costs, the customer was able to produce a higher quality, more consistent product. This brought about increased sales and an edge in the highly competitive cereal and snack food market place.

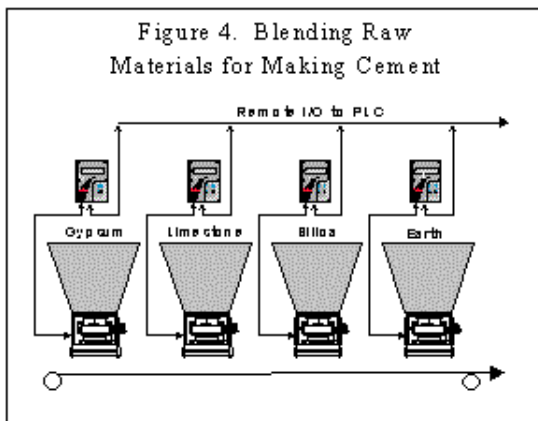
Blending Raw Materials to Make Cement

Problem:

A world-class cement manufacturer was upgrading its facility and wanted to add a new system of weighfeeders for blending raw materials. The company required new weighfeeders that were capable of communicating with the plant's process control system using Allen-Bradley Remote I/O™ protocol.

Solution:

The user installed a series of high-capacity, heavy-duty weighfeeders that could communicate with an Allen-Bradley™ control system (Figure 4). A lump relieving inlet was also installed to improve the material flow into the weighfeeders.



Description:

The weighfeeders are used to blend raw materials such as gypsum, limestone, and silica to manufacture cement. The blend ratios can be modified in the plant's control system, which will immediately change the feed rate set-points in the weighfeeder integrator/controllers. The company also gathers daily raw material usage data through the communications link.

In the event of a sudden failure, such as an unexpected stoppage, broken belt, or belt-tracking problem, the plant's control system is notified through the communications link. In addition, operators in the control room can remotely initiate a daily routine zero, an essential maintenance guideline. In the future, the control system may be programmed to automatically initiate routine calibrations through the communications link.

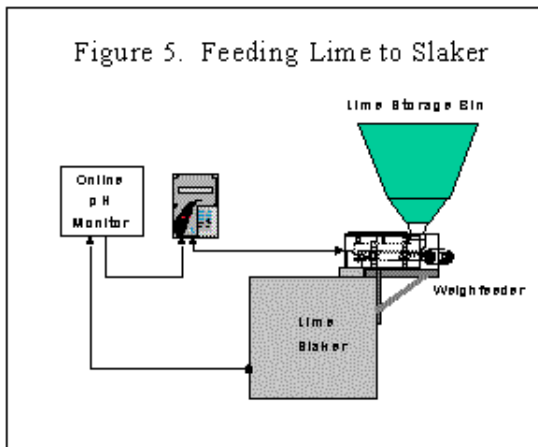
Feeding Lime to a Slaker

Problem:

At a water treatment facility, the previous feeders were difficult to operate and did not meet the process requirements or the customer's expectations. Feed rates were inconsistent and unreliable. The existing feeders required a great deal of maintenance - in excess of ten minutes each day - just to keep operating. In addition, parts for the aging feeders were hard to find and costly to obtain.

Solution:

The customer installed a low-capacity, enclosed weighfeeder to deliver a controllable rate of lime from the storage bin to the lime slaker (Figure 5).



Description:

In water treatment processing, lime is added to adjust the pH of the water. The new weighfeeder is used in this process. The remote set point for rate control on the weighfeeder is connected to an online pH meter for continuous response. The new weighfeeder is significantly easier to maintain than the previous equipment. It is also capable of delivering lime at a controlled, uniform flow rate that is measurable with +/- 0.5% accuracy, which is considerably more consistent than comparable methods.

The water treatment plant also wanted to monitor the amount of lime being fed into the process for accounting and inventory purposes. The new weighfeeder allows the operator to monitor the daily total of lime used.

By using a weighfeeder, the operator was able to obtain better control of the process and provide a more consistent pH level in the water. Use of the weighfeeder resulted in material cost savings. And by feeding the optimum amount of lime, the system improved the quality of treated water. Due to the age and deterioration of previous equipment, the facility also saved nearly \$10,000 in annual maintenance costs.

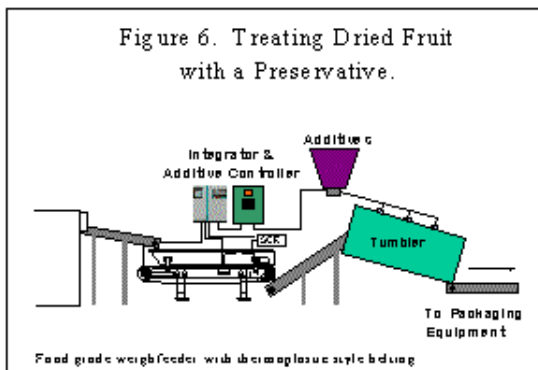
Blending Dried Fruit with a Preservative

Problem:

The user could not effectively control the amount of preservative solution added to dried fruit during processing. Some batches of the dried fruit were getting too much preservative and others were not getting enough. The operator was having difficulty producing a consistent product.

Solution:

The customer installed a medium-capacity, sanitary-duty weighfeeder to control the rate of dried fruit entering the mixer/tumbler. A preservative was then added at the tumbler in direct proportion to the amount of fruit measured by the weighfeeder. Thermoplastic belting was used to allow rinse water to drain from the dried fruit before it reached the weighbridge (Figure 6).



Description:

The customer processes and sells a wide variety of dried fruits. Sun-dried fruits are cleaned, then treated with a preservative, and packaged. The facility has to meet FDA food-grade standards, so its equipment must be cleaned daily with hot water. Consequently, sanitary-duty equipment is required in the plant. Since the fruit is wet and heated when it is transferred, the equipment must be able to continuously withstand harsh conditions.

In this sanitary-duty installation, the integrator/controller receives input from the load cells on the platform style weighbridge. A magnetic speed pickup mounted between the motor and reducer sends belt speed information to the integrator.

A designated rate of fruit is programmed into the integrator/controller, which sends a signal to an SCR drive to adjust the belt speed. A rate signal is also sent to an external PID controller, which sets the flow rate of liquid preservative to be added to the process.

This setup allows the correct proportion of preservative to be added to the dried fruit. The operator now has the capability to produce a much more consistent, higher quality product. This pleases their customers and makes the company more competitive in the marketplace. The company also saves on excess costs for preservative solution. In addition, plant operators totalize daily production for specific manufacturing lines. This helps the company monitor plant utilization and productivity.

Conclusion

Most processors using bulk solids can improve overall product quality and cut material costs by installing a quality weighfeeder. By their very nature, weighfeeders are efficient systems designed to meter out material in a proportional manner. The latest generation of weighfeeders add digital communications capabilities that allow full integration with process control systems, giving users a level of functionality not previously seen. This level of automation allows users to make more efficient use of personnel, and it gives operators unprecedented control over their processes. Users today can make minute changes in blend ratios without ever leaving the control room, and they can track raw material usage more closely than ever.

In order to achieve this level of control, proper installation and maintenance are crucial. It also is vital to select the right weighfeeder, but with minimal effort, operators typically can realize cost savings that will pay for their investment in short order.

Sheldon Shepherd is Industry Consultant for Siemens Milltronics, Inc. You can visit <http://www.sea.siemens.com/ia> web site by clicking the "hot-linked" company name.

+++++

Welcome to Ask Joe!, a monthly column by our resident materials handling guru, Joe Marinelli of Solids Handling Technologies. Joe addresses the issues that bug you the most. And Joe knows!! Formerly with Jenike & Johanson, Solids Flow and Peabody TecTank, Joe is an expert on materials handling.

For past articles, **Ask Joe!** Archived Articles.

Guest articles for the **Ask Joe!** Column are always welcome, for more information please contact Joe Marinelli directly at his email address: joe@solidshandlingtech.com.

© Powder and Bulk.com