Applying weighfeeders in biomass blending operations

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 power generation, weighfeeders can be used in many locations to provide rate control and for blending bulk solid fuels with recoverable calorific value. Typical fuels measured include biomass such as wood chips and energy crops and fossil fuels such as coal and coke.

Weighfeeders can be used in standalone blending operations or they can be interfaced into a facility’s process control system. They may also be connected to operate in conjunction with other equipment such as belt scales, additive addition, moisture measurement or even calorific value compensation. The choice and setup of an appropriate pre-feed device is also an important factor in conditioning and feeding the material for rate control. Accurate rate control during blending can reduce material costs and help produce a more consistent, higher quality fuel.

Introduction

Today we see many compelling environmental and economic reasons to include biomass as a power generation fuel. Combusting biomass feedstock does not
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contribute to global warming and helps avoid the release of other harmful emissions. Also, viable fuels are produced in many industries with no additional processing costs involved, further strengthening the financial feasibility.

Additionally, many countries have established subsidies to make biomass-based power generation economically viable. The possibility of co-firing a power plant on diverse feedstocks is an additional support for project economics and helps ensure security of fuel supply. As we strive to move to a low-carbon economy, biomass energy for both industry and electricity generators will become increasingly important. Add in new climate regulations and increasing fossil fuel price and the argument becomes even more compelling.

Numerous aspects have to be considered for the planning and implementation of automation, control and instrumentation components for plants using biomass. The implementation of weighfeeders to accurately control the rate of fuels during blending operations can help companies assure their long-term viability by improving consistency of fuels 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. Engaging experienced equipment manufacturers is an important step toward commissioning any new operation incorporating biomass.

**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 to vary the feed rate is comprised of an integrator (controller), variable frequency drive (VFD) and a reduction gearbox. 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. 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 sources of data, the integrator calculates the rate of material transferred along the belt, usually in kilograms or tons per hour.

Motor speed control is derived from a proportional/integral/derivative (PID) signal sent from the integrator to the VFD. 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. This is illustrated in Figure 2.

Major components of the weighfeeder include the metal frame and enclosure, weigh bridge, belt, VFD, motor, reduction gearbox, speed sensor, inlet, shear gate, skirt boards and belt conditioning devices.

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 into the enclosure.

Belt scrapers and return belt plows are commonly used to keep the belt clean and free of material buildup; this is particularly common on biomass applications. Suppliers offer a wide variety of components and accessories to suit most applications. Rollers, idlers or slider bars may be used as load-carrying devices, particularly in heavy-duty applications. However, rollers or idlers require routine maintenance and can become fouled with material. For this reason, slider bars are preferred in wet environments and for use in low-capacity feeding of powders and pellets.

A slider pan weigh bridge is recommended for very 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 weigh bridge. In

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**Figure 1: Weighfeeder components (side view)**

**Figure 2: Typical weighfeeder system**

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addition, better alignment can be maintained across the approach and retreat idlers.

**Configuring a weighfeeder**

The application of a weighfeeder is tailored to the individual requirements of each process. Detailed information about the material, the process, the control and the size of the unit are all considered when engineering a weighfeeder. The material characteristics and the way it flows from one process to another is a large factor in the sizing of a weighfeeder. Compared to a belt scale application on an existing conveyor where size and speed of the belt are known, a weighfeeder is an independent machine that interfaces between two connection points to control or monitor the material flow.

Every component of a weighfeeder is configured to the specific needs of the application. Belt speeds need to be slow enough to ensure that shearing material from a bin or hopper is consistent and does not damage the belt or create belt slip. Motors are sized to exceed the power demands of starting a static belt under a full belt loading condition. Gearboxes are selected to achieve a specific belt speed to maintain a design rate and transfer high motor RPM to a usable conveyor speed.

Weighfeeder belting needs to be configured based on the material abrasiveness and its temperature. The weighbridge components need to be configured so that load cell capacity and speed sensor inputs are adequate to meet the requirements of the integrator. This is all in addition to normal conveyor design to ensure that the frame and structure is rigid enough to handle the load and friction forces from shearing and conveying material. Throughout the configuration process, strict safety standards and components are applied including belt tracking switches or pull cord alarms. Applying these rigorous design standards ensure that weighfeeders are designed specifically for weighing accuracy and feeding consistency.

While weighfeeders can be selected in principle using a minimum amount of data, specialised materials such as biomass or unusual process conditions will usually require more input and forethought.

The basic information required to design an application-specific weighfeeder includes:

- Type of material: Minimum, average, and maximum flow rate
- Bulk density: Average and maximum particle size
- Moisture content: Minimum and maximum values
- Material temperature: Minimum and maximum values
- Angle of repose and surcharge angle
- Inlet size and pre-feed device
- Space limitations and mounting constraints
- Environmental conditions: e.g. dust, abrasive or corrosive, hazardous area

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 which are reluctant to flow under normal conditions.

**Application example – power generation**

Coal is typically stored in bunkers or silos at a power plant, ready for use. Feeding the coal from these storage bins in a consistent manner is fundamental to the efficiency of the power plant. A weighfeeder ensures uninterrupted coal flow, while monitoring and controlling the material throughput. Too much coal fed into the system will overload other processes and cause expensive downtime and maintenance. Conversely, not enough coal will create a loss of potential power and efficiency. In an optimal system, several weighfeeders and boilers typically work together to ensure production is never shut down.

The feed rate of coal is based on boiler demand and the amount of air available for drying and transporting the pulverized coal. Coal is fed into the pulverizer, along with air heated to about 350 °C. As rollers crush the coal, hot air dries it and blows the usable fine-coal powder to the fuel process. This rate of feeding the coal into the process is controlled by flow-rate set-points from the control system. As demand increases, the weighfeeder increases throughput by increasing belt speed, or slowing it down for a rate decrease.

An emerging trend is co-firing coal and biomass together to reduce costs and pollution. This combined process prolongs the use of coal as a sustainable resource. Typically up to 20 percent of the mixture can be biomass material. This mix results in a reduction of nitrogen, carbon and sulphur emissions from the coal burning process. The addition of biomass to the process requires an additional feed point controlled by a second weighfeeder.

Biomass material typically consists of agricultural crop residue, wood and bark remains from pulp and paper mills or wood processing plants, manure and other organic waste. This material is fed into the boiler and monitored for the correct ratio to coal. Although biomass properties make it superior to coal as a fuel, it has a relatively low bulk density so transportation and storage costs are higher due to a larger requirement of material compared to coal. Combining coal and biomass gives the end user lowered pollution emissions and lower overall production costs compared to using 100 percent coal in their process.
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Weighing and feeding biomass can present its own unique challenges. For weighing: the low bulk density alone means that careful selection of the correct weigh element is vital. Direct loading onto dual load-cells is the preferred method, avoiding secondary load transfers via bearings, pivot points, linkages and cables – all of which can introduce hysteresis and hence inaccuracy. For feeding: mass flow in-feeds chutes, automatically controlled shear gates or even PID-controlled mechanical pre-feeders may be needed. A properly engineered, well maintained weighfeeder solution will offer years of reliable service with no degradation of accuracy or repeatability. A typical installation is shown in Figure 3.

Blending with weighfeeders

Weighfeeders can be interfaced with other standalone devices or directly with a plant’s control system in a variety of ways. Multiple weighfeeders can be connected simply using an analog signal for cascaded proportional blending.

As an example, one weighfeeder (or belt weigher) 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 a 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 remote set-point input in each of the secondary integrators.

Integrators in a blending operation do not always need to be cascaded for proportional blending, particularly in applications 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 to modify the blend.

A blend recipe may also be set by using an interface between each of the integrators and the plant’s control system. Each weighfeeder is connected to the plant’s control system using two 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 integrators that are compatible with industry-standard communication protocols such as Profibus or Modbus. These protocols offer a wide range of options for transmitting and receiving data between the weighfeeder and the plant’s control system.

The current generation of integrators take this a step further. They are directly incorporated into the PLC hardware, removing the need for standalone, supplier-specific integrators and allowing any weighing device, regardless of manufacturer, to be connected and programmed from within the PLC environment. This helps the automation and visualization system to handle the measurements and clearly visualize the process values. That includes messages, alarms, trend analyses and reports for preventive or condition-based maintenance.

A typical PLC weighing module is shown in Figure 4.

Optimization and efficiency

The cost benefits of using a weighfeeder which will achieve an accuracy of ± 0.5% when compared to a more traditional volumetric feeding device, which would be expected to reach ± 5%, may be obvious. However, further improvements can be made through good design and innovation.

The weighfeeder will typically run 24/7 and a high efficiency drive train can reduce the energy required by over 30% when compared to standard designs. The judicious application of premium efficiency motors, VFDs and energy-efficient helical bevel gearboxes all contribute to
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the greatly reduced running costs whilst offering improvements in reliability and reduced downtime.

Conclusion

Most operators using bulk solid fuels can improve overall consistency and quality, as well as cut 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 have the capability to fully integrate 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 easily repay their capital investment.