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Ten things you need to consider when choosing and installing a roller press system

Scott Wennerstrum The Fitzpatrick Co.

Compacting your powder into briquets or producing granules with a roller press system can make both you *and* your customers happy. The briquets and granules are easier to handle than powders — they're much less dusty, don't segregate by size, shape, or density, and provide several other benefits as well. But selecting the right roller press system for your application and completing the installation is a complex process. After introducing you to some roll compaction and roller press basics, this article details 10 things you need to consider when choosing and installing a roller press system.

Roll compaction is a form of high-pressure agglomeration. The method requires a roller press, which exerts mechanical pressure on a powder or other dry bulk material as it's forced between two counter-rotating rolls. This pressure compresses the material into compacts, which are either briquets or a sheet that's subsequently passed through a mill to produce granules.

The latter process, called *compaction-granulation,* offers advantages over wet granulation processes. In many cases, the dry process requires no liquid binder. It costs less to operate, requires less and simpler equipment, and can handle moisture-sensitive materials.

Whether to produce briquets or granules depends on your needs. Typically, briquets are desirable when you require large, dense agglomerates. Shaped like pillows, almonds, nuggets, wafers, or sticks, briquets are typically the final product form. Granules are desirable when you need smaller, uniform particles. They're usually an intermediate product form, such as granules that will be fed to a tablet press to ensure more efficient feeding.

In addition to being easier to handle than powders, briquets and granules provide several other advantages.

Producing uniform blends. Differences in particle size, shape, and density can cause mixtures of discrete powders to segregate during handling or shipping. Making granules of uniform consistency eliminates segregation and can help your customer get consistent particle analysis results with every shipment.

Producing a uniform particle size range. Roll compaction can help you produce uniform briquets or granules of a specific size to meet precise product requirements.

Improving flow properties. Compaction-granulation will improve flow because granules flow more easily than powders and resist bridging and caking. As a result, the granules can give you higher flowrates and more evenly fill your containers and packages.

Controlling dust. Dust released from powders not only wastes your material but is dangerous to workers, increases housekeeping labor, and can be just plain annoying. Briquets and granules are far less dusty than powders, eliminating these dust problems and preventing dust from cross-contaminating your batches, too.

Controlling bulk density. Increasing your powder's bulk density by compacting it can make it easier to handle, transport, and store. In most cases, roll compaction can greatly increase a material's bulk density with good control.

Improving wetting or dispersion rates. In some cases, compaction-granulation can change the material's tendency to sink or float to match your application requirements. Granules are denser than powders, which allows them to sink, exposing the granules' surface area to the liquid for faster wetting and dissolution.

Controlling particle hardness. Roll compaction can sometimes change particle hardness to match your product specs, such as for greater crush strength or faster disintegration.

How the roller press works

The roller press is part of a system that includes other equipment. What other equipment you require depends on whether the roller press will form briquets or a sheet that will be reduced to produce granules.

To produce briquets, the system includes the roller press, a screener, and, often, a recycle bucket elevator (or other conveyor). The screener separates the briquets from the fines (or *flashing*). If included, the recycle bucket elevator returns the fines to the roller press for compaction. If the process requires a binder, a mixer with a binder-metering system is installed before the roller press.

For producing granules, you'll need to add a mill (or other comminutor) between the roller press and the screener. A typical compaction-granulation system is shown in Figure 1. The mill reduces the sheet to granules, which pass to the screener. The screener separates the on-size granules from particles that are too large or too small to meet your product requirements. The recycle bucket elevator returns this off-spec material to the roller press.

In addition to the recycle bucket elevator, various types of handling equipment in the system can move the powder into the feed hopper or move the briquets, sheets, and granules to other equipment.

Roller press components. The roller press typically consists of a pair of rotating, shaft-mounted rolls of equal diameter. The rolls are mounted on bearing blocks and powered by a motor linked to a drive assembly.

The *roll gap*, as shown in Figure 2, is the distance between the rolls at their closest point and depends on the pressure applied to the rolls (by hydraulic cylinders or other methods) and the amount of powder that's passed between the rolls.

The area where the powder is compacted between the rolls is called the *nip region* (Figure 2). The *nip angle* measures the nip region. This angle is directly affected by the roll diameter and is established in a line through the rolls' centers to a point on either roll where the powder is starting to move at the same speed as the roll surface. The roll diameter, roll speed, roll surface, and feeding method (discussed

A compaction-granulation system can produce compacts and granules in a range of sizes.

in the following section) can be selected to maximize the nip angle for obtaining the desired briquet or granule characteristics. The compressibility, gas permeability, and flow properties of the powder also affect the nip angle.

The roll diameter and speed are chosen to match the roller press production requirements. Roll diameter is typically selected based on the roller press's required capacity. Roll speed determines the powder's *dwell time*— that is, the time the powder spends in the nip region, which in turn affects the powder's ability to deaerate before passing between the rolls.

The surface of each roll is designed to increase the roller press's efficiency and achieve consistent briquet and granule density. To form briquets, the surface is cut into half-briquet cavities or pockets. Forming a sheet that will be milled to produce granules requires a smooth surface or one with a shallow pattern. In either case, the surface design must maximize the friction between the powder and roll surface while handling the powder's bulk density and any tendency it has to stick to the rolls after compaction. Roll surface examples for compaction-granulation are shown in Figure 3.

A feed hopper and feeder are located above the rolls. In a few cases, such as when the powder is dense and free-flowing, the powder can be gravity-fed to the roller press,

Figure 1

Typical compaction-granulation system

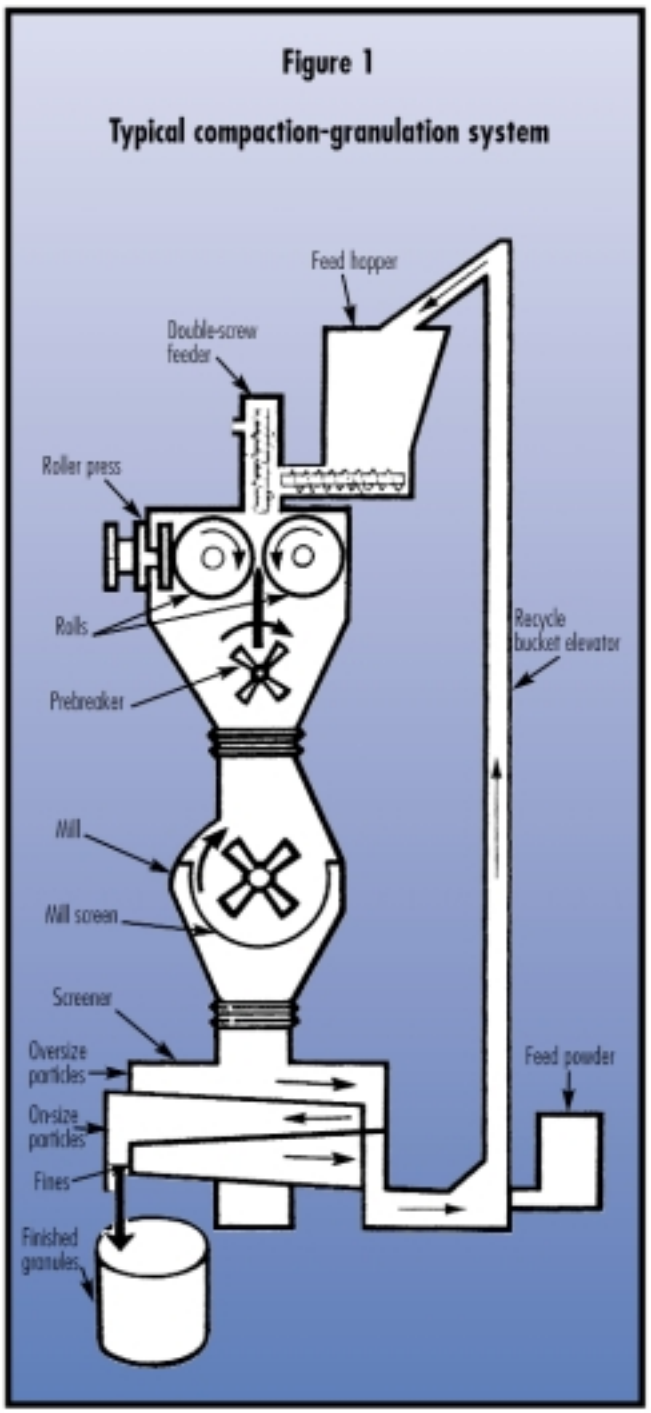


Figure 2

Roller press operation

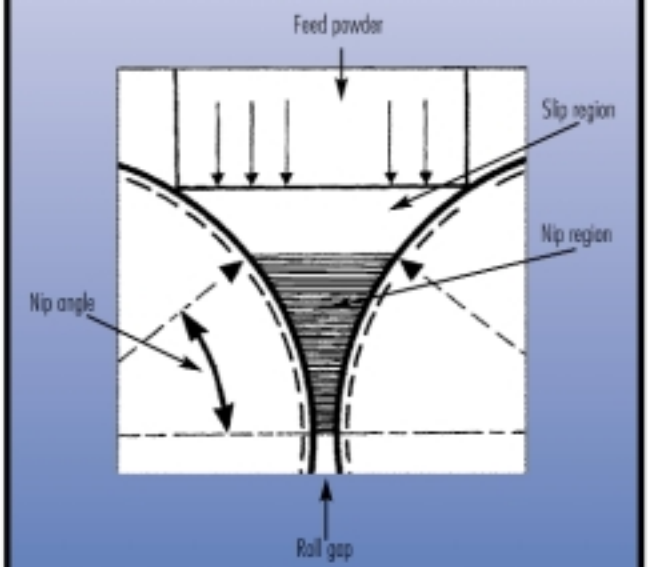


Figure 3

Various roll surfaces for compaction-granulation

as shown in Figure 4a. Gravity feeding usually requires only a pipe or chute below the feed hopper outlet to direct the material into the roller press nip region.

But for most powders, which tend to be lightweight and don't flow freely, a feeder is required to apply a downward force, called *precompression force,* to the powder as it enters the roller press. The force increases the friction between the powder and the roll surfaces to improve compaction. Two basic types of feeders can apply this force: single screw and double screw.

The *single-screw feeder,* as shown in Figure 4b and the photo on page 42, has a single vertical screw. Powder flows by gravity from the feed hopper to the screw, which force-feeds the powder down into the roller press nip region. The screw design can be changed to accommodate the feeding requirements of different powders.

The success of your roller press installation and the safety and comfort of workers in this area depend on good dust control.

For use with a roller press with rolls up to about 4 inches (100 millimeters) wide, the *double-screw feeder,*[1] as shown in Figures 1 and 4c, consists of one horizontal screw and one vertical screw. For larger roll widths, the feeder has two or more of each screw, located side by side, so that powder can be fed uniformly across the entire roll. Each horizontal screw meters powder from the feed hopper to the vertical screw, and each vertical screw precompresses and force-feeds the powder down into the nip region. The feeder can be adjusted during operation to handle a powder's changing flow properties.

Vacuum deaeration can also be applied during feeding to remove excess air from a powder with low bulk density. This eliminates entrained air that can cause the powder to resist the precompression force applied by the feeder. The technique can be especially useful for a high-efficiency, once-through compaction-granulation process with no screening or recycling steps or for greatly increasing a roller press's compaction efficiency. Vacuum deaeration requires a vacuum pump system. The system is linked to the feeder and forcibly removes the powder's entrained air through a filter before the powder enters the roller press.

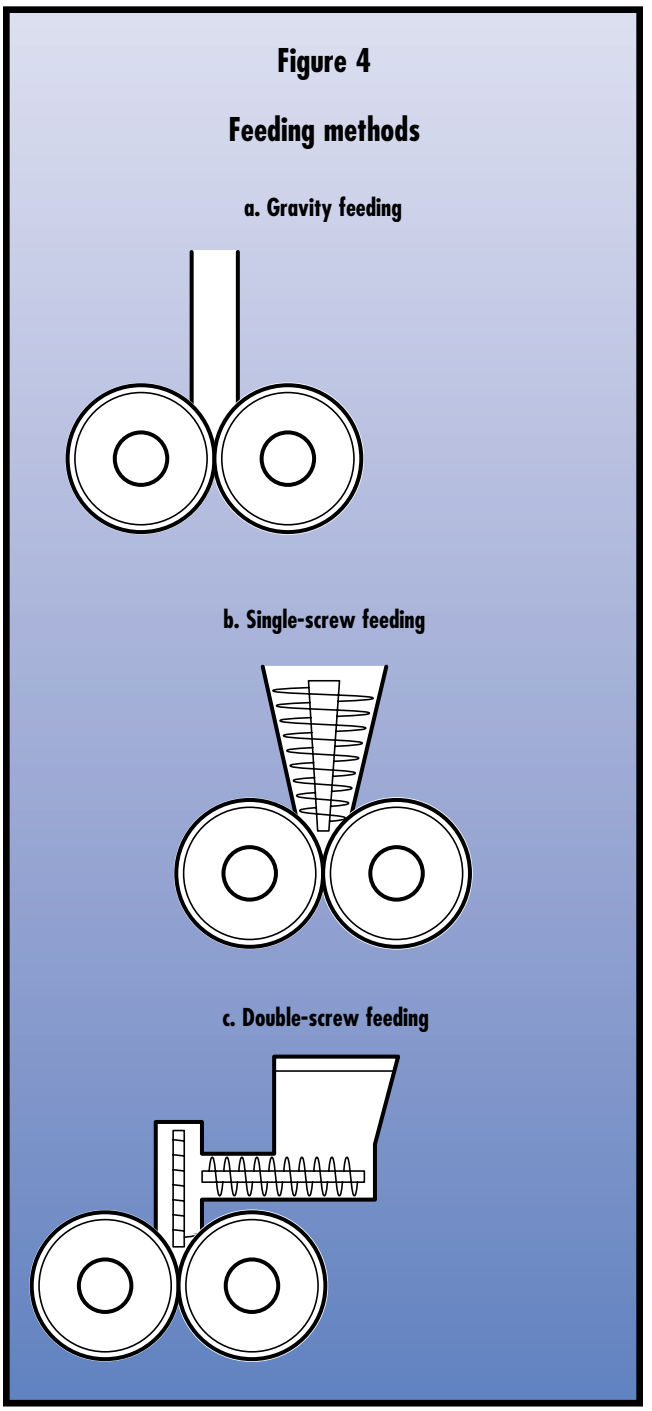
In some compaction-granulation operations, a small size-reduction machine called a *prebreaker* (Figure 1) is located inside the roller press housing below the rolls and above the roller press outlet to reduce the large sheet to intermediate-size pieces. These pieces can be fed more consistently to the mill downstream from the roller press than the large, irregular chunks that exit the rolls.

Roller press operation. In operation, powder either flows by gravity from the feed hopper directly into the roller press or flows into the feeder and, from there, into the roller press. The powder first enters the *slip region* between the rolls (Figure 2), where particles shift and accelerate to the same speed as the roll surfaces. Maximum consolidation occurs at the start of the nip region.

For forming briquets, the half-briquet cavities on the opposing rolls align through the roll centerline as the rolls ro-

Figure 4

Feeding methods



tate, forming whole-briquet cavities. To form sheets with patterned roll surfaces, the patterns on the opposing rolls match up in the same way.

The briquets exit the roller press and flow by gravity or via a belt conveyor or other handling equipment to the screener. The sheet (or sheet pieces) discharges in the same way to the mill for reduction to granules.

Start selection with equipment testing

Feasibility testing and lab or pilot plant testing are the first and most critical steps in selecting a roller press. In feasibility testing, the roller press manufacturer compacts a sample of your powder to determine whether it can be compressed under pressure.

The next step, lab or pilot plant testing, involves running samples of your powder through an operating lab or pilot plant roller press for several hours. This determines if the powder will build up on the roll surfaces or heat up and affect the roller press operation or the final product quality. Based on these tests and the manufacturer's process experience, the roller press can be scaled up to a production-size unit for your operation.

How much powder you need to supply for each test depends on the roller press size and your desired production capacity. As little as 100 grams or as much as 200 or more kilos of powder can be required.

This roller press has a single-screw feeder and compacts powders into briquets at up to 16 t/h.

Plan to be present for the tests. This will help the manufacturer get to know your requirements and help you gain confidence in operating and adjusting the equipment.

Ten things to consider when selecting and installing the roller press system

Once the testing is done and you've decided to purchase the roller press system, you need to work closely with the manufacturer to ensure that you've considered several factors related to the roller press's installation, operation, related equipment, and optional components. Ten of the most important items to consider are discussed in the following sections.

1 Equipment space and other layout requirements

Before you select the roller press, consider how much space it will require in your plant. The required space extends beyond the roller press footprint and height to the space needed for assembly and disassembly, platforms for parts servicing, and related equipment in the system.

The roller press manufacturer can supply detailed assembly drawings to help you determine how to lay out the roller press system in your plant. The drawings will show how much overhead clearance is needed for removing and replacing the roller press rolls and how much side clearance is needed for servicing other parts.

Reviewing these drawings will help you understand how the entire roller press and related equipment are disassembled and how much space this requires. For instance, disassembling a briquetting operation's screener and changing the screens requires several square feet of space around the screener.

You also need to allow space for platforms around the equipment. Workers will use the platforms to observe, maintain, and service the roller press and related equipment. Also consider where to locate an emergency stop switch on each platform level, where to place inspection ports on hoppers and other equipment, and how the ports are accessed from the platforms so workers can monitor the process and spot and correct problems.

If space allows, consider installing the roller press, mill (if required), and screener on separate floors in your plant so it's easy for workers to walk around each piece of equipment. If space is limited, consider using easily movable equipment. An example, shown in Figure 5, is a roller press with a mill suspended on tracks below the press so the mill can be rolled out for maintenance.

Other layout factors to consider include floor loading, hoist location, and controls location. Request floor loading information for the roller press and related equipment

from the manufacturer so it can be included on the assembly drawings. This will help you ensure that your plant floor has enough support for the equipment.

While many roller press components such as swing-down housings and roll-out feeder screws are designed to make them easy to clean, the roller press has some heavy parts that can only be disassembled with the aid of a hoist. Examples are the rolls, which are too heavy to remove manually for cleaning or replacement. Before the roller press is installed, you must carefully consider where to locate the hoist or provide access for a forklift so you can service these components. The hoist can be permanently installed or moved into place when required.

Also consider where the roller press controls will be located, depending on whether the system will be integrated with your plantwide control system or have local dedicated controls. In the latter case, locate the controls away from but conveniently close to the machine, and specify a NEMA 4X or IP 55 enclosure for the controls if water or another cleaning solution will be used liberally in the roller press area. If you need fast, easy installation, the roller press electrics can be prewired to a junction box on the machine. Tell the roller press manufacturer where your plant's utility feed is located so the manufacturer knows where to place the junction box on the assembly drawings.

2 Dust control

The success of your roller press installation and the safety and comfort of workers in this area depend on good dust control. The manufacturer's assembly drawings will show various dust pickup ports on the roller press and related equipment that will link the equipment to a dust collector. The amount of airflow required at each pickup port depends on the port's location and can be recommended by the roller press manufacturer.

The specifics of designing your dust control system depend on your application:

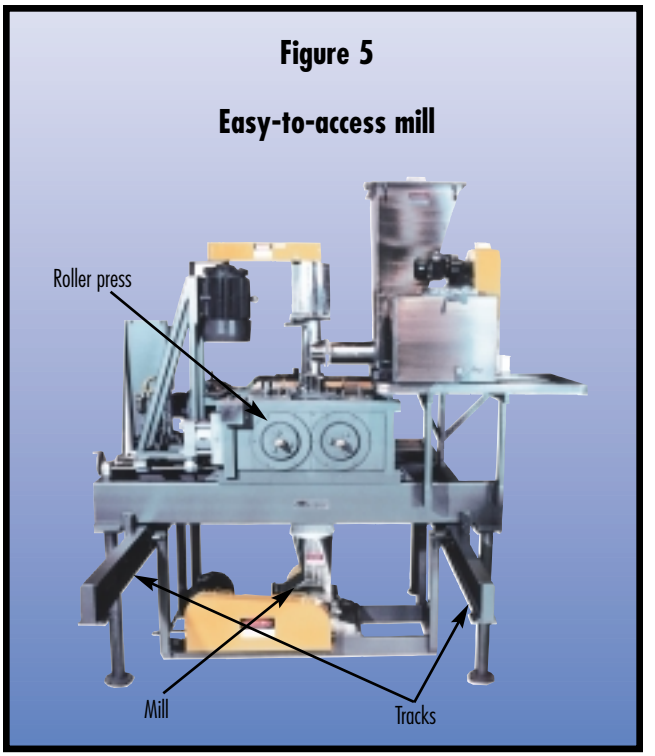
- If your roller press will handle only one powder and the dust collector handles dust only from the roller press system, you can recycle the collected dust to the feed hopper.

- If your powder has high value and can't be recycled to the feed hopper, ensure that the dust control system doesn't draw off too much dust with the process gas. The roller press manufacturer can often provide another type of dust filtering system to allow this.

- If the roller press will handle different powders from batch to batch, or if the unit must be cleaned between batches, locate the dust collector close to the roller press and use easily disconnected flexible hoses rather than metal ductwork to connect the dust pickup ports to the collector.

Figure 5

Easy-to-access mill



3 Noise control

Worker safety and comfort can also be improved by controlling noise in the roller press area. Noise from the roller press system is generally a combination of noise from its loudest parts — the roll motor and screener. On a large roller press the motor can reach a noise level of 80 dBa or higher. A screener can be much louder.

By considering noise levels ahead of time, you can control them. For motor noise, specify a low-noise motor or a noise cover for the motor. However, be aware that a noise cover can compromise the motor's operation unless you provide adequate venting to keep the motor cool. To make the screener quieter, consider using cleaning balls in it rather than cleaning rings. You can also construct a noise shroud to cover the entire screener.

4 Handling equipment

Consider what handling equipment is best for conveying your feed powder and moving the compacts to your downstream process or shipping area. Handling equipment that moves powder into the feed hopper should minimize air in the powder. The equipment at the roller press, screener, and mill outlets should gently handle the compacts. For instance, a dense-phase pneumatic conveyor may handle them more gently than a dilute-phase unit. Also consider whether your compacts will require a specialized conveyor to provide treatment such as curing, drying, or cooling as they travel downstream.

5 Product sampling

Before the roller press is installed, consider where to locate sampling ports on the equipment. This depends on what you need to know about various processing stages for quality control. For instance, you may need to sample the material before and after the roller press, the mill, and the screener. Appropriately located sampling ports will help you analyze samples to set up and optimize the roller press system at startup and monitor the equipment performance thereafter.

In a smaller roller press system, dust bags or socks are often used to make connections between one piece of equipment and another; these are easy to remove for sample taking. In a larger system, metal ductwork or rubber boots with hose-clamp connectors link the equipment and aren't designed to be taken apart for sampling. Sampling in such a case requires diverter valves or sampling ports that are designed into the equipment. Several sampling devices are available, and the cost for each varies depending on how it operates.

6 Utilities

Consider what utilities the roller press system will require and make sure they are available in your plant. The roller press manufacturer typically specifies these requirements in the price quotation.

The system requires three-phase electric power. You may need compressed air to actuate a hydraulic pump system. If your rolls require cooling, you will also need a supply of cool water and either a waste-water drain or a water-recirculating system.

7 Safety

As with all industrial equipment, the roller press system can be extremely dangerous if you don't take adequate safety precautions. Make sure workers can't gain access at equipment feed and discharge interfaces. Specify that sampling and inspection ports be properly covered. If the roller press system will be part of a larger process in your plant, make sure the system's equipment has safety interlocks with upstream and downstream equipment.

8 Cleaning

Before the roller press system is installed, establish standard operating procedures for cleaning the equipment. These will depend on your application. For instance, a roller press that compacts chemicals might run 24 hours a day, 7 days a week, and require no cleaning. But a roller press that compacts different colors of dye powders may require thorough cleaning between batches to prevent color contamination. Review your cleaning requirements with the roller press manufacturer. The manufacturer can help you understand how to clean your equipment and what optional features can make cleaning easier.

9 Maintenance

Work with the roller press manufacturer to determine what maintenance the equipment in the roller press system will need and how often you need to provide these services. A major consideration is the lubrication schedule for various parts. For instance, roller press roll bearings are often shipped pregreased and hand-packed so they don't require regreasing between major overhauls or roll repairs. A larger roller press often has grease fittings and drain plugs to allow you to replace the grease without disassembling the rolls or removing them from the machine. Most of the other bearings in the system are sealed and don't require periodic lubrication. An exception is the mill's rotor bearings, which do require lubrication on a regular schedule.

10 Spare parts

How many spare parts you need to stock for the roller press system depends on the roller press size and location, your powder's abrasiveness, and how costly roller press downtime is for your operation. Work with your manufacturer to establish a spare parts inventory that's practical for your operation.

The costliest spare parts are the rolls. You may need to stock these if your powder is extremely abrasive or if downtime is costly for your operation, such as when the roller press receives powder from a continuous upstream process. If your roller press is very large, you can speed roll changes by stocking a complete drop-in roll assembly, which includes both rolls and the bearing blocks, bearings, seals, and related parts.

The manufacturer can supply you with a spare parts package that includes commonly replaced parts. This can be a good idea if upstream process demands are high or if your plant is located overseas from the roller press manufacturer. Typically included are a drop-in roll assembly, feeder screws, mill blades, and screens. Expect the package to cost about 15 to 30 percent of the roller press's total price.

Some final advice

Working closely with the manufacturer to select the roller press and related equipment will make installation easier and faster and minimize the effort required by all involved. As the installation date nears, continue to work with the manufacturer to plan the equipment's rigging and installation details. **PBE**

Reference

1. Chilsonator feeder, The Fitzpatrick Co., Elmhurst, Ill.

For further reading

Find more information on roll compaction in articles listed under "Agglomeration" in *Powder and Bulk Engineering*'s comprehensive "Index to articles" (in the December 1999 issue and on *PBE*'s Web site, www.powderbulk.com).

Scott Wennerstrum *is technical director and director of marketing at The Fitzpatrick Co., 832 Industrial Drive, Elmhurst, IL 60126; 630/530-3333, fax 630/530-0832 (swennerstrum@fitzmill.com). He holds an MBA from the Illinois Institute of Technology in Chicago and a BS in mechanical engineering from the University of Tulsa in Tulsa, Okla.*

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Corporate Headquarters
832 Industrial Drive
Elmhurst, IL 60126 USA
Phone: 630-530-3333
Fax: 630-530-0832
E-mail: info@fitzmill.com

Eastern U.S. Division
4219 S. Clinton Ave.
South Plainfield, NJ 07080 USA
Phone: 908-561-1500
Fax: 908-561-9636
E-mail: info_nj@fitzmill.com

Fitzpatrick Europe N.V.
Entrepotstraat 8
B-9100 Sint-Niklaas, Belgium
Phone: +32 (0)3 7777208
Fax: +32 (0)3 7661084
E-mail: info@fitzpatrick.be

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