Packaging your pallet loads secures, stabilizes, and protects them during storage and shipping. After describing common pallet-packaging methods and their pros and cons, this article explains how to select a method based on its total ownership value.

Loading powders or granules into small bags, bulk bags, boxes, or other packages, stacking the packages on pallets, and then tightly wrapping the pallet and packages together to form a unitized load before shipping is a common process in bulk solids plants. When you’re designing, upgrading, or refurbishing your packaging line or distribution center, the pallet-packaging method you choose may not seem like a critical factor in the project’s success. Yet the choice you make can greatly affect the packaging operation’s profitability and the pallet loads’ performance throughout the distribution chain. To select the right pallet-packaging method for your application, you need to consider its cost of ownership.

Before discussing what cost and benefit factors go into this evaluation, let’s review common pallet-packaging methods, as shown in Figure 1: spiral stretch-wrapping, heat shrink-hooding, and stretch-hooding.

**Spiral stretch-wrapping**

Spiral stretch-wrapping (Figure 1a), the most widely used method for packaging pallet loads, stretches cast or blown linear low-density polyethylene (LLDPE) film around the pallet load. The film can be wrapped in any of several patterns and number of layers to suit the pallet load’s stability and protection requirements.

**Equipment and materials.** Stretch-wrapping film and stretch-wrapping equipment — ranging from semiautomatic low-speed turntables to fully automatic high-speed rotary-arm and satellite machines — is available from a large number of distributors and manufacturers. The semiautomatic equipment consists of a turntable and a film dispenser holding a film roll. The pallet is placed on the spinning turntable, and the operator attaches the film end from the roll to the pallet load. As the turntable spins the load, the dispenser moves vertically to wrap the pallet load, and the operator cuts the film and attaches the film tail to the load. The operator can place a top sheet on the load, if required for added load protection. This equipment operates at up to 35 pallet loads per hour, depending on the wrapping pattern and load height.

With the automatic rotary-arm (also called overhead-straddle) equipment or satellite (also called rotary-ring) equipment, the operator starts the equipment, or it starts automatically via a signal exchange between the palletizer and the stretch-wrapping equipment. A film dispenser that’s been preprogrammed with a wrapping pattern attaches the film end to the pallet load. With the rotary-arm unit, the arm spins around the stationary pallet to wrap the load with the desired pattern; with the satellite unit, the film dispenser, which is mounted on a ring-shaped frame suspended above the load, descends and ascends while circling and wrapping the load. Both rotary-arm and satellite machines can automatically cut and attach the film tail and can be equipped with an automatic top-sheet dispenser and automatic film-roll change and corner-board-application equipment. Fully automatic equipment can wrap up to roughly 100 pallet loads per hour, depending on the model, wrapping pattern, and load height.

Stretch-wrapping film can be prestretched from 60 to 400 percent before wrapping the load, depending on the equip-
ment type; the operator adjusts the machine settings to achieve the desired percentage. However, prestretching more than 250 percent provides little extra yield because the film will be stretched to a narrower band.

While the stretch-wrapped pallet load often has a top sheet to protect it during storage and transport, this sheet can’t provide adequate protection during outdoor storage and shipping on open-flatbed truck trailers and open railcars in inclement weather.

**Pros and cons.** While stretch-wrapping provides cost-effective pallet packaging in some applications, the resulting pallet loads can be insufficiently stable and poorly protected:

- Because the load is often wrapped in multiple layers of relatively narrow film bands, there’s little vertical holding force to unitize the pallet and the packages loaded on it, limiting the load’s stability.

- While the stretch-wrapped pallet load often has a top sheet to protect it during storage and transport, this sheet can’t provide adequate protection during outdoor storage and shipping on open-flatbed truck trailers and open railcars in inclement weather. In fact, to adequately protect the stretch-wrapped loads, you may need to build additional warehouse capacity or buy protective tarps for shipping in open carriers, thus incurring additional costs.

- During shipping, the friction between the films covering adjacent pallet loads can cause tears and loosen film tails, compromising the pallet load’s integrity.

Stretch-wrapping film’s physical properties also present some challenges:

- While stretch-wrapping film is only 0.6 to 1.2 mils thick, the overlapping film layers can obscure the package labeling, preventing accurate bar-code scanning and making it difficult for customers at retail outlets, such as home stores, to read the labels.

- The overlapping layers tend to trap moisture, which can lead to mold and algae formation, and the film typically includes a “cling” additive that attracts dirt and dust; both can contaminate the packaged product.

- Stretch-wrapping film is available only in relatively low-volume rolls, so the stretch-wrapping equipment requires fairly frequent roll changes that reduce the equipment’s uptime and increase operating costs due to the labor required to change the rolls.
• It can be difficult to accurately forecast and control the cost of the stretch-wrapping film because the operator often chooses the film’s pre-stretch percentage and number of film layers. Furthermore, due to the limited stability and protection provided by stretch-wrapping, other packaging materials may be needed (such as optional hot melt, cold adhesives, and grip sheets), adding to the total packaging costs.

Stretch-wrapping equipment also has many wear parts that require regular inspection and service.

Heat shrink-hooding

In heat shrink-hooding (Figure 1b), gusseted tubing made of coextruded polyethylene film is cut and sealed to form an open-ended bag, the bag is placed over the pallet load, and then the bag is heated, which shrinks the film and forms a tightly sealed hood over the load.

Equipment and materials. The equipment is available in semiautomatic low-speed and automatic medium- and high-speed models. With a semiautomatic model, the operator places the premade shrink bag over the pallet load, and then the equipment applies heat to shrink the bag onto the load, achieving a pallet-packaging rate of up to 20 pallet loads per hour. With an automatic model, no operator is required. This equipment can have one or two stations (in the latter case, one for placing the shrink bag and the other for shrinking it onto the load). An automatic one-station machine operates at medium speeds of up to about 60 pallet loads per hour; the two-station version operates at high speeds of up to 100 or more loads per hour.

Older semiautomatic and automatic models often use a bell-shaped oven to shrink the film; the pallet load can be moved into the oven, or the oven can be lowered over the load. Newer equipment typically uses a ring- (or frame-) type heater that’s moved down over the pallet load to shrink the film, as shown in Figure 1b. The latter provides better heat control for the shrinking step and provides a bottom shrink for the pallet load by lifting the pallet and sucking the open ends of the film bag under the load before shrinking the film, helping to better unitize the pallet load. Both the bell-shaped oven and ring-type heater typically apply hot air to shrink the film; the heat source for the air can be a natural gas or liquid propane gas burner, infrared heater, or electric hair-dryer-type heater.

Pros and cons. The heat shrink-hooding method provides very good pallet-load stability and protection for nonsettling pallet loads. It’s particularly well-suited for securing a load with a substantially smaller footprint than the pallet, because the film shrinks tightly around the load’s contours. The clear, one-layer shrink hood doesn’t obstruct package graphics and prevents barcode-scanning problems.

However, shrink-hooding isn’t as suitable for pallet loads containing bagged products that settle, such as fertilizers and polypropylene pellets: The shrink hood can’t retain its tension around the load when these products settle, causing the load to become unstable.

Shrink-hooding also has high operating costs, because of several factors:

• Because the equipment shrinks rather than stretches the film bag, the bag must have a larger preshrink circumference than the pallet load’s perimeter so that the equipment can place the bag over the load before heat is applied, increasing the amount of film required compared to stretch-hooding (described in the following section). Even though the heat-shrink film costs less per pound, the cost per pallet load is far higher due to the much larger film bag needed.

• The heat for shrinking not only consumes a lot of energy, but carries a fire risk, which can often increase a plant’s insurance premiums.

• The shrink-hooding equipment has many wear parts and fairly high maintenance requirements.

Stretch-hooding

Stretch-hooding (Figure 1c) uses gusseted tubing that is made of low-density polyethylene (LDPE)-LLDPE-blend film with ethylene vinyl acetate (EVA) and has a circumference smaller than that of the pallet load. All equipment for this method is automatic. The equipment measures the pallet load’s height and dispenses the required amount of film, seals the tubing’s top opening to form a hood, gathers up the hood, stretches the hood to the load footprint’s dimensions (using crimping bows, as shown in Figure 2), pulls the hood down over the pallet load, and releases the
film so it snaps back under the pallet. This produces a tight-fitting, clear, one-layer hood that unitizes the pallet load.

**Equipment and materials.** Some models of automatic stretch-hooding equipment can achieve rates of more than 150 pallet loads per hour. In applications requiring less protection and stability, the equipment can be programmed to allow the tubing end to remain open, forming a nonsealed sleeve rather than a closed hood, thus reducing film consumption. The controls on stretch-hooding equipment provide an intuitive graphic interface for operators, as shown in Figure 3. This interface simplifies equipment operation and troubleshooting for operators of various experience levels and cultural and linguistic backgrounds and for operations with high labor turnover.

**Pros and cons.** Automatic stretch-hooding equipment has a higher purchase cost than semiautomatic stretch-wrapping equipment. However, when comparing stretch-hooding equipment with fully automatic stretch-wrapping equipment, the cost difference in recent years has become much easier to justify because it can be as low as 10 to 20 percent depending on equipment options. Shrink-hooding equipment remains the most expensive option, both in terms of equipment cost and operating cost. Stretch-hooding is becoming more popular not only because the equipment cost has become more competitive with that of stretch-wrapping, but also because stretch-hooding provides better value in terms of speed, versatility, reliability, operating costs, and pallet-load performance during shipping and storage and at the point of sale in retail outlets:

- Stretch-hooding equipment is faster than automatic stretch-wrapping and automatic shrink-hooding equipment.
- Stretch-hooding equipment controls provide an intuitive graphic interface for operators, simplifying the equipment’s operation and troubleshooting.
- As the pallet load enters the equipment, the stretch-hooding machine automatically measures the load’s height, ensuring that only the precise amount of film required to cover the load is dispensed.
- Recently developed stretch-hood films can be prestretched more than 80 percent, and this combined with a film thickness down to 1.6 mils makes the film’s cost per pallet load comparable to that of stretch-wrapping film.
- Stretch-hooding’s energy consumption is very low because the film doesn’t require heating. Some equipment uses servo drive technology rather than traditional gear motors, not only further reducing energy costs, but reducing required maintenance and operating noise levels as well.
- Because the stretch-hood film consistently maintains its stretched tension on the pallet load, it’s particularly well-suited to protecting bagged products that tend to settle.
- Because it’s not possible to remove a package from a stretch-hooded pallet load without tearing the film, stretch-hooding provides ready evidence of tampering, unlike stretch-wrapping.
- The smooth film surface on a stretch-hooded pallet load makes it easier to load into and unload from truck trailers and other carriers than a stretch-wrapped load.
- The clear, one-layer stretch-hood film allows much better product recognition at the point of sale than multilayer spiral stretch-wrapping film and allows accurate barcode scanning. The stretch-hood film itself can also be printed with advertising and handling instructions.
These stretch-hooded pallet loads are well-protected for outdoor storage.

The high quality of stretch-hood film allows a single film-hood format to be used with multiple pallet sizes, with certain limitations. Be aware, however, that the total film cost will be lower if each pallet size has a dedicated hood format. [Editor’s note: For more information on this, contact the author.]

**Calculating the cost of ownership**

When evaluating pallet-packaging methods, you need to go beyond comparing equipment purchase costs. Film and labor costs also significantly affect the equipment’s cost of ownership and, thus, your return on investment. The following sections outline these costs for each method.

**Equipment cost.** Spiral stretch-wrapping equipment is available in models for every budget, with semiautomatic or automatic operation in several speed ranges. Prices for semiautomatic low-speed turntable models start below $10,000, and automatic high-speed rotary-arm or satellite models can cost $120,000 or more.

With heat shrink-hooding equipment, semiautomatic low-speed models typically start at $50,000 and automatic high-speed models can cost $200,000 or more.

Automatic stretch-hooding equipment ranges from about $150,000 for models providing a single film-hood format to $200,000 or more for those providing multiple formats. While this cost may seem high, in a higher-output application the faster speed of one stretch-hooding machine can allow it to replace several stretch-wrapping units.

**Film cost.** For an application where pallet-load stability and protection are secondary requirements, stretch-wrapping’s film costs can be very low. This is because of the stretch-wrapped load’s minimal film thickness and the film’s high prestretch percentage compared with that of the other pallet-packaging methods. But in applications where stability and protection are critical, requiring multiple layers of film and a top sheet for protection, the film cost per pallet load greatly increases.

Shrink-hooding’s film cost is significantly higher than that of stretch-wrapping or stretch-hooding because the film hood must be oversized to pull it over the load before shrinking. In fact, the film cost per load for shrink-hooding can be more than 40 percent higher than that for stretch-hooding. Shrink-hooding also has a high energy cost.

The film cost per pallet load for stretch-hooding is now comparable with that of stretch-wrapping for applications requiring moderate pallet-load stability and protection. This is because recently developed stretch-hood films are much thinner and have much higher prestretch percentages than were previously possible.

**Stretch-hooding has the lowest labor cost of the three methods.**

**Labor cost.** Stretch-wrapping equipment is fairly simple to operate and maintain, and semiautomatic models in particular require little operator training. However, maintenance costs for both semiautomatic and automatic models tend to be high because they have many moving parts. At higher pallet-packaging rates, the relatively low-volume stretch-wrapping film rolls must be replaced fairly often, which adds labor cost for models that don’t provide automatic roll-changing. Yet machines that do provide this option are more complex, potentially leading to higher maintenance costs. Additional labor is required to cover stretch-wrapped loads with tarps if the loads will be stored outdoors or shipped in open carriers; climbing onto carriers to apply the tarps can also be hazardous for workers.

Shrink-hooding equipment has more wear parts that require regular replacement, so it requires more maintenance labor than stretch-wrapping or stretch-hooding machines.

Stretch-hooding has the lowest labor cost of the three methods. Changing film rolls is required much less often because the rolls are available with up to 10 times the film quantity of a typical roll of stretch-wrapping film. The process for changing stretch-hooding film rolls is also very simple. The end of the old film is simply spliced together with the beginning of the new film, typically taking no more than 10 minutes to return the machine to operation.
Unlike stretch-wrapping equipment, stretch-hooding equipment doesn’t require the operator to make adjustments to machine settings to alter the film prestretch percentage or wrapping pattern. Because stretch-hooding machines have fewer wear parts than stretch-wrapping and shrink-hooding machines, they also require less maintenance. The top and sides of stretch-hooded pallet loads are better protected than stretch-wrapped loads, so no additional labor is required for covering the loads with tarps.

Making your choice
To choose the right pallet-packaging method for your application, you must evaluate each method’s cost of ownership. But you also need to consider how the method you choose will affect your product’s performance throughout the distribution chain. When your product leaves your plant in the form of packaged pallet loads, the product is in its highest-quality, value-added state — and it should arrive at your customer’s dock in the same condition.

When choosing a pallet-packaging method, follow these rules of thumb: If you have a low-throughput application where pallet-load stability and protection are secondary concerns compared with the equipment’s purchase cost, stretch-wrapping is an attractive alternative. An example would be a small-scale bagging and palletizing operation in a sand and aggregate plant that delivers most of its product in bulk to local customers. But if you have a high-throughput application and need more production-line efficiency, more stable pallet loads that have more protection against the elements, and better recognition of your product at the point of sale, stretch-hooding will provide the best combination of ownership value and packaging performance.

For further reading
Find more information on palletizing in articles listed under “Bagging and packaging” in Powder and Bulk Engineering’s comprehensive article index (in the December 2010 issue and at PBE’s Web site, www.powderbulk.com) and in books available on the Web site at the PBE Bookstore. You can also purchase copies of past PBE articles at the Web site.

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