

Form-fill-seal machines for bulk solids — vertical or horizontal?

Graham Rawlings Concetti

A variety of factors need to be considered when choosing form-fill-seal packaging equipment. This article describes vertical and horizontal form-fill-seal machines and discusses some of the considerations that might impact the purchasing decision when choosing between them.

Form-fill-seal (FFS) machines are the ubiquitous workhorses of polyethylene bag filling, the preferred packaging solution for an infinite variety of loose bulk solid materials. FFS machines work by *forming* the bag from a reel of film, *filling* the bag, and then *sealing* it closed. Early vertical machines were patented in the 1930s, but their widespread use really started around the 1950s with rising demand for automation, especially for high-speed filling of small retail packs.

Later, to meet the need for heavier, more industrial and business-to-business (25- to 100-pound) bag sizes, horizontal FFS machines appeared. These aren't to be confused with other horizontal systems sometimes also known as "flow wrappers."

But for manufacturers of bulk industrial materials, there's no escaping the fact that many vertical FFS machines, with their retail pack origins, are often better suited to the easier conditions of a confectionery plant than being pressed into service in a bulk chemical factory, as they sometimes are.

Horizontal and vertical FFS machines achieve the same result, but they use quite different methods:

- Vertical FFS machines create a bag from single-wound flat film fed from a reel over a special forming shoulder and steel forming tube. The film is overlapped around the forming tube and heat-sealed longitudinally to create a tube from the polyethylene film. Horizontal top and bottom seals are made simultaneously, and the filled bag is then separated from the film tube.
- Horizontal FFS machines use already formed tubular film (with or without gussets) wound onto a reel. The machine cuts and forms the bag's bottom

seal, then moves the bag horizontally through the machine, filling and closing it at separate stations along the way.

Recent improvements in film technology as well as health and environmental issues are opening up other industries traditionally associated with paper bags, especially paper valve bags, to the use of FFS machines. Some of these improvements include reduced dust when filling and better recyclability when compared to combination polyethylene-paper bags. Cement and cementitious premixes, for example, are increasingly packed into polyethylene using innovative seams that allow air to escape but prevent water ingress, giving extended shelf life and even allowing uncovered outside storage of these moisture-sensitive materials.

Factors to consider

Now we'll look at some simple guiding principles that can influence your decision when choosing between a vertical and a horizontal FFS machine. (Note: these are more general principles than hard and fast rules. Talk to suppliers for specific information and test your material to make sure you get the best machine for your needs.)

Vertical and horizontal FFS machines each have their pros and cons:

Package size. Vertical FFS machines, with their retail packaging background, dominate the smaller pack sizes but can also extend right up to the largest. Horizontal FFS systems are usually limited to larger packs, mainly aimed at the business-to-business market, but these machines also are used in the retail sector for heavier packs of construction materials, for instance.

In this context, small is less than 12 inches face width and exclusively vertical FFS territory. Wider and up to a typical maximum face width — excluding gussets — of around 18 inches, a choice of the two systems is available.

As for bag length, with a break-point of around 22 to 24 inches, vertical FFS machines tend to dominate for shorter bags, while horizontal systems often start at this point but go up to as high as 40 inches or more in length.

Packing speed. Vertical FFS machines often have an impressive packing rate, but don't forget that this is often based on very small amounts of a few ounces or a few pounds and filling relatively easy granular materials. When filling larger amounts, particularly of fine powders, speeds typically come down to more modest levels.

In fact, for bulk quantities up to 100 pounds, horizontal FFS systems usually have the edge on speed simply because multiple steps are taking place simultaneously. One bag is filled while the next is being cut and bottom-sealed and a third bag is being closed after filling. With free-flowing granular materials, like pelletized plastics for example, a horizontal machine can reach speeds of more than 2,000 bags per hour. A conventional vertical machine would perhaps reach half of that or, at best, slightly more.

Most operators outside the plastic pellet industry, however, typically aren't concerned with outright speed. But, the horizontal FFS machine's separation of simultaneous activities also offers higher speeds and practical benefits when filling materials that are less easy to handle.

Material properties. It goes without saying that either vertical or horizontal FFS machines can easily handle clean, dry, free-flowing granular materials. The problem is that many bulk solids are much more difficult to handle.

Many materials need compacting before closing the bag mouth. When dispensed by gravity, most materials don't immediately settle to take up the minimum volume possible. Fine powders, in particular, entrain air, while larger irregularly sized materials may need some vibration for efficient bag filling and closing. For optimum output, the bag size should fit the material density as it is just before closing. A bigger bag can be filled and closed faster but costs more and loses shape when the material naturally compacts later. This issue affects palletizing and transportation safety as well as aesthetics.

Compacting bag contents as much as possible before closing reduces the bag size, and horizontal machines can offer some advantages. Two methods normally used are bottom vibration, or "possing," and deaeration, which involves inserting vacuum or porous probes directly into the material. These methods are more difficult to incorporate into a vertical FFS machine. When using a horizontal system, accessing the bagged material after filling is relatively easy and can be done through the unit's filling spout or by incorporating additional processing steps in the system to assist in material settling or densifying prior to closing the bag. Additionally, the horizontal FFS machine doesn't sacrifice output since these actions can take place simultaneously with filling the next bag.

Handling dusty or powdery materials can impact sealing reliability. Dust contamination can weaken the bag seal and lead to unacceptable failure rates. On vertical systems, the longest seal is made in order to create a tube of film so avoiding any contamination here is important. The same goes for the top seal area since forced cleaning after filling is far more difficult inside the tube.

Horizontal FFS machines require no longitudinal seal since the film arrives as a tube already on the reel. Moreover, the top seal area is freely accessible after the bag is closed but before it's sealed. Many suppliers offer integrated air-blast cleaning systems to ensure that contamination doesn't compromise seal strength, permitting more reliable sealing on dusty and other difficult materials.

Film size flexibility. Both vertical and horizontal FFS machines can accommodate some variation in film widths within the limits of the machine. On vertical machines the forming shoulder and tube need to be changed for every different film size. Changing forming parts on small vertical FFS systems is a matter of a few minutes but on larger film and pack sizes these parts may be large and cumbersome so changing can be time-consuming.

For horizontal machines, changes in film size can be made without any change parts — again within limits — so switching from one film size to another can be a relatively quick operation.

Note: The actual variation in film width will not be infinite on any machine so some rationalization may be needed if there's a wide range of formats. Using pillow sacks on smaller sizes and gusseted bags on larger ones can extend the range. Ultimately, however, considering two machines may be necessary.

Cost. Vertical FFS machines are usually the lower-cost solution. Horizontal FFS machines tend to be larger, marginally more complex, and more expensive, but they tend to be able to handle more rugged applications and have lower consumable costs.

When comparing systems, the whole cost of ownership needs to be considered. The film overlap required for a vertical FFS machine's longitudinal seal requires perhaps 1 to 1.5 inches of additional polyethylene. If you use 14-inch-wide pillow bags, for example, this would add about 5 percent to film costs over the entire life of the machine. On a 16-inch-wide bag with 4-inch gussets, the additional cost would be slightly less, at about 3.5 percent, but still significant.

Depending on the application and the production volume, it's not unusual for an FFS machine, even on bulk materials, to annually consume polyethylene film equivalent to the machine's own capital cost or more.



A horizontal form-fill-seal machine filling 66-pound packages of dry concrete. Innovations in film technology are allowing an increasing number of materials to be packaged in polyethylene.

Over a machine's 20-year life span, generating a 5 percent film savings by avoiding the overlap would pay for the machine itself.

The strength, versatility, and water-resistant qualities of polyethylene film have always been recognized, but the recyclability and latest developments in film technology are creating opportunities in new markets. Choosing the right machine is key to maximizing those opportunities.

PBE

For further reading

Find more information on FFS machines in articles listed under "Bagging and packaging" in *Powder and Bulk Engineering's* article index in the December 2017 issue or the Article Archive on *PBE's* website, www.powderbulk.com. (All articles listed in the archive are available for free download to registered users.)

***Graham Rawlings** (marketing@concetti.com) is a senior packaging specialist for Concetti SPA in Italy and the company's former UK sales manager. He has more than 30 years of experience in European bag filling and palletizing.*

Concetti North America

Hoschton, GA

844-601-5475

www.concetti.com