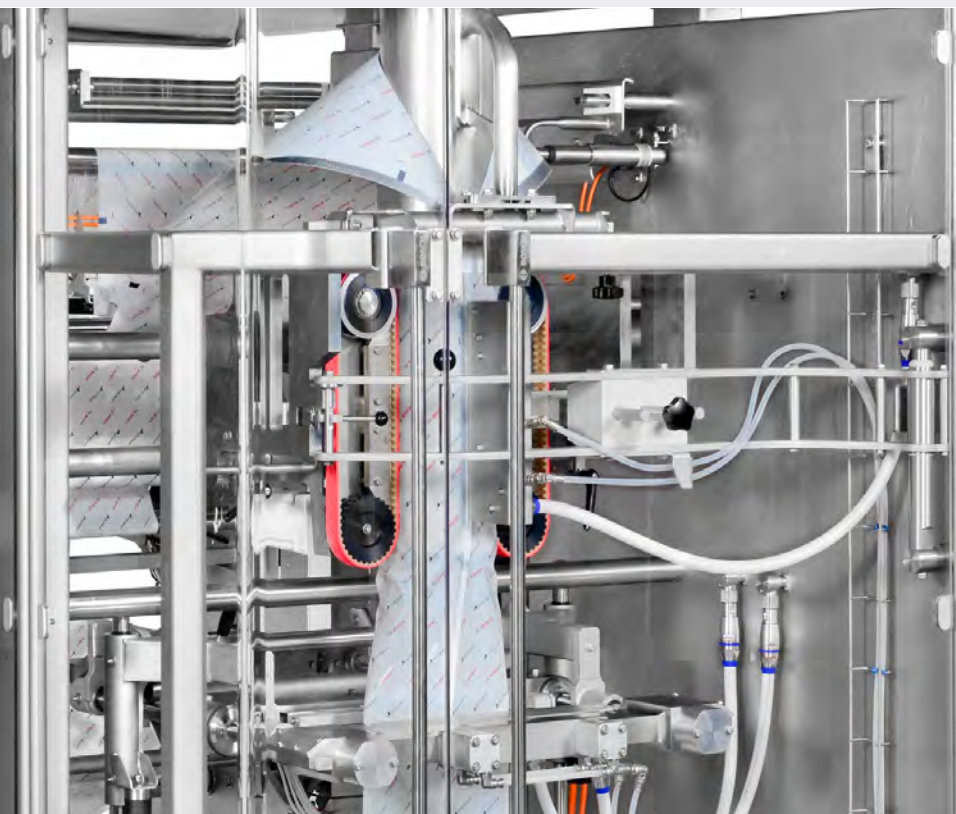




Guide to Vertical Form-Fill-Seal Baggers

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INTRODUCTION

Packaging machines are fascinating. They can be used to pack a wide range of products in widely ranging ways. This brochure is about only one of the many types: the vertical form, fill, seal machine, or the VFFS machine. The information you will find offered here is essential if you want to start working with VFFS machines. And for anyone who works with VFFS machines, it can be worthwhile or even just fun to know a bit more about everything they can do, or how to use them to their optimum capabilities.

Overview

In this brochure, you can read all about the key capabilities of VFFS machines, the different bag shapes, the parts of VFFS machines and their function in bag packaging, and about how to optimize your machine settings. This knowledge will expand your understanding of the machines you work with or will be working with, and you will be better informed if you are considering purchasing a new machine. In addition, this brochure makes other literature about the subject much easier to understand.

Chapter 1 and beyond

If you are completely unfamiliar with VFFS machines, read the first two chapters in particular. Otherwise, if you are already familiar with VFFS, you can easily skip these chapters. The glossary at the back of this brochure is also the index, rendering it easy to find all the subjects discussed.

Acknowledgements

Bosch gratefully acknowledges the contribution of Gerard Verduyn as the primary author of this book.

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1. VFFS Machines?

Vertical form, fill, seal machines are extremely flexible machines. Widely ranging products can be packed efficiently and effectively, and can be attractively presented – from your daily coffee to hand-crafted tortellini, from a selection of fresh vegetables to frozen shrimp. And of course, insecticides, detergents and marbles are also packed in bags.

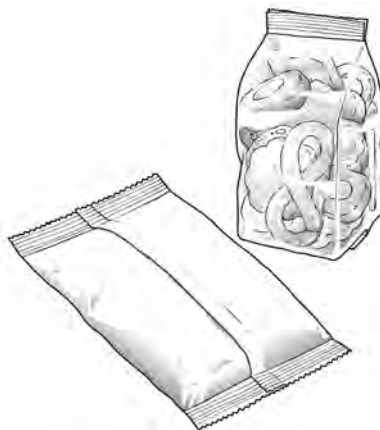
The first VFFS machines were built in the middle of the last century. The development of these machines, partially made possible by the introduction of plastic packaging materials, was an effective answer to the increasing demand for the mechanization of all possible aspects of the production processes.

Thousands

Over the past decades, the VFFS machine has become the machine of choice for many different product types. We can only speculate about the number of machines in use around the world. It is clear that hundreds of VFFS machines are sold annually. Practical knowledge, based on our wide experience with the many possibilities these machines offer, suggests there are thousands of these machines in operation around the world.

Broadly deployable

The broad use of VFFS machines is simple to explain. To start with, one single machine can be used to produce wide-ranging bag shapes. This is made possible due to a large variety of simple-to-exchange parts such as forming shoulders and forming tubes. Chips, for example, are usually packed in a simple, brightly colored, pillow-shape bag, while breakable cookies are presented in a deluxe, transparent bag with a block bottom – and both bags can be produced by the same machine.



Chip bag and deluxe, transparent bag with a block bottom for cookies.

Low cost

A second factor is the low price of this type of packaging. The machines allow for high packaging speeds, and machines that are well-selected, and set optimally and maintained can continue to operate uninterrupted for a long time.

Materials

There is a huge variety of packaging materials that can be processed on VFFS machines: however, virtually every product has a number of unique requirements. Screws should not poke through the packaging, salty snacks have to remain crispy as long as possible, and the aroma of the coffee cannot be lost, just to name a few obvious examples. In addition to single-layer packaging materials, laminates are often used, in which each layer has a specific function attuned to the product.

Air-tight

A frequently occurring requirement is that the product requires an air-tight package. An additional level of protection occurs in a modified atmosphere package “MAP” where the air in the packaging is replaced by an inert gas that combats oxidation and extends shelf life.

Printing

Both printers and labelers can be added to a VFFS machine, separately or in combination. A printer (or date coder) is usually supplied to print a “date used by” for perishable products or other product specific information. A labeler is used to apply label stock that can be pre-printed or printed by the labeler within the VFFS machines.

Extras

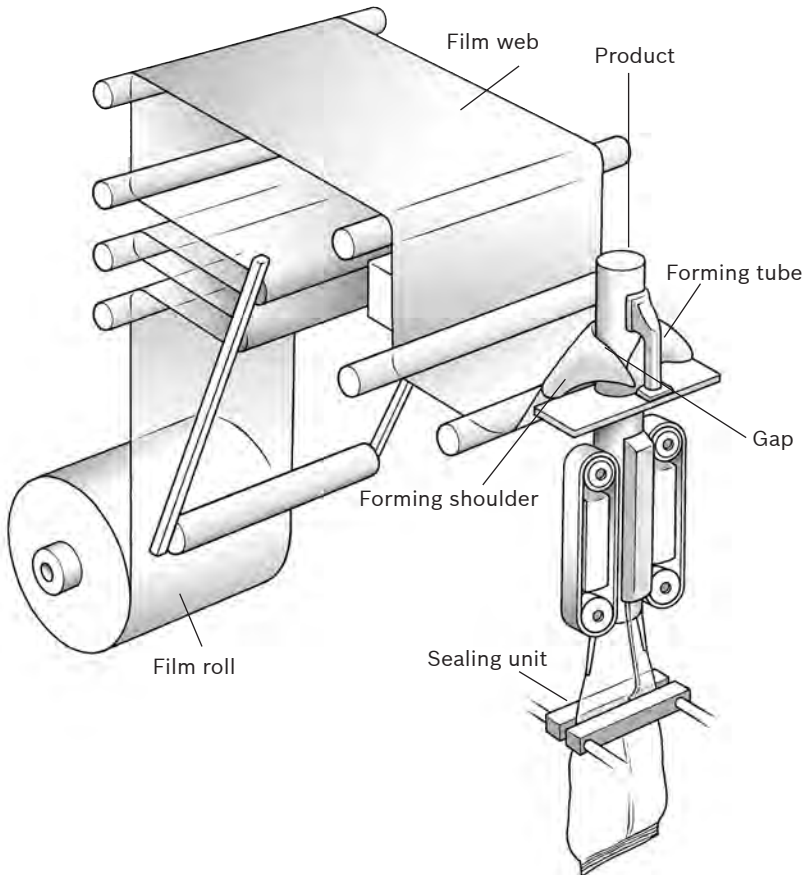
In addition to labels, other extras can also be added to packaging by VFFS machines, varying from techniques that make the packaging easier to open to aids that make it possible to reclose bags multiple times.

Efficient output

The examples that are named in this introductory chapter are just a few of the hundreds of possibilities that the VFFS machines offer. It is especially impressive that these machines, no matter what the packaging requirements are that have to be met, are usually able to provide a reliable and efficient output even at a high speed.

2. A BROAD OVERVIEW

In order to make the later chapters in this book more understandable, in this chapter you will find a general description of the most important elements and functions of VFFS machines. A brief introduction of the various bag types and the packaging materials used for them is also included here. All of these subjects will be discussed in greater detail later.



Vertical packaging machine

VFFS machines are suited to a broad range of products that can be divided into the following four main groups:

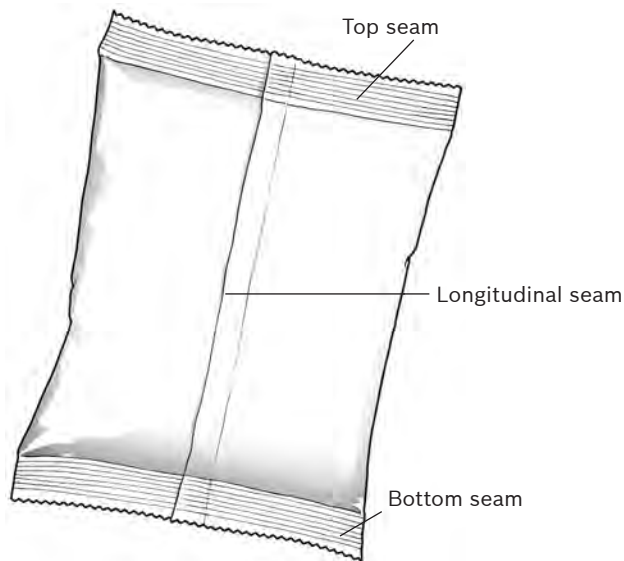
- bulk goods, varying from nuts and cookies to bolts and screws;
- powders, such as ground coffee and dehydrated milk;
- grains or granulate, such as detergent;
- liquids: usually one-time (portion) packages such as ketchup, mayonnaise, salad dressing or bath gel, for example.

Bag Making

In theory, all vertical packaging machines work the same. A flat web of film, originating from a large roll of film at the start of the machine, is shaped into a tube. This tube is closed at the bottom: this is the bottom of the new bag. As soon as the product is dispensed into the bag, the top side is also closed. The time and steps that are needed to make one bag are collectively called a machine cycle.

Three seams

A bag produced in this manner theoretically has three seams. The longitudinal seam is the seam that runs down the length of the bag: here the left and right side of the originally flat film web come together. The bottom seam closes the bottom of the bag; the top seam closes the top. Both of these are also referred to as the cross seams.



The three seams of a bag

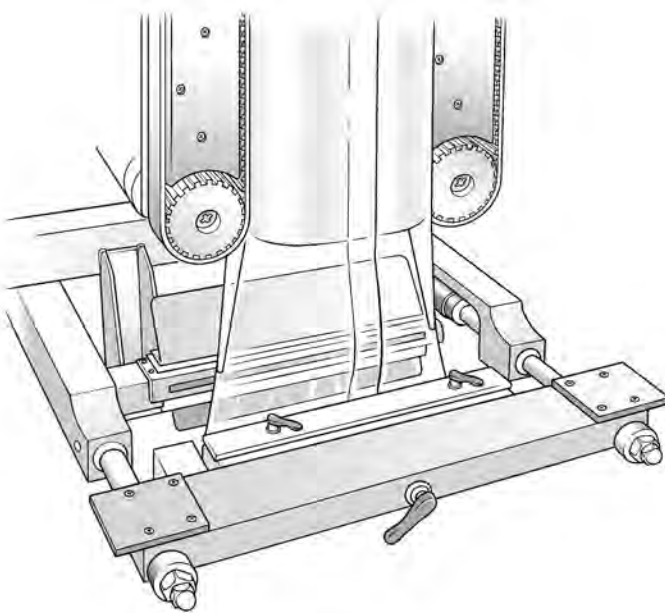
Sealing

The seams are closed by sealing. To do this, the packaging material is compressed and heated briefly, and the sealing medium (usually polyethylene) melts. As soon as the sealing medium has cooled off enough, the seams are stable. This occurs in milliseconds.

Bottom, top and cutting

The sealing unit, at the bottom of the forming tube, contains four sealing bars. The lower two sealing jaws form the top seam of the bag that has just been filled. At the same time, the upper two jaws closer to the forming tube form the bottom seam of the next bag. The blade that cuts and separates both the bags is located between the two sets of sealing jaws.

The film material is compressed together and heated by the sealing jaws.



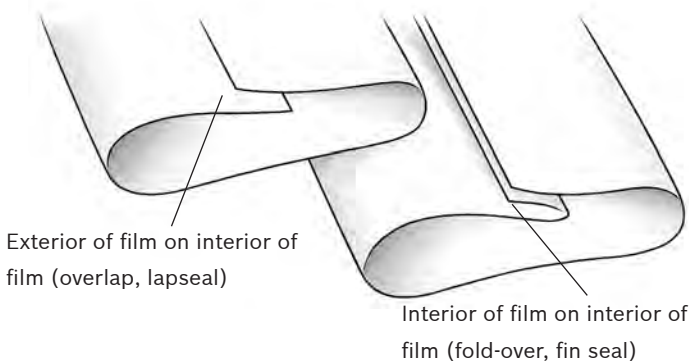
The film material is compressed together and heated by the sealing jaws

Forming tube and forming shoulder

Every packaging machine can form various different bag sizes, fill them and seal them. The size and shape of the bag are determined by two important components: the forming tube and the forming shoulder. The web of film is pulled over the forming shoulder, so that the material around the forming tube is shaped from a flat film to a tube. The shoulder and tube are collectively called the forming parts. Every bag width requires its own forming parts.

Overlap seam or fold-over seam

There are two types of longitudinal seams. In the overlap seam or lap seal one edge of the web of film is placed over the other edge, so that the material overlaps. In this way, the inside of the first edge is sealed to the outside of the other edge. With a fold-over seam or fin seal, one edge of the web of film is folded over, so the inside of the one edge is sealed to the inside of the other edge. The choice between these seams is determined by the (structure of) packaging material, such as is discussed on pages 28-29.



Dispensing

In order to ensure that the correct quantity of product is always packaged, a doser is required. Depending on the product, the doser works on the basis of a filling weight per bag (filling scale) or on the basis of a certain volume per bag (dispensing cup or auger dosing). For liquids, a special pump is used that dispenses a certain amount of liquid for each package. When packaging a certain number of product units per bag, a counting machine is used.

Bag types

In principle, VFFS machines produce three types of bags. Within these main types, there are countless possible variations in model, length and width.

- Products such as fresh vegetables, chips or candy are usually packaged in a pillow bag. This bag shape is also called a flat bag.
- A common variation on the pillow bag is the gusset bag and it is usually presented in combination with a carton or box around it. It is commonly used for packaging breakfast cereals.
- A bag that can stand up with a flat bottom, often referred to as a block bottom bag and is used for cookies or coffee, for example.
- The doy bag, is another form of stand-up bag, and is often referred to as a stand up pouch.



Pillow bag



Block bottom bag



Gusseted bag



Doy bag

Film material requirements

Nearly every product influences the selection of packaging material.

Combined with the ever increasing demands that consumers, organizations and governments place, there are now countless different packaging materials. Some film materials consist of a single layer (monofilm); but usually materials consisting of multiple layers (laminates) are used.

Monofilm

Polyethylene is often used as a sealing medium. In addition, this stretchable material is also used as a monofilm. It is not air-tight but it is moisture proof, rendering it suitable for packaging frozen products, cereal, for example, that do not emit any odor and that cannot spoil due to oxygen exposure. A second type of monofilm is polypropylene, a material that can be sealed reasonably well. It is very clear and easy to tear open, which explains why it is used for transparent candy packages, among other things.

Materials and sealing systems

Laminates are sealed by briefly pressurizing them with heat (heat sealing). Polyethylene is an ideal sealing medium because it has a relatively low melting point. This low melting point does mean that bags made entirely of polyethylene must be sealed in a different way. Therefore, pure polyethylene is sometimes referred to as non-heat sealable material although it is in fact sealed using heat. Different sealing systems are discussed in Chapter 4.

Horizontal machines

In addition to vertical machines, there are also horizontal packaging machines, that work in roughly the same way. Horizontal machines are used for example for packaging candy bars, granola bars, individually packed candies and trays of cookies or other sweets. The product is not dropped from above into a film web formed into a tube, but is slid into it horizontally or placed on it (please see Bosch's "Guide to Flow Wrapping" for more information on this type of machine).

3. FROM FILM TO BAG

In the packaging machine, a flat web of film is made into sealed, filled bags. This chapter follows the course of the film roll, paying attention to such elements as the different types of seams, the forming of the bag, the transport of the film through the machine and the machine speed that is partly contingent on the preceding factors.

With the machines discussed in this book, three basic bag shapes can be made. There are countless possible variations of these basic models.

The Pillow bag

The pillow bag or flat bag is the simplest bag shape. To prevent pleats in the cross seams, there are bag spreaders at the bottom of the forming tube (see page 27).

The gusset bag

The gusset bag, a variation on the pillow bag, is generally used for products that are then packaged in a cardboard box, such as breakfast cereal. In this type of bag, extra packaging material is folded inwards on both sides. This side fold makes the bag less wide, but gives it extra depth during filling, so that the space in the cardboard box can be better utilized.

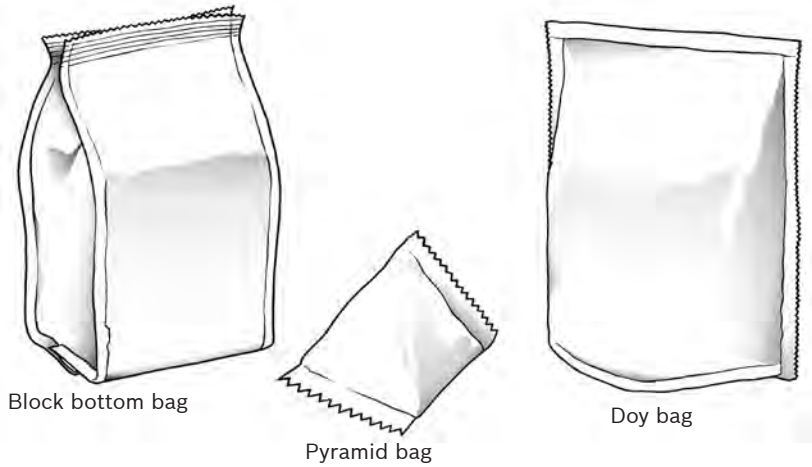
The bag with a block bottom

The bag with a block bottom or stand up bag, in which coffee or cookies, for example, are packaged, is yet another variation of the gusset bag. At the bottom of the forming tube, a mouthpiece is attached that extends from the round shape of the forming tube to the rectangular form of the bottom of the bag with a block bottom. Some manufacturers use a rectangular forming tube instead of a round one (see page 25).

Other bag shapes

All other bag shapes that can be made on these machines are derived from the above basic shapes. Some examples:

- corner seal- or quad seal bags, known from such products as coffee pods;
- pyramid bags, in which gummies are packaged, for example;
- doy bags sealed on three sides with a block bottom (doypacks) such as those used for 250-gram packaging of candy.



THE FILM ROLL

The film roll forms the basis of the packaging process. A full roll usually has a diameter between 350 (14") and 650 mm (25.5"). At such a size and corresponding weight, these rolls are still manageable. In some cases, rolls with a diameter up to 1000 mm (39.5") are used. A weight of over 80 kilograms (176 lbs) is not out of the ordinary.

Figures

The number of meters of packing film with a certain diameter is contingent in part on the film thickness. At an average thickness, there is over 6500 meters (25,500") of film on a roll of 650 mm (25.5"). At a bag length of 140 mm (5.5") and a machine speed of 80 bags per minute, using such a roll, one can operate continuously for over 9.5 hours. If all other factors remain the same, a roll of 450 mm (18") is sufficient for approximately 4.5 hours. Smaller rolls must be changed more often, which negatively influences productivity. On the other hand, smaller rolls are easier to handle.

Core

The film material is wound around a cardboard core on the roll. Normally, the core diameter is approximately 75 mm (3"). Rolls with a diameter over 650 mm (25.5") use a core that is twice as large. If the core diameter is too small, too much tension is placed on the last meters of film: this is the same tension you feel when you try to wind a piece of paper around a pencil. In a packaging machine, such tension creates a strong tendency for the film to curl, rendering it difficult to work with.

Width of the roll

The front, back and longitudinal seam of the bag are formed from the width of the web of film. That means that the bag is half as wide as the film width minus the width of the longitudinal seam. Expressed in a simple formula, that looks like this:

$$\frac{\text{Film width} - \text{longitudinal seam width}}{2} = \text{bag width}$$

Inversely: the packaging material must be twice as wide as the bag to be made, plus the material that is required for the longitudinal seam.

Longitudinal seam

In most cases, 15 to 25 mm (.6" to 1") of film is needed for the longitudinal seam. The type of longitudinal seam is a factor as well as the total bag width.

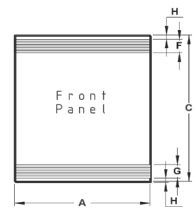
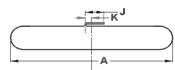
Film widths

The minimum and maximum film widths differ per machine. Smaller machines can handle film widths of approximately 10 to 54 cm (4" to 21"); larger machines run from approximately 18 to 80 cm (7" to 31.5"), and the largest machines can deal with film widths of 50 to 170 cm (19.5" to 67") or more.

Pillow Bag - Fin Seal - Right

Bag Features			
Bag Style	Pillow Bag		
Film Type	Heat Seal Film		
Long Seal Style	Fin Seal		
LS Fold Direction	Right		
LS Location	Back of Bag, Center Seam		
LS Offset Direction	Left of Center		
Film Unwind	Bottom Leading - Inside Print		
Hole Punch Style/Size			
Bag Opening Option			
Closure Options			
Cross Seal Serration Pattern			
Top Seal Pattern	Horizontal Serrations		
Top Serration Pitch	3.0mm Serrations		
Bottom Seal Pattern	Horizontal Serrations		
Bottom Serration Pitch	3.0mm Serrations		
		Dim (mm)	Ref (inches)
Bag Width	A	120	4.72
Bag Height	C	150	5.91
Long Seal Overlap	J	15	0.59
Long Seal Offset	K	5	0.20
Long Seal Width	L	8	0.31
Top Seal Width	F	16	0.63
Bottom Seal Width	G	16	0.63
Free Skirt Width	H	2	0.08
Flat Bag Width		120	4.72
Web Width	E	270	10.63
Film Repeat	N	150	5.91
Film Offset	P	70	2.76

Customer: _____
Description: _____

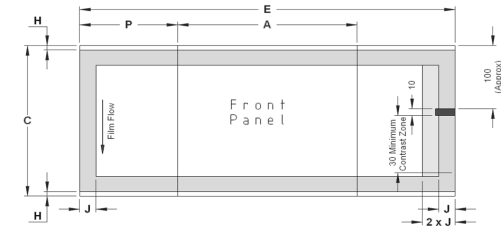


Existing Film Thickness
Existing Film Width
Existing Film Repeat



Sketch No: _____

Date: _____



Approved by: _____ Date: _____

Printing

The film roll must run through the machine as straightly and simply as possible. The course of the film web is influenced by a number of factors. One factor is the printing. If the film material has more colors on the side that is to be on the front of the bag than it does on the side next to it (the future back of the bag), the film web will tend to move sideways; the extra ink that is needed for the larger number of colors makes the film thicker on that side, causing uneven tension.

Longitudinal seam does not close

If the film web tends to move gradually toward one side, the longitudinal seam will not be sealable after some time; the two sides of the film formed into a tube will not touch each other anymore. In the phase before that, the printing on both sides of the longitudinal seam will no longer match up properly, either.

Checking

A film roll is relatively easy to check for uneven tension. Usually it suffices to unroll the material over a length of 10 meters (33') and see if the course continues to run straight and proper. If the web exhibits a curve to the left or right, then in some machines the position of the roll will have to be adjusted frequently. In other machines, the course of the web can be corrected manually, and in advanced machines there is automatic correction such as ultrasonic and photo eyes for edge detection.

Parallel

It is very important that the roll is wound well and evenly on the core; the side of the roll must be completely flat. If the winding comes undone, the film web will have the tendency to shift sideways, creating problems with forming the longitudinal seam.

ATTACHMENT OF FILM ROLL

There are different ways to place the film roll on the machine. In some machines, a loose film spindle is inserted through the core of the roll; in machines with a fixed spindle, one slides the roll over this spindle. The roll is fixed in place with conical disks that are pushed from the outside against the core, or with tension elements that are pressed using air pressure from the spindle against the interior of the core. This latter solution is preferable; when using the conical clamp system, the core of the film roll can easily become damaged on the sides leading to damaged long seals.

Position of the film roll

For the film web to have an optimum run, the film roll must be attached at exactly the right spot on the spindle. The position for different film widths are typically indicated on the film spindle.

Systems with no spindle

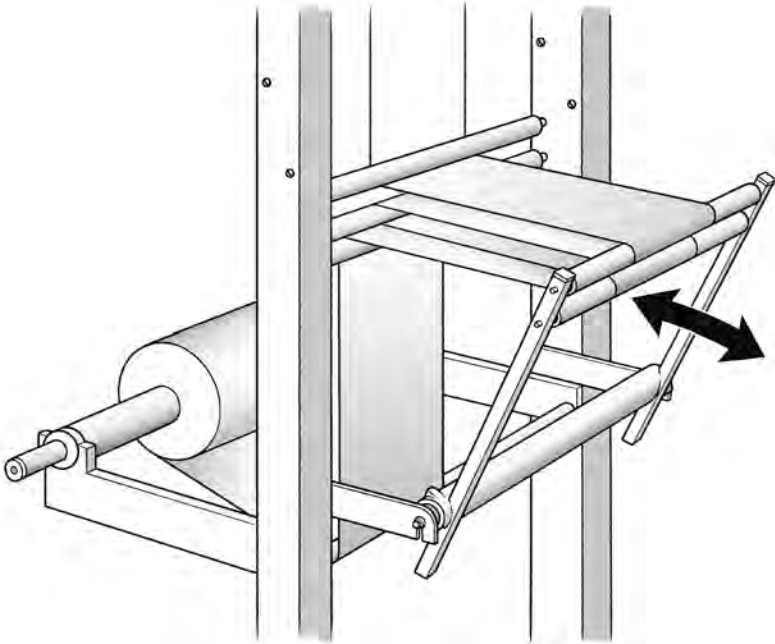
There are also systems without any spindle, where the film roll is placed loose on a table with powered rolls. Vertical rolls prevent sideways movements of the film roll. In this system, it is easy to change the film roll, but on the other hand there is less control over how the roll unwinds. As an alternative, there are systems without spindles where the core is attached with pneumatic clamp cones. Such systems are often used in machines that use large film rolls that are placed with automatic hoisting devices.

THE WEB OF FILM

The web of film runs via a number of guiding rolls to the forming shoulder and the forming tube, where the bag is made. The film path is determined by such factors as the machine concept and any extra steps that are taken before the film arrives at the forming shoulder. This could include the printing of a date code (best-by or expiration date), a label (such as product or sales information) or a reclosable feature (such as a zipper closure or tape; see chapter 7).

Dancer arm

In order to transport the web of film as evenly as possible, the web is guided by a moving “dancer” arm that moves from front to back. This dancer arm is attached to torsion springs that keep the web of film under the right tension. This improves the unwinding of the roll and the course of the film through the machine.



The spring-mounted dancer arm keeps the film web under the proper tension

Tensioning and stretching

The film path has a minimum length that is generally determined by the factors stated above. Usually, the path is three to six meters. The longer the film path is, the greater the chance that the course wants to go to the left or right, and the more tension on the course that will be created. Too high tension leads to uncontrollable stretching of the film, creating differences in bag lengths and misaligned printing.

Marking

The web of film has a print registration mark on it. The combination of this and a photo cell within the machine set to read it guides the transport of the web of film. There is one mark for each bag length. The photo cell “sees” the mark and assures the transport of one bag length per machine cycle.

Printed mark or contrast

Depending on the type of photo cell, there must be a clear contrast between the printed mark and the other printing. Instead of a conventional printed mark (often black bar), the marking can also be a strong, once-occurring contrast in the printing. With a color-sensitive photo cell or color sensor, it could also be a color difference, and again a sufficient degree of contrast is necessary here.

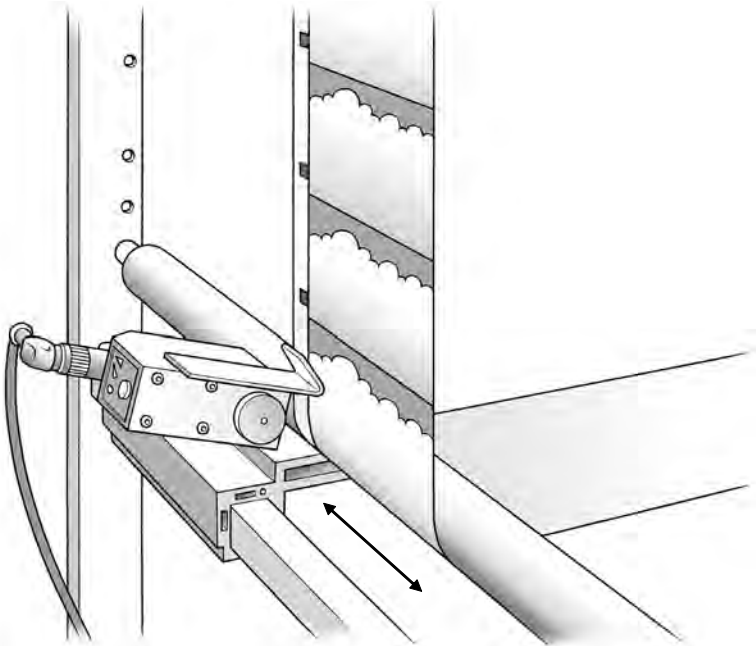


Photo cell that can be moved in the web width

Position

The photo cell can always be moved to match the width of the film web and can be set to the position of the marking on the packaging material.

Cutting position

The distance between the photo cell and the blade in the sealing jaw unit determines the cutting position between each of the two bags. If this distance is too small, the blade will cut too high in the packaging and vice versa. In conventional machines, this distance is regulated by lengthening or shortening the portion of the web of film between the photo cell and blade. The machine has an adjustable roll for this purpose. In newer machines, the cut-off point is automatically corrected.

Monochrome

Some machine systems require that the printed mark is located on a monochrome (one-color) printed portion of the film web. During set-up, the machine transports the packaging material automatically until the photo cell sees the printed mark. Such machine systems can set the proper bag length automatically.

Non-monochrome

For non-monochrome printing, the printed mark must come by in a predefined time window. The photo cell is only active during this window of time. The rest of the printing that comes by is ignored. The advantage of this system is that the packaging can be printed fully, and that this printing does not theoretically cause any errors if it has strong contrasts. However, it is not as easy to set up the machine because the cutting position must be determined by trial and error.

FILM TRANSPORT

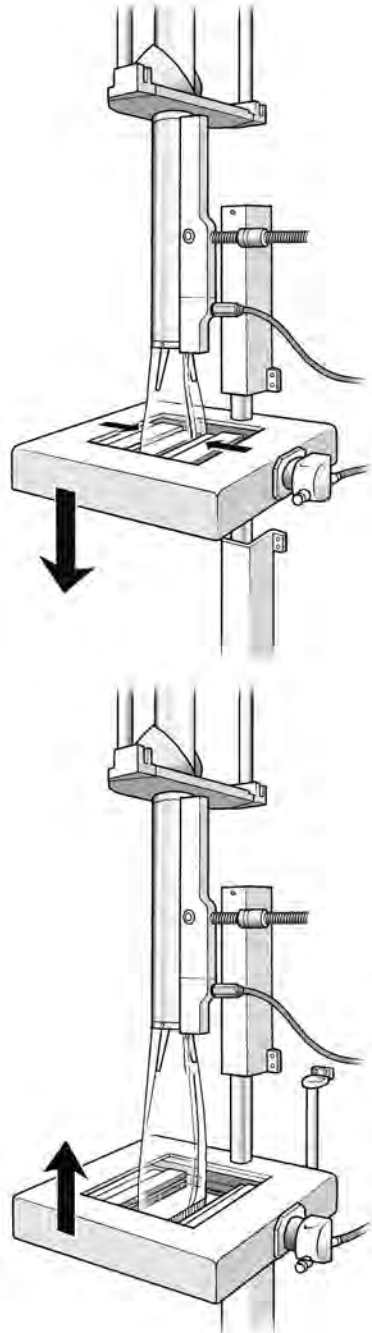
There are two techniques to transport the web of film through the machine. The simplest technique uses the sealing jaws, that grip the web of film like the draw bar and pull the material downwards. This is called the jaw draw off principle. The second technique, the belt principle, uses conveyor belts with which the packaging material is pushed down along the forming tube.

Draw bar pick-up principle

In the jaw draw off, the sealing jaws move upwards for each new bag. The jaws close to grip the packaging material. Then they are moved downwards, starting the film transport. During this downward movement, the material is directly sealed. In achieving the desired bag length (that is mechanically set and controlled by a photo cell), the jaws open and the film transport stops. The jaws then move upwards for the next cycle.

Down and Up

The downward movement usually goes more slowly than the upward movement does. The film transport, sealing and filling takes up 7/12 of the machine cycle; the upward movement takes place in 5/12 of the cycle.



The draw bar principle

Benefits of the jaw draw off principle

There are four important benefits of the jaw draw off principle, used often in the past.

- It is a relatively simple system, especially because it uses existing components (the sealing jaws) and there are no separate provisions (such as conveyor belts) required.
- The system yields high downward forces, which allows for a steeper entry angle of the forming shoulder and thus better tracking behavior of the web of film (see page 29).
- The sealing jaws move along with the packaging and also with the falling product to ensure that there is a soft landing of the product in the bag, which is especially important for products susceptible to breakage.
- This saves time because two steps are combined in one machine cycle, the web of film is simultaneously sealed and transported.

Drawbacks

There are two drawbacks on the other hand.

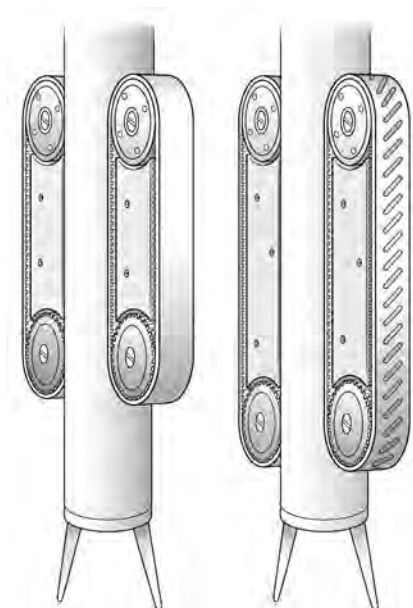
- Because the sealing jaws pull on the material, no bag with a block bottom can be made, but only pillow bags and gusset bags.
- The volume of the bags is smaller because the bag is folded closed during transport.

Belt pick-up principle

The often-used belt principle works with conveyor belts running on either side of the forming tube. These belts push the web of film downwards along the tube. Three types of belts are used: friction belts, vacuum belts and a combination of these two types.

Friction belts

Friction belts make use of the fact that the friction between the conveyor belts and the packaging material is greater than the friction between packaging material and forming tube. Packaging material with a smooth exterior and polyethylene on the interior (creating extra friction), can have a friction difference that is so small that it can create problems.



Friction belts and vacuum belts

Vacuum belts

With vacuum belts, the film is sucked against the belts. This means there is no friction between the film and forming tube and the process goes much more smoothly.

Vacuum-supporting friction belts

With a combination of these two techniques, the friction between film and forming tube is reduced, but not eliminated entirely.

The difference

The difference between these three types is expressed mainly in the life expectancy of the belts. While friction belts last two to four weeks with a certain combination of packaging material and forming tube material, vacuum-supporting belts last a few months given these same conditions, and vacuum belts last multiple years.

Driven rolls

For better control of the film web, some machines have a driven roller, pinch rollers, and/or drive the film reel itself, in addition to the belts. The extra forward thrust that is supplied by this mechanism also allows for a steeper running angle and provides for better tracking behavior (see page 29), especially when running at high speeds with heavy rolls.

Benefits and drawbacks

The two most important benefits of the belt principle are that this technique allows for the production of all conceivable bag shapes and the bag volume is maximized. The drawbacks are the smaller forces and the fact that the film is not pulled downwards but pushed forwards. Also due to the extra resistance of bag spreaders or a block bottom mouthpiece, the film material can get bunched up around the forming tube. In addition, the film transport and the sealing of the cross seam take place after each other. For each of these steps, one third of the machine cycle is available.

THE FORMING SHOULDER

The forming shoulder is the heart of the packaging machine. The complex shape of the shoulder influences such factors as the tracking behavior of the web of film, the belt tension and the required forces for the film transport.

Longitudinal seam and film

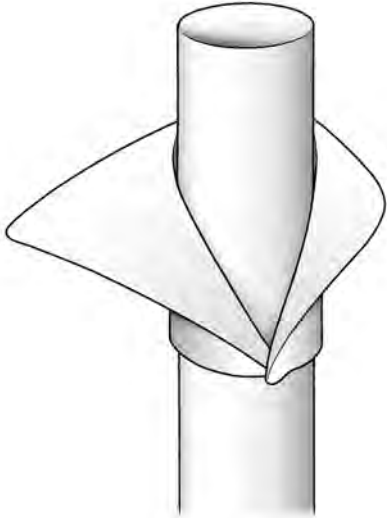
The model of the shoulder also determines the position of the longitudinal seam (in the middle or at an edge of the bag) and the type of longitudinal seam (fold-over seam or overlap seam). The maximum thickness and rigidity of the film that is possible to be run is also connected with the model of the forming shoulder.

Forming parts

The shoulder shapes the flat film web into a tube that is divided into individual bags by sealing and cutting. The bag width is determined by the outer diameter of the forming tube, with which the product is poured in the bag. The forming shoulder and forming tube are the *shaping* parts or the *format* set of the machine. Every bag width has its own forming shoulder and forming tube.

Wings and collar

The most important elements of the forming shoulder are the wings, over which the web of film runs and the collar, where the shoulder transitions to the forming tube; that is the point where the web of film is formed into a tube.



Forming shoulder and forming tube

Run-in angle

The wings of the forming shoulder lead the web of film at a certain angle to the collar of the shoulder. This angle, the so-called run-in angle, depends on the bag width (determined by the diameter of the forming tube) and on the available force of the machine.

Steeper is better

The big benefit of a steeper run-in angle is better tracking behavior of the web of film. For a steeper run-in angle, the forces of the machine must however be sufficient. Good tracking behavior is of course essential to uninterrupted production. For optimum continuity and optimum tracking behavior, a good compromise must be found between the available forces and the model of the forming shoulder.

The collar

A steeper run-in angle demands greater forces because the resistance on the collar is higher. In addition, the collar will have a “sharper” form, causing it to be more susceptible to wear and tear - and a worn collar creates risk of damage to the packaging material.

Forming shoulders: the material

Forming shoulders are made out of solid metal (bronze or aluminum), web metal (stainless steel) or plastic.

Solid metal

Solid metal shoulders are cast according to the model of a mother shoulder and are then polished by hand. The collar has a hard steel wearing plate that can be replaced over time. Solid metal shoulders are very tough and relatively simple to repair: for example the shoulders can be re-polished and re-finished. On the other hand, they are very heavy, which makes them difficult to handle, and the number of models is limited by the high costs of the required materials. As a result, these shoulders have sharply dropped in popularity.

Web metal

Web metal shoulders are made from a web of stainless steel that is forced into the model and then sealed around a form. Complicated computer models are used to calculate and form the web.

Plastic

Different combinations of hard plastic cores with a smooth exterior layer are used for plastic shoulders. The shape of the shoulder is obtained by a special procedure of following the natural course of the packaging material with a dual component plastic. This makes it possible to create virtually an infinite array of bag shapes.

The benefits

Plastic shoulders have outstanding features in operation; they are light and wear-resistant, and they are not more expensive than shoulders of other materials. However, they are relatively vulnerable to damage from falling.

THE FORMING TUBE

The forming tube is the part that connects directly to the forming shoulder. The tube not only helps determine the bag shape and the bag width, but also the packaging speed.

Forming tube and bag width

The product falls through the forming tube – which is why it is also sometimes called the filling tube – into the bag. The bag width is determined by the forming shoulder size of the forming set.

Gap

The film web glides over the collar of the forming shoulder and then disappears into the gap between the forming tube and the forming shoulder surrounding it. The width of this gap is critically important to uninterrupted production and perfect looking bags. If the gap is too tight, the film material will have the tendency to bunch up around the forming tube. A gap that is too wide gives the film material too much space, and the bag will exhibit diagonal folds (the so-called “lightning strikes”). The gap does have to be wide enough to allow any stickers or recloseable features that have been placed on it in an earlier phase to pass through. (Reference Page 5- Vertical packaging machine figure)

Inner diameter of forming tube

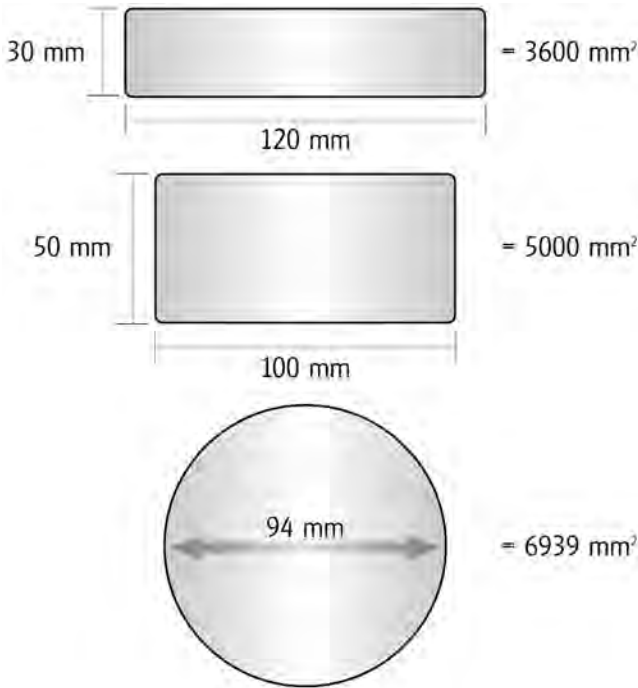
The inner diameter of the tube determines the opening for the product. A smaller opening slows the maximum possible packing speed, simply because less product fits through at the same time. Page 37 discusses this further.

Forming tube shape

For a certain bag width, a round forming tube provides the largest opening. With large bag sizes, often oval forming tubes are also used. The path that the sealing jaws must travel in every machine cycle (opening, closing) can thus be minimized, and the machine remains compact. Oval forming tubes are sometimes also used for packaging larger flat products such as frozen fish.

Rectangular forming tubes

For some bag shapes, rectangular forming tubes are used. For a given bag width, this shape has the smallest opening.



If the bag width remains the same, the round tube has the largest and the rectangular tube has the smallest opening. In the oval tube, the path that the sealing jaws must travel from open to closed position is the shortest.

Wear and tear of forming tube

Wear and tear of the forming tubes occurs mainly at the collar, where the web of film is moved downwards between the forming shoulder and forming tube. The material of the forming tube helps determine the degree of wear and tear.

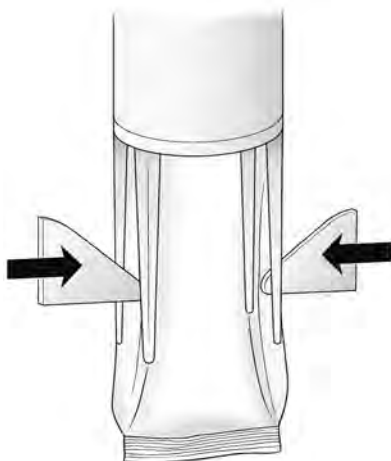
Material - forming tube construction

Another consideration when choosing the material of the forming tube is the weight. Lighter shaping parts are easier to change, which benefits production time. Forming tubes are made from hard chrome-plated steel, stainless steel, anodized aluminum or plastic. The two lightest materials, aluminum and plastic, are unfortunately limited in their application in the packaging of foodstuffs. Salt affects aluminum and not all suitable plastic compositions have been adequately tested for their effect on foodstuffs.

Bag spreaders and side gusset spreaders

At the bottom of the forming tube there are one or more elements that help produce a well-shaped bag.

- For the production of pillow bags or flat bags, bag spreaders are needed. These “fingers” made of spring steel stretch the bag in the width direction before the cross seams are made. This prevents pleats in the cross seams and straight, flat seams are obtained.
- The folds in a gusset bag are made by gusset spreaders mounted on either side of the forming tube. These triangular spreaders fold the required extra amount of packaging material around two steel pins inwards.
- When making stand-up bags or a bag with a block bottom, a special mouthpiece is used. This mouthpiece allows the web of film moving over the round forming tube to transition to the square or rectangular shape at the bottom of the bag. Just before the cross seam sealing jaws close, the film is folded inwards by horizontally mounted spreaders around the mouthpiece.



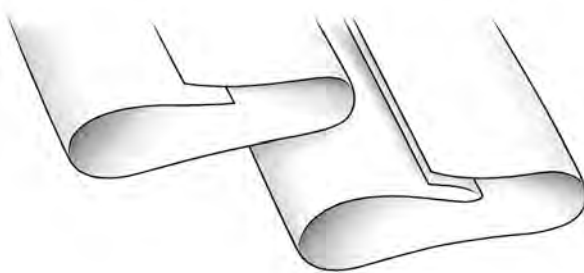
A gusset bag in the making

LONGITUDINAL SEAM

The longitudinal seam is the seam running the length of the bag. The choice between an overlap seam or a fold-over seam depends on (the composition of) the packaging material.

Forming and Placement of the Seam

The seam is formed by the extension of the forming shoulder, which also determines the placement of the seam. In some bags, the seam is in the middle or the back of the bag; other bags have the seam on one of the edges.



The longitudinal seam is thus formed by the extension of the forming shoulder

Overlap seam

With the overlap seam or lap seal, the inside of one side of the web of film is placed over the outside of the other side of the film web. The overlapping inside is sealed onto the outside of the film underneath it. The benefit of the overlap seam is that less packaging material is used than in the fold-over seam, such as the ILLUSTRATION clearly shows. Such a seam can only be made if both the inside and the outside of the film material is sealable. In practice, this means that overlap seams mainly occur in bags made of pure polyethylene (PE) or polypropylene (PP), or in bags that are coated on the outside with a special seal coating.

Fold-over seam

With the fold-over seam, one side of the web of film is folded over approximately 10 mm (4"). This causes the inside of the film material to be on top. The other side of the material is then placed over it, and then it is sealed. So the inside is sealed onto the inside of the material. The fold-over seam is generally used for film laminates where the sealing medium is located on the inside of the material.

Longitudinal seam, bag width and film width

In the start of this chapter, you already encountered the following formula:

$$\frac{\text{Film width} - \text{longitudinal seam width}}{2}$$

Required material

For an overlap seam, 15 or 20 mm (.6 to .8") of film material is usually required. This extra material is symmetrically divided: 7.5 or 10 mm (.3" to .4") of film material is used both on the left and on the right side of the web of film. A fold-over seam of course requires more material. In most bag sizes, 20 mm (.8") is required and with larger packages even 25 mm (1") or more. This material has to be found largely on one side of the web of film, specifically on the side onto which the edge is to be folded over.

In the center or not

An overlap seam is located in the center of the roll in the length or the heart of the forming shoulder. To make a fold-over seam, the roll must be positioned 10 or 15 mm (.4" to .6") to the left or right.

Less wide

This means that the maximum bag width for bags with an overlap seam is often larger than it is for bags with a fold-over seam: if the film runs exactly down the center of the machine, the available width is used optimally. When making a fold-over seam, there is unused space on one side of the web of film placed in the middle.

Tracking behavior and longitudinal seam

The tracking behavior of the film is very important for a well-sealed longitudinal seam. If the web of film shifts, the edges of the material no longer match each other, so sealing is not possible. In the previous situation, the printing on both sides of the seam will no longer match up properly. If there is poor tracking behavior, the operator will have to continually check the web of film and adjust it when necessary. One of the most common sources of interruption is when packaging material runs to the left or the right. In continuous machines such disruptions occur significantly less often than they do in intermittent machines. The differences between these two machine types are discussed on pages 31-33.

Sealing the longitudinal seam

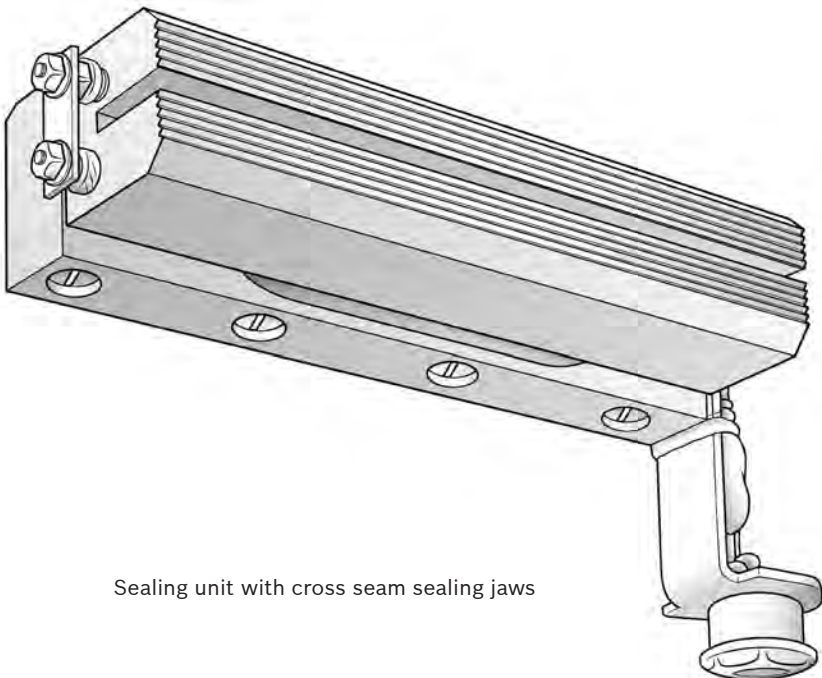
The longitudinal seam is sealed by a sealing unit placed parallel to the forming tube that presses both layers of the material against the forming tube and allows the heat to melt it. The length of the sealing unit (in an intermittent VFFS unit) will usually be equal to the maximum bag length that can be made on the machine. That means that in practice the longitudinal seam is sealed multiple times in shorter bags.

THE CROSS SEAMS

The making of the cross seams is the most sensitive part of the packaging process because here the packaging material and product come together at the time the bag is closed and cut off. Chapter 4 goes into this process in more detail.

Cross seam sealing jaws

The sealing unit that makes the cross seams is located under the forming tube. In this sealing unit, there are two pairs of cross seam sealing jaws. One pair seals the top seam of the filled bag, while the other pair simultaneously seals the bottom of the bag to be filled immediately thereafter.



Sealing unit with cross seam sealing jaws

Heating under pressure

Just like the longitudinal seam, the cross seams are also sealed by pressing together and heating the two layers of material with the sealing jaws. The sealing medium melts, and then immediately hardens when cooling, creating a stable seal.

INTERMITTENT AND CONTINUOUS MACHINES

Vertical form, fill, seal machines come in two main types: intermittent machines and machines with a continuous operating principle, the so-called continuous machines.

Intermittent or continuous

In an intermittent machine, the packaging material must be still as the longitudinal seam is sealed (once per machine cycle). With a continuous machine, the material is transported continuously – as the name suggests.

Higher output

Initially, continuous machines were mainly purchased because they offered a 30 to 50% higher output, but such machines also offer many more benefits.

Lower film speed

Despite the higher output, the packaging material moves much more slowly in a continuous machine than in an intermittent machine: it is continuously transported, while the material in an intermittent machine is still for approximately two thirds of the cycle. In the remaining third, the film must pass a relatively large distance and a high speed is needed.

A factor of 3

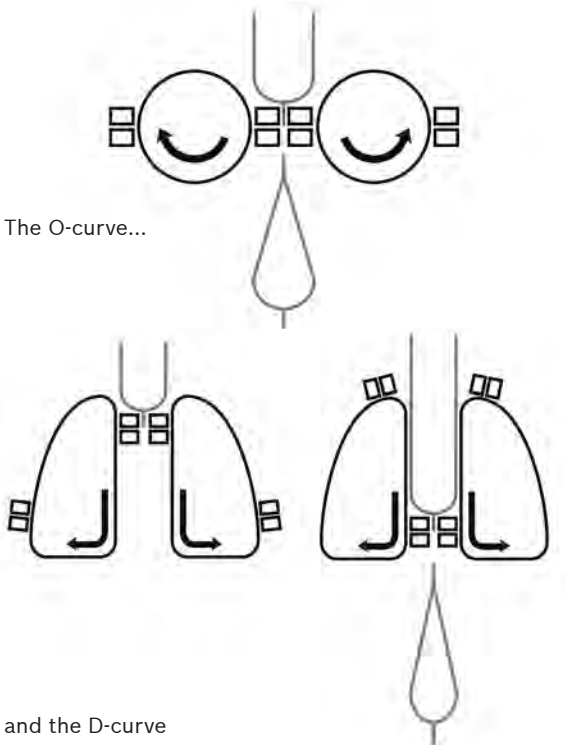
When making a bag length of 300 mm (12”) and a speed of 60 bags per minute, the film in an intermittent machine has a speed of 1 meter per second. In a continuous machine, that speed was reduced to 0.3 meter per seconds: that is a factor of 3 lower.

More rest, less disruptions

A lower film speed creates fewer disruptions. The material also progresses much more regularly because the web of film does not have to start and stop during every cycle; it does not “skip” as occurs in intermittent machines. Also the chance of sideways shifting is minimized, keeping problems in the longitudinal seam area to a minimum.

O- and D-curve

In order to be able to seal the cross seams in a continuous machine, the sealing jaws must move along with the packaging material. In some machines, the sealing jaws must describe a fixed curve. If both sealing jaws follow a rotation or O-curve, then they only touch each other briefly, so the sealing time is limited. With a D-shaped curve, when the straight sides of the D's face towards each other, the sealing time is longer, sealing occurs as long as both sealing jaws follow the right side of the curve. The most important drawback of these fixed curves is that the sealing time can only be extended by reducing the machine speed.



Vertical

That drawback does not exist for continuous machines, where the sealing jaws follow the packaging material by also making a vertical movement in addition to the usual horizontal movement. The sealing time can then simply be varied by having the jaws move along with the film for a shorter or longer time. A longer sealing time can be compensated by having the jaws move up more quickly, so that the packaging speed remains the same.

Less breakage

The vertical movement of the sealing jaws in a continuous motion bagger softens the landing of the product, reducing the risk of breakage.

Variable speed

The risk of breakage can be reduced even more by varying the speed of the sealing jaws and the packaging material. If the sealing jaws move slightly faster than the packaging material, the bag is pulled into a V-shape. Cookies and other breakable products are thus better caught because they fall along the slanted sides of the V downwards.

Packaging material faster

If on the other hand the packaging material moves down faster than the sealing jaws do, then the bag has the maximum opening – sort of like when a sock is easier to pull on if the “bottom” (where the toes go) is brought closer to the opening of the sock. This improves the filling degree of the bag, which can be important for chips and similar products.

Dusty products

Because the film and the sealing jaws are always in movement, a downward air flow is created. This has a positive effect on the packaging of dusty products such as powders and herbs, as well as sugar-coated candy. The air flow ensures that the dust goes into the bag together with the product, and does not end up in the sealing seam.

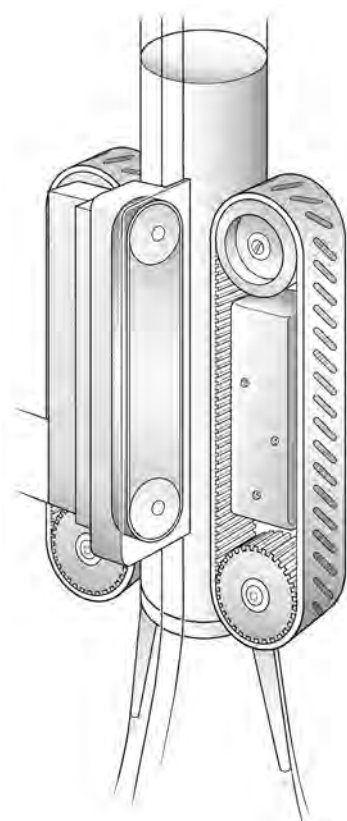
The longitudinal seam

How the longitudinal seam is made is partly contingent on the packaging material used. The longitudinal seam of low melting point materials is created on continuous machines with hot air. For heat-sealable materials, which includes most laminates, there are three techniques, with the third being a variation on the second.

- In the drag longitudinal seam, a longitudinal seam anvil is pressed against the film moving underneath it. This simple system demands little maintenance, but does require a reasonable force and a more or less constant film speed. Because the film moves, only slight pressure can be placed on it. This is compensated by sealing it longer. If the bag is equally as long as the longitudinal seam anvil, sealing occurs during the full machine cycle, and therefore a longer time for shorter bags. The longitudinal seam anvil comes off of the film when the film transport stops. This prevents the packaging material from melting or burning.
- The second technique uses a separate sealing band that is driven by a separate servo- or step motor that is pressed against the film and forming tube. A good synchronization of belt speed and film speed is of course of great importance. The extra pressure that this system yields is required for packaging materials such as the PVC-free anticondensation film used for packaging fresh vegetables.
- A variation on this system uses two driving sealing belts that the film is guided between. This is an expensive and complex system that is only used when the packaging material requires this, such as the case with HDPE-film. This material is used for the packaging of breakfast cereal for example, such as cornflakes and granola.

Low melting point materials

For low melting point packaging materials (sometimes referred to as non-heat sealable), such as polyethylene film, used mainly in the frozen food industry, a hot air longitudinal seam is formed via a tube fitted with outflow holes that blow hot air onto the film. The tube is heated by sending power through it, with the temperature controlled by measuring the resistance of the tube and adjusting the amount of power as required.



A driven sealing belt

PACKAGING SPEED

The speed with which bags can be made is mainly determined by the sealing time of the packaging material and the length of the product stream. The product stream is the distance between the first and the last product from one batch, or the distance between the first and last peanut of the contents of one bag. In addition, the bag length and – sometimes – the falling time of the product play a roll.

Sealing time

The variables in the sealing process are the sealing time, the pressure of the sealing jaws and the temperature used. The temperature is limited by boundaries dictated by the nature of the packaging material. The sealing pressure has limits of a mechanical nature, the most important factors of which related to the construction of the cross seam jaws and the nature of the serrations (see page 42). The remaining variable besides these two is the sealing time, which is also contingent on the other variables, and which of course has a direct influence on the machine speed. Just to be clear, we are talking about milliseconds.

Length of product stream

The length of the product stream is much more important for the packaging speed. The bag can only be closed once the complete batch (portion of product) is in it. The length of the product stream is determined partly by the volume of the product and the opening of the forming tube. The size of that opening is in turn contingent upon the bag width and the shape (round, oval or rectangular) of the forming tube.

Fast or slow

A compact product in a short, wide bag yields the fastest machine speed. For more voluminous products that are packaged in a long, narrow bag, the machine speed is dramatically reduced.

Falling time

Often it is thought that the falling time of the product also determines speed, but that is a misunderstanding – with some exceptions. If there are high speeds, multiple batches can be underway simultaneously. The one precondition is that there be adequate distance and time between each sequential portion to allow for the cross seam jaws to close again. If the product is interrupted while falling, for example by catch plates (see page 71), then the falling time is important: the product must get back up to speed after each interruption.

Funnel

If the size of a batch is smaller than the diameter of the forming tube, then the product will fall without any delay into the bag. Often however, the size is larger, and then a funnel is required to guide the product into the forming tube. The shape of the funnel depends on the product features and the associated manner in which the dispensing unit dispenses the product. An optimally designed funnel means that the product stream is as short as possible (and so the machine speed is as high as possible), while at the same time preventing an hour glass effect at the transition of the funnel into the forming tube, slowing down the filling process (see page 70).

4. SEALING SYSTEMS

Vertical packaging machines can only process packaging materials that can be melted to themselves under the influence of temperature, time and pressure. A stable seal or seam is created when the material cools off. Heating and cooling is a question of milliseconds in most cases.

There are two main sealing systems. The choice of one or the other system depends on the packaging material used.

- Heat-sealable packaging materials, which includes most laminates, are sealed with a heat-sealing system.
- For sealing low melting point materials such as polyethylene, a special polyethylene sealing system or PE-sealing system is used (see page 47).
- A third seal system is being used in select markets. In this system, ultrasonics is used to weld the film together.

Variables of the heat sealing system

In the heat-sealing system, there are three important variables: temperature, pressure and time. Within certain constraints, a low sealing pressure can be compensated by a higher sealing temperature. The sealing time is always a function of the variable sealing pressure and sealing temperature.

Sealing temperature

The sealing temperature is determined by the packaging material. The temperature window indicates the minimum and maximum temperature at which the material melts but does not burn. Such a temperature window can run for example from 110 °C (230 °F) (minimum melting temperature) to 150 °C (302°F) (burning temperature).

Temperature and product

Also the ambient temperature and the temperature of the product can play an important role in the sealing temperature. For example, frozen products are packaged in refrigerated rooms. The packaging material of course takes on the same temperature, and cold film requires extra time to reach the sealing temperature. In other products, relatively high temperatures are worked with. For example, to prevent bacterial growth, ketchup can be dispensed at approximately 80 °C (176 °F). At a sealing temperature of 120 to 130 °C (248 °F to 266 °F), cooling off of the sealing seam goes slowly, so the chance of leaking packages increases. Certainly with these types of extreme circumstances, a good balance between sealing temperature, pressure, time and cooling is extremely important.

Movement of the sealing jaws

An additional problem of temperature control of the sealing jaws is caused by the movement that the sealing jaws make. This movement causes cooling. In continuous machines and machines that work according to the draw bar pick-up principle, the jaws move not only horizontally but also vertically.

Cold seal

Especially in the chocolate industry, use is made of materials with a very special cold-seal coating. Here, the seal is created exclusively by pressure.

Sealing pressure

The available sealing pressure depends on the machine. In many cases, this pressure can be set to the maximum, determined by the machine. Also the profile of the sealing jaws (discussed on the next pages) determines the pressure that can be exerted on the sealed seam.

Sealing time

The sealing time is directly related to the machine speed, a longer sealing time usually requires a slower machine speed. With an intermittent machine, sealing (which includes the jaw close and open time) take up more than 1/3 of the machine cycle.

Sealing medium for heat-sealable materials

In heat-sealable materials, the sealing medium is often polyethylene. Following the discussion of the different longitudinal seams on page 28, in an overlap seam, both the interior and exterior layer of the packaging material must consist of polyethylene; in a fold-over seam, only a polyethylene layer on the interior is required. Polyethylene melts at a relatively low temperature (120 °C) (248 °F). If polyethylene is the sealing medium, the carrier film of the packaging material must have a higher melting temperature. If that is not the case, then the backing of the material will also melt and so the seam will be cut and stick to the sealing jaws.

Cross seam sealing jaws

The heat sealing system for the cross seam consists of two metal blocks: the sealing jaws. The width of these blocks corresponds at least to the broadest bag that can be produced on the machines. On the side where the blocks push on the material, the sealing jaws have a sealing profile.

Sealing profile and pressure

This sealing profile determines the width of the sealing seam, and thus also the pressure on this seam; a sealing profile for a narrow seam means a higher surface pressure than a profile for a broad seam, like a high heel exerts a higher surface pressure than does a flat rubber sole.

Serration

Sealing jaws also differ according to the type of profiling, or serration. Each type of serration has special properties and application possibilities. The two main types are the horizontal and the vertical serration.

Horizontal serration

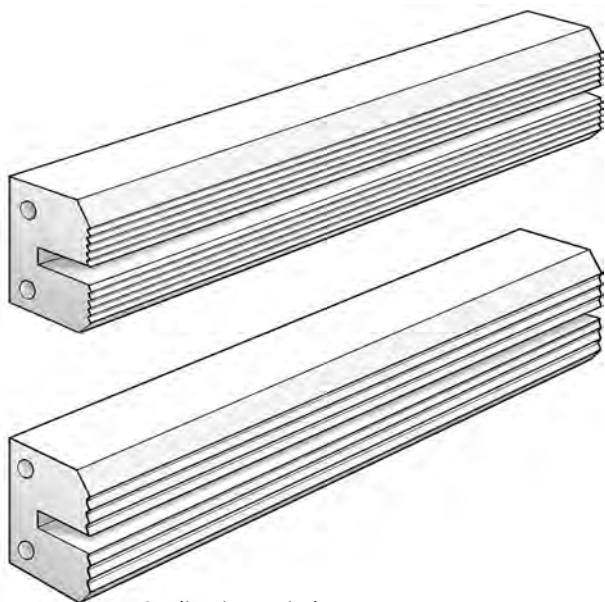
With horizontal serration, the profile (or ribs) runs parallel and equidistant along the length of the sealing jaws. The profile exerts a high surface pressure, so that the cross seam can be made gas-tight.

Gas-tight or air-tight?

If a package is air-tight, this usually means in practice that no noticeable amount of air escapes if the packaging is squeezed. A package that is gas-tight meets higher requirements. The gas inserted in the bag to protect the product (see chapter 6) cannot escape, and oxygen cannot get in.

Pitch

The distance between the serrations is called the pitch. If there is a fixed width of the sealing jaws, a bigger pitch means the profile has fewer serrations. This increases the surface pressure: the same mechanical pressure is exerted by a smaller surface (fewer serrations) on the material.



Sealing jaws pitch

Common sizes

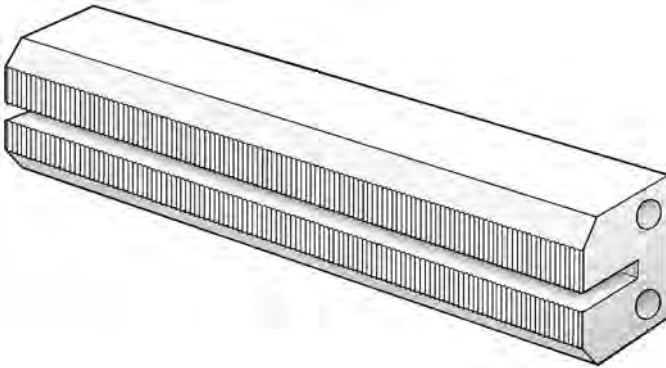
The most common sealing jaws have a jaw width of 12 mm (5"). This is called a 12/12 sealing jaw, indicating both the width of the lower and of the upper jaws. For products that do not have to be packaged gas-tight, the pitch is usually 1.5 mm (.06"). If gas-tight packaging is required, the pitch is at least 3 mm (.12").

Material thickness

The thicker and stiffer the packaging material, the higher the pressure needs to be in order to seal the film. This also means the pitch may need to increase.

Vertical serrations

In vertical serrations, the serrations run perpendicular to the longitudinal direction of the sealing jaws. The pitch is usually 1.5 mm (.06"). While a horizontal serration is mainly used in products that must be packaged gas-tight, one uses sealing jaws with a vertical serration for example for packages that must be easy to rip open; the vertical pleats form a sort of break or fracture line in the length of the packaging. Such easy-opening-packages are used particularly in the candy industry.



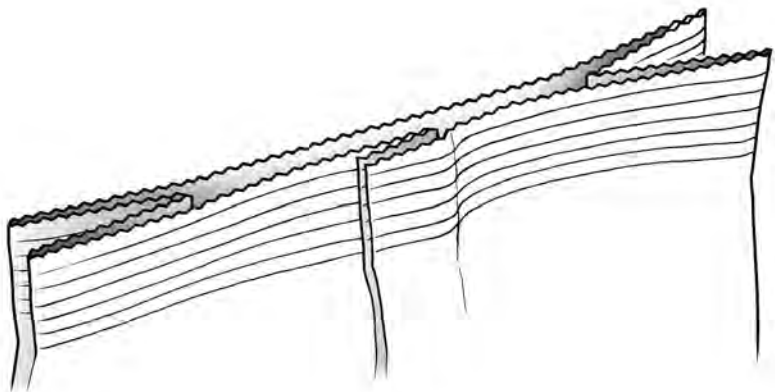
The vertical serration makes the packaging easy to open, but difficult to make gas - or air-tight

Assembly and wear and tear of the sealing jaws

Because the sealing pressure must be distributed evenly over the material, it is important that the sealing jaws be mounted perfectly parallel in the unit. The drive of the sealing jaws cannot have any play. The evenness of the sealing pressure is simple to check by holding a piece of carbon paper folded in half between the sealing jaws, that have a temperature of 85 to 90 °C (185 °F to 194 °F), and closing them. The carbon print must be even over the entire length of the sealing jaws. Also pay attention to the outline of the serration: the serrations are subject to wear and tear. If the print of the rippling is too vague, the sealing jaws can be replaced or re-rifflé (a limited number of times).

Transitions

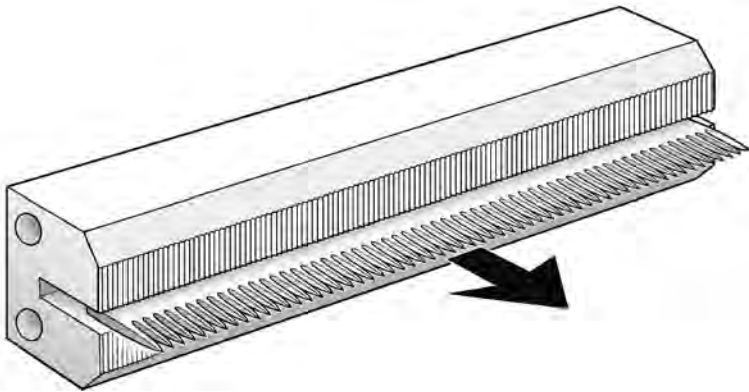
The cross seam is not entirely flat: at the level of the longitudinal seam, there is a thickening because multiple layers are on top of each other there. With an overlap seam, there is a transition from the two layers of the cross seam to the extra layer of the overlap seam, and back. With a fold-over seam, the number of layers transitions from two (cross seams) to four (cross seam plus fold-over) to two (cross seam). Bags with a block bottom have another two extra transitions at the corners, where four layers are on top of each other: the two layers of the cross seam plus the two layers of the corners folded inwards. At every transition, there are vertical channels. The greater the transition, the greater the channel. In order to have the channels seal properly with melted polyethylene, adequate pressure and an adequate polyethylene sealing layer is required.



A bag with a block bottom has four layers of material on top of each other in some places.

The blade

Once a bag is filled, it is cut directly above the top seam. This is done with a blade mounted between the sealing jaws. The blade has an asymmetrical cutting edge, just like with the halves of a pair of scissors, there is a flat side and a slanted side. As a result, an unsealed edge of film is left over at the top or bottom of the bag. This cutting edge is usually 2 mm (.08") wide.



The blades moves between the sealing jaws

Serration

The serration of the blade starts the cut. How coarse or fine the serration is depends on various factors including the packaging material. For a reinforced paper bag full of dog chow, a coarse serration will be chosen; the resulting notches in the cross seams make it easier to rip the bag open. For thin packaging material and for material that tears easily, blades with fine serration are generally used. Also for aesthetic reasons, a coarsely or finely serrated blade can be selected. There are also unserrated blades that of course yield a smooth edge.

Longitudinal seam sealing unit

The sealing unit for the longitudinal seam works according to the same principle as the cross seam sealing unit, but it has only one sealing jaw. The packaging material is sealed with this one sealing jaw, with the two sides of the seam pressed between the sealing jaw and forming tube. This longitudinal seam sealing jaw which is usually 4 to 8 mm broad does not create any serration (including hot air, pinch seal and dual band seal).

Compensation for short bags

For intermittent motion machines, the longitudinal seam sealing jaw must be as long as the longest bag that the machine can make. Keeping the theory of a machine cycle in mind, the longitudinal seam of short bags can be sealed multiple times as they are fed past the longitudinal seam sealing jaw in a number of steps during the cycle. This compensates for the low pressure of the sealing jaw without a serration profile. In addition, two flat lying layers are always sealed to each other. For continuous motion machines the length of the long seam does not matter, it just needs to have adequate time for the heat and pressure drag seal to properly bond together.

Compensation for long bags

For bags that are equally long or nearly equally long as the longitudinal seam sealing jaw, the lack of a serration must be compensated by a slower machine speed, so that the sealing time increases. In practice, this is rarely a limiting factor. In such long bags, usually so much product must be packaged that the length of the product stream does not permit a high machine speed.

Ultrasonic sealing

Ultrasonic sealing is a cold sealing system making it ideal for heat sensitive products. Friction is created by an oscillating tool that generates heat only in the area between two film layers, which eliminates the potential of product contact with heat. The vibrations for generating friction are caused by ultrasonic energy at frequencies of 20 - 40 KHZ. Heated seal jaws can cause sensitive products to melt into the sealing jaws causing contamination and more cleaning time. Ultrasonic sealing prevents

products from melting, resulting in less product waste, maintenance and eliminates film sticking to the sealing jaws. Production line speeds can increase significantly with minimal time for cool down in the seal, so product can be loaded immediately after a seal is made.

Heating

The heat required for sealing is supplied by heating elements installed in the sealing jaws and controlled by a built-in temperature sensor.

Constant and uniform temperature

It is essential for a good sealing seam that the sealing jaws have a constant temperature that is uniform across the entire length. This is complicated by the fact that the sealing jaws move (horizontally, but also vertically in many machines) and by the fact that only a portion of the length of the jaws touch the cold film when processing smaller bags, so heat is lost at that place. In processes where the seam is not stabilized quickly enough, (this is called a poor hot-tack), compressed air is used for cooling immediately after sealing, which adds an extra processing step.

Temperature control

In order to keep the temperature as even as possible in these circumstances, the following factors are important:

- the material of the sealing jaws;
- the type and the mounting of the heating elements;
- the position of the temperature sensor;
- the control loop.

Material of the sealing jaws

It is very important that the material of the sealing jaws has good heat conduction. Every machine builder uses his own recipe based on his own experience for this. The most commonly used materials are hard chrome-plated steel, steel/aluminum composites and chrome/copper composites. In order to prevent the packaging material from sticking to the sealing jaws, the jaws sometimes have a special ceramic coating.

Constant temperature

The temperature control loop and the heating elements must jointly keep the temperature of the sealing jaws within strict limits. In most applications, a temperature deviation of no more than 5% is still acceptable, but the ever more complex packaging materials require increasingly narrow margins. Many machines have control loops that continually adjust the heating profile according to the temperatures read from the sealing jaws.

Machine shut down

To prevent open bags from being made, the temperature limits must be closely monitored. As soon as the set limits are exceeded, the machine must automatically stop.

POLYETHYLENE SEALING SYSTEMS

The relatively low melting temperature of polyethylene (120°C) (248 °F) demands a special sealing system for monopolyethylene and for laminates that are made mainly out of polyethylene, such as polyethylene with a vapor precipitated metal layer serving as an oxygen barrier.

Cutting sealing jaws

When such materials are processed with a heat sealing system, the sealing jaws can function as blades owing to their temperature. The weight of the filled bag hangs on the lower sealing jaws. Because the sealing jaws cause the polyethylene to melt, the bag would break off at the site of what is now the liquid seam, so the bag would fall before it could be closed.

Jaws

In the polyethylene sealing systems, the packaging material is therefore held above and below the sealing seam with special clamps, and the film is already cut before it is sealed. In this way, there is no more tension on the sealing seam during sealing when the material melts. After sealing, the seal seams are cooled with compressed air. As soon as the seam is stable, the clamps let the bag go.

Blade

The blade with which the film is cut can be mounted in the inset pieces that do the sealing. These inset pieces or sealing jaws move independently of the other jaws that grip the film. The blade protrudes out from the inset seal jaws, so cutting precedes sealing.

Teflon cloth

The sealing jaws are coated with Teflon cloth. The Teflon prevents the film that has just been cut and sealed from sticking to the sealing jaws.

Two sealing methods

Two different sealing methods are used: one that uses sealing wires, and a second that has more similarities in terms of construction with the heat sealing systems.

Sealing wires

The system with sealing wires is the oldest of the two. The sealing wires are stretched over the aluminum sealing jaws coated with silicone rubber: each sealing clamp has one sealing wire. Over that, the Teflon cloth is stretched.

Power

The sealing wires are heated by transmitting electrical current through them. This heat can be emitted directly to the packaging material. The most important benefit of this method is the rapid heating and the fact that the wires immediately cool off once the power is cut off.

Overheating

A drawback is the sensitivity to overheating of the wires at those places where the packaging material does not draw away any heat. Overheating substantially reduces the life of the sealing wires. The length of the sealing wires corresponds with the maximum bag width that the machine can make. The smaller the bag that is made, the greater the portion of the wires that is exposed to overheating.

Tin-coating

Overheating can be combated by tin-coating the parts where they do not touch the packaging material. However, this means that the wires become size-dependent: for each new bag width, they would have to be changed. In practice, this is not done.

Temperature control

Temperature control is complex. If the temperature is too low, the sealing seam is not good. If the temperature is too high, then holes melt into the packaging material and ultimately the Teflon cloth also burns, which has a burn temperature of 240 °C (464 °F).

Two systems

One of the two systems to control the temperature is the impulse system, in which the powered wires are given a short, powerful electrical impulse for each bag. The second system works with a constant temperature control. Here the temperature is controlled and regulated based on the constant resistance measured in the sealing wire. This yields reliable results.

Heated sealing jaws

A second polyethylene sealing method does not use sealing wires, but rather sealing jaws made of special alloys with built-in heating elements and temperature sensors. The temperature control of these pieces is considerably easier than that of the fragile sealing wires. There is also no more machine downtime for replacing the burnt sealing wires and burnt Teflon cloth.

5. DOSING SYSTEMS

It is of course important that each bag contains the correct amount of product. Different dispensing systems have been developed to make sure this happens.

The choice of the dispensing system depends on the product features.

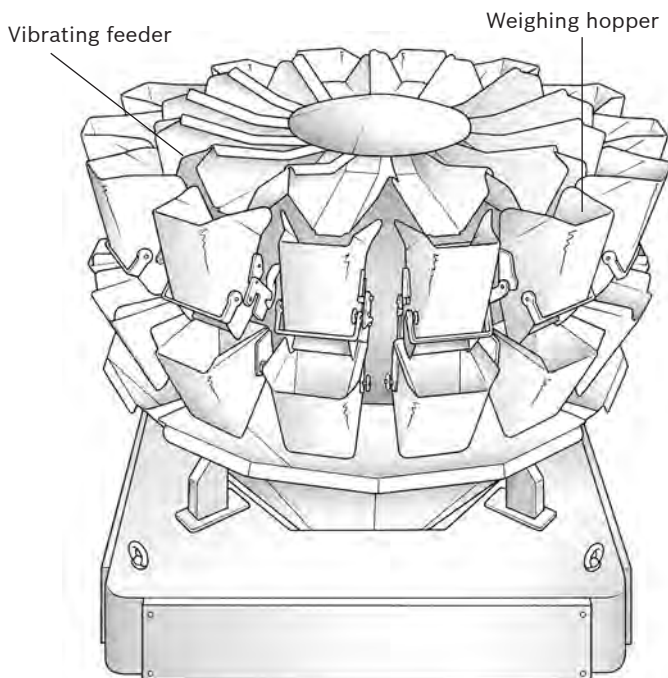
- Filling scales and counting machines are the most commonly used dispensing systems for products such as candy, macaroni, snacks, chips, nuts, screws and bolts: bulk goods, that are fed into the forming tube in free fall.
- Homogeneous bulk goods with a small piece size and a relatively low cost price, such as detergent, rice, peas, fertilizer and granulated sugar, are often dispensed with a dispensing cup or cup filler.
- Powdery products such as ground coffee and dry milk could whirl around during free fall, causing product to get into the sealing seams. With such products, one uses an auger filler or auger dosing that transport the powders to the bottom of the bag.
- Liquids (ketchup or salad dressing, for example) are dispensed with a dispensing pump.

Multihead weigher

The most common filling scale, the so-called multihead weigher, owes its popularity to its speed, its precision and its broad applications. As the name suggests, the multihead weigher uses multiple weighing hoppers at the same time. Each of the eight to thirty-six weighing hoppers is filled, then the multihead weigher determines at a high rate which combination of the hoppers contains the desired amount, or as closely approximates this as possible. If dispensing must be done without a multihead weigher for a product where each unit weighs 4 to 6 grams (.14 oz. to .21 oz.) (large nuts, for example), then for a 250-gram (8.8 oz.) package, one must often choose between dispensing 248 or 252 grams (8.7 oz. to 8.9 oz.). With a multihead weigher, such deviations are avoided; with a combination of three to five of the available hoppers, correct dispensing is always possible within narrow constraints.

Always ready

Multihead weighers work quickly, partly because never more than three to five of the available hoppers are emptied. The individual filling weights are always combined, so they are always ready for the next dispensing.



A multihead weigher is quick, precise and broadly deployable

Vibration feeders

The hoppers are often filled via vibration feeders, that ensure that a more or less equal amount of product runs into each hopper during a set amount of time. This amount can be varied by shortening or lengthening this time.

Collector bins

To assure the process goes as quickly as possible, the product first transitions down from the vibration feeders into collector bins mounted above the weighing hoppers. From these bins, the product is emptied into the weighing hoppers. The weight dispensed is transmitted to microprocessor, that determines the right combination for the next dispensing.

In a circle or next to each other

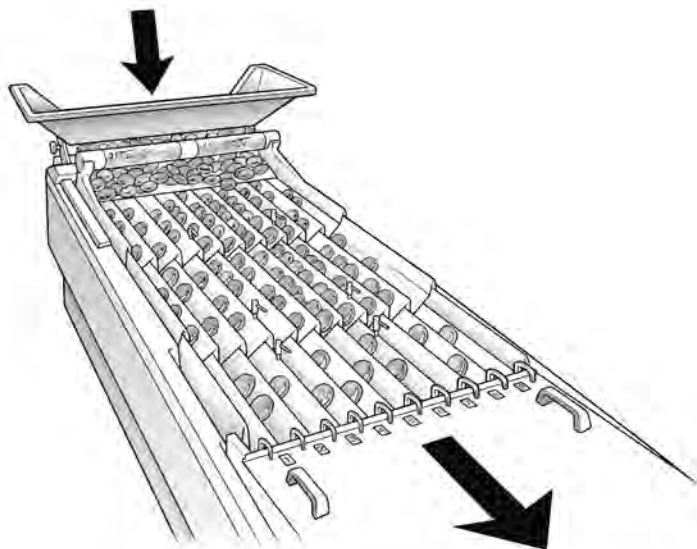
In most multihead weighers, the combinations of vibrating feeder, collecting bin and weighing hoppers are mounted in a circle. This allows for the most compact machine construction possible. The product is dispensed from the weighing hoppers into a shared funnel. Long products, such as fish, are difficult to divide in a circular fashion. For such products there are also multihead weighers with feeders and bins next to each other.

Linear filling scale

In linear filling scales, the product is fed over a central vibration feeder to a weighing hopper. The vibration feeder is divided into a coarse dosing, where a large flow of products is found, and a fine dosing, that contains a small amount of product. As soon as a set percentage of the desired weight has been supplied, the coarse dosing is switched off and only the fine dosing continues on until the total weight has been achieved. At that time, the bag can be filled. This is a time-intensive process. In addition, the precision is never greater than the weight of the product that is still underway between the time the weight is reached and fine dosing is switched off. Linear filling scales come with one to four weighing hoppers.

The counting machine

The counting machine, that is used for example for biscuits and flower bulbs, as well as for candies, resembles the linear filling scale in some respects. The product units are placed in a row behind each other on the vibration feeder. A sensor counts the passing units that then end up in the bag via a funnel. As soon as the set number of units has been achieved, a valve closes the vibration feeder. A combination of vibration feeder and counting sensor is called a channel. Counting machines come in models with six, eight and sixteen channels.



A counting machine in action

Counting multihead weighers

With some multihead weighers, it is also possible to count. By entering the piece weight of the product, the weigher can calculate how many pieces are in the weighing hopper, and it determines whether the combination of hoppers contain the desired dispensing amount. This of course, works only with products whose piece weight does not vary.

Dispensing cup fillers

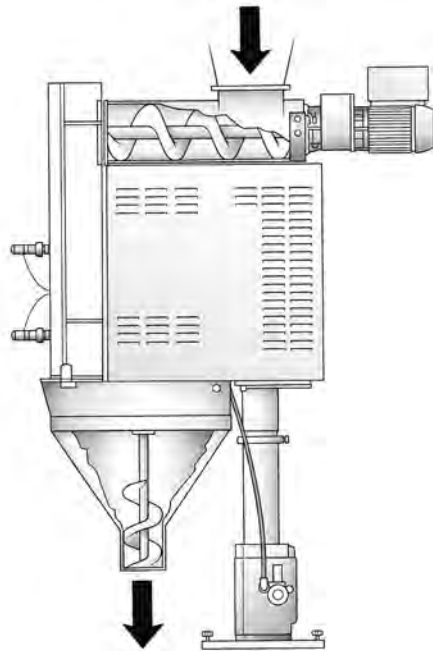
Dispensing cups are volumetric dosings; they do not measure weight, but volume. Simply stated, a dispensing cup consists of a number of containers between two disks. Above that, there is an inflow channel and a filling funnel filled with product. The disks with the containers run under the filling funnel, so that they are filled one by one. The filled containers then turn in the direction of the forming tube, above which they are emptied by opening a valve located at the bottom of each container, or simply by rotating over an opening in a plate above the tube.

Two-part dispensing cups

The containers consist of two parts that can slide apart and together vertically, which allows the content of the containers to be varied infinitely within certain limits. The precision of the dispensing cup is directly contingent on the homogeneity of the product and the consistency of the container filling.

Auger dosing

With auger dosings, the often “dusty” product is found in a supply hopper. Under the hopper is a dispensing tube in which the auger filler rotates. The dispensing tube can be closed at the bottom by a valve ball, or a clam shell, etc.



An auger dosing

Agitator

An agitator causes the product to move from the supply hopper to the auger filler. The auger rotates the powder downwards. An amount of product is transported during every revolution of the auger and transfers a certain amount of product with each revolution.

Volumetric dosings

Auger dosings are volumetric dosings, like cup fillers. The volume depends on the speed and the inclination of the auger, or the auger movement. These elements determine how much product fits between the wall of the dispensing tube and the screws of the auger.

Revolutions

By setting how many revolutions the auger makes per dispensing, one can determine how much product volume will end up in each bag. The filling weight of the bag is determined by the specific gravity of the product. The precision of an auger dosing depends on the degree of filling required from the auger filler and of the consistency of the product volume.

Stop

After every time it dispenses, the auger filler stops briefly. In order to prevent product running out of the dispensing tube at that point, the tube is closed with a valve or ball for easy flowing products (such as corn starch, for example). For ground coffee, pancake mix and other products that do not flow as easily, a restrictor is used at the bottom of the dispensing tube. That could be a ring or a screen for example.

Speed

The combination of dispensing tube, auger filler and closing mechanism is placed in the forming tube of the VFFS machine. The diameter of the dispensing tube is a determinant for the packaging speed. The greater the diameter, the more product that can be transported in one revolution. The diameter is always reduced by the space that any closing mechanism takes, therefore reducing speed.

Dispensing pump

The operation of a dispensing pump is comparable to that of an auger dosing. The pump carries the desired amount of product with a filling tube to the bottom of the forming tube. This filling tube is closed after each time dispensing not with a valve, but with a filling nozzle that depends on a product. This keeps product from falling out of the filling tube between dispensing. There are different types of pumps, such as hose pumps, displacement pumps and rotation pumps. The selection of pump is determined by the product characteristics.

Quantity designation

All consumer packages must have a weight designation that meets the specifications of the Fair Packaging and Labeling Act (FPLA). In short, this decree states that on average no less than the specified weight can be in the packaging, with the average taken of the packages made during a certain period (for example a half hour). Deviations in the specified weight can remain within strict limits.

Control weigher

When using weight, count and especially volumetric dispensing systems (auger fillers, cup fillers), it is recommended to set up a check weigher behind the VFFS machine. This weigher checks each bag and knocks or blows bags that are underweight or overweight off of the conveyor belt.

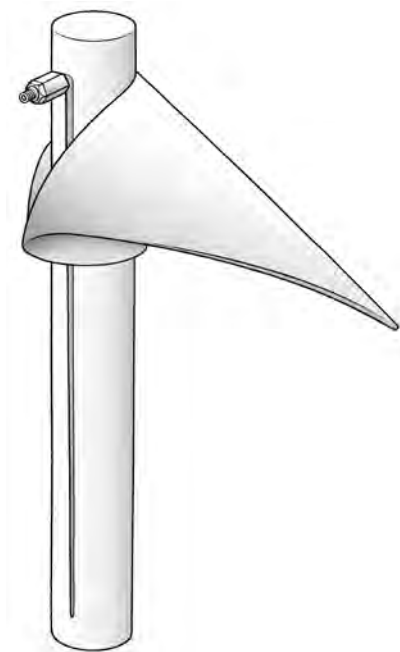
Volume change

The check weigher also documents systematic weight changes. For example, the specific gravity of coffee can exhibit differences within one batch. If that is the case, it is possible to pass on to the dosing that the filling volume must be adjusted accordingly (tendency control).

6. MODIFIED ATMOSPHERE PACKAGING

With an increasing number of products, the air in the bag is replaced by a gas. Usually this is done to combat oxidation of products such as nuts, fresh vegetables, dried milk, biscuits or coffee.

This technique is called Modified Atmosphere Packaging (MAP). The gas is known as an inert gas: carbon dioxide (CO_2), nitrogen (N_2) or a mixture of both gasses.



Forming tube and shoulder with gas supply tube

Gas tube

The gas is inserted in the bag by a gas tube that is mounted in the forming tube and connected to a gas tank, or a gas mixing system. A flow meter regulates the amount of gas pumped into the bag. The diameter and the shape (round, rectangular or oval) of the gas tube depends on the required amount of gas and the space the forming tube offers. The gas tube must be incorporated without disrupting the product flow. To prevent the product from being blown upward by the gas flow, it is advisable to keep the flow speed of the gas low.

Pre-modified atmosphere packaging

Certain products, such as dry baby food and dried milk have a large amount of oxygen enclosed in the product. In order to be able to achieve the required residual oxygen value, such products must be “rinsed” for a longer time with gas. This pre-modified atmosphere packaging takes place in the supply hoppers and the dosers.

Residual oxygen value and gas use

MAP in combination with this pre-packaging “rinsing”, can eliminate oxygen in the packaging sufficiently. The residual oxygen value can generally amount to between 0.5 and 2%. The gas use depends on the product and the amount of oxygen enclosed in the product itself. Values are between 1.5 and 4 times the bag volume; for a bag of 100 cc, between 150 and 400 cc gas is used.

Measurement tube

With a measurement tube, it is possible to continually or randomly monitor the gas climate at the bottom of the forming tube. Part of the air and gas mixture is sucked up by the measurement tube and transported to a gas analyzer. If the residual oxygen percentage increases above a set value, the operator is notified and the machine is stopped.

Measuring filled bags

Of course it is also possible to measure the amount of oxygen in filled bags in a random sampling. A needle is inserted into the packaging. The tested bag of course now has a leak and cannot be sold anymore.

Self-regulating analyzer

A recent development is a gas analyzer that regulates how much gas must be supplied based on the measured residual oxygen value. This reduces the gas use to a minimum, and prevents the outflow of gas to the manufacturing space.

Gas-tight?

How gas-tight the packaging is can be tested randomly by placing a filled bag in a basin of water and then sucking away the air above it. The negative pressure that is now created causes the gas in the packaging to expand. Any leaks are then visible as air bubbles.

7. EASY-OPENING AND RECLOSABLES

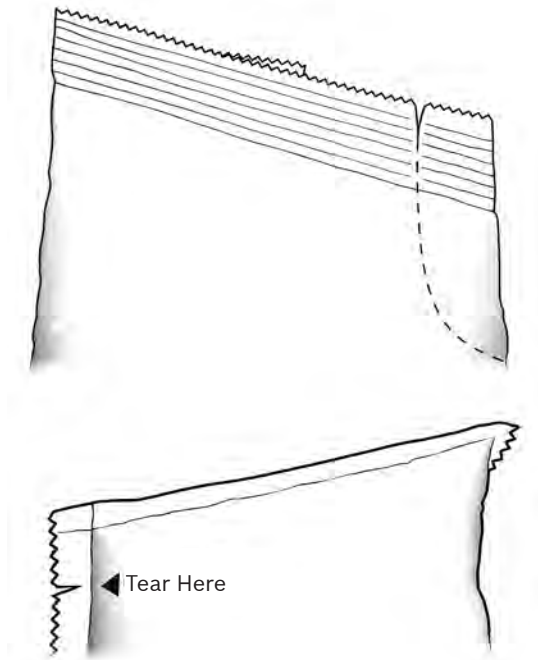
For many packages, it is important that they are easy to open, while other bags must be reclosable as well. Different solutions for easy-opening and reclosable packages exist.

Whether packaging is easy to open depends in part on the packaging material. A bag made of polypropylene film with a serrated cutting edge will tear open easily, but this material is not of course suitable for every product. Laminates with polyester (PET) for example or nylon (PA; polyamide) cannot be torn open without tools. There are laminate packages that exist that can be opened by pulling apart two layers sealed on top of each other.

Techniques

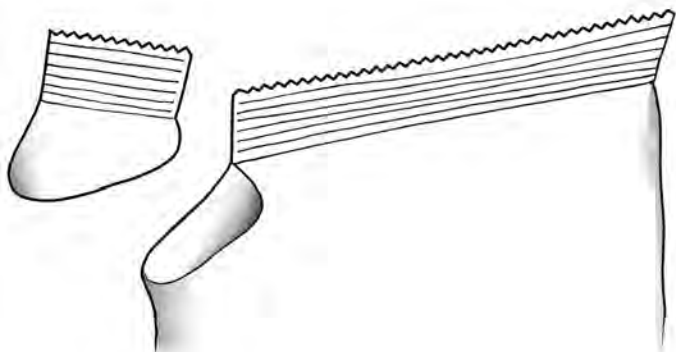
In order to make opening bags easy, the following are some of the techniques used.

- By using a coarsely serrated blade, a serration is created in the cutting edge. If the material allows for it, each “notch” of packaging formed from the serrations, can easily be ripped.
- A vertical notch is an indentation added by an extra blade to the cross seal seam. This makes it possible to tear off a corner of the packaging, such as with portion packages of mustard.
- For a horizontal notch, the sealing seam is made considerably broader on one side of the bag. Thanks to a notch added to an indentation on this side, the top of the bag is easy to tear off. This technique is used for example for packages of grated cheese and is often found above reclosable zipper features.



A vertical and horizontal notch

- The top of the bag is also easy to tear off if the bag is perforated under the top seam. Such a package is not gas-tight or moisture-tight, of course. Use of perforation occurs especially often in the frozen food industry.
- Laser cutting is a technique where the outermost layer of a laminate is already cut into with laser beams by the film supplier. With this increasingly used technique, virtually every model of incision can be created. For example, predefined tearing paths can be created which form a pouring nozzle when the packaging is opened.
- A peelable film is a laminate with a peelable layer, where the sealing seam can be pulled open. The seam has a spacious, loose overlap (the free skirt) that offers enough grip to be able to exert the required pulling force. The seal temperature determines the required peeling force. By working with different temperatures, the top seam can be made peelable while the bottom seam is not. Of course, this requires an unbalanced temperature control and the upper and lower sealing jaw must be well-isolated from each other. The peelable film is used for applications, such as cereal in a bag.



A bag with a pouring nozzle

RECLOSABLES

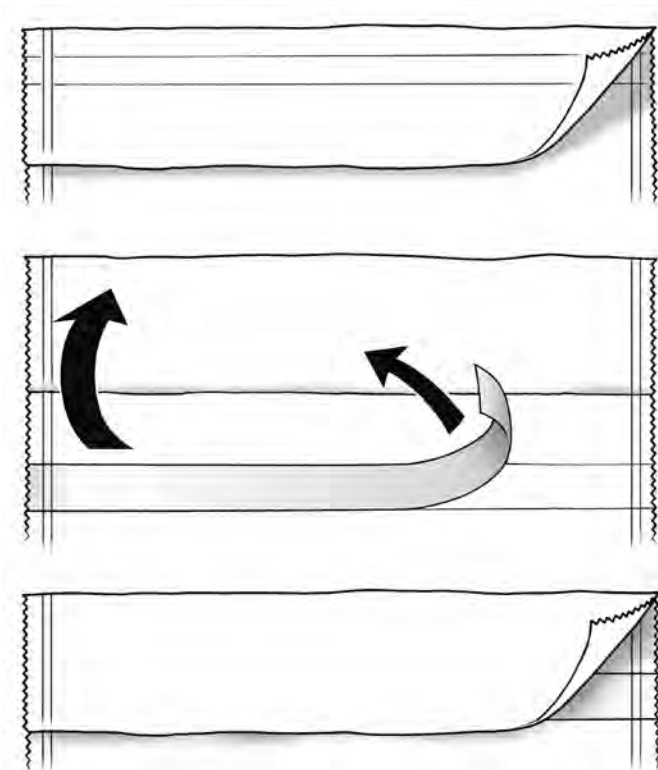
For many products, it is desirable or necessary for the partially emptied packaging to be properly reclosed. There are various systems that can be installed on VFFS machines for this. Choosing the right system depends on the product and packaging, and definitely the price. Making a package recloseable increases the price considerably. Of the systems below, a reclosable with a zipper closure is the most costly. Sealing tape adds the least amount to the packages cost.

Sealing tape

The sealing tape reclose feature is a piece of tape (or label) located somewhere on the exterior of the bag. To close the bag, the top of the bag is rolled down and secured in place by the tape (or label), on the outside of the package. It is important that the sealing tape maintains adequate adhesive strength after a few times of sticking and pulling it off, so the product can be used many times.

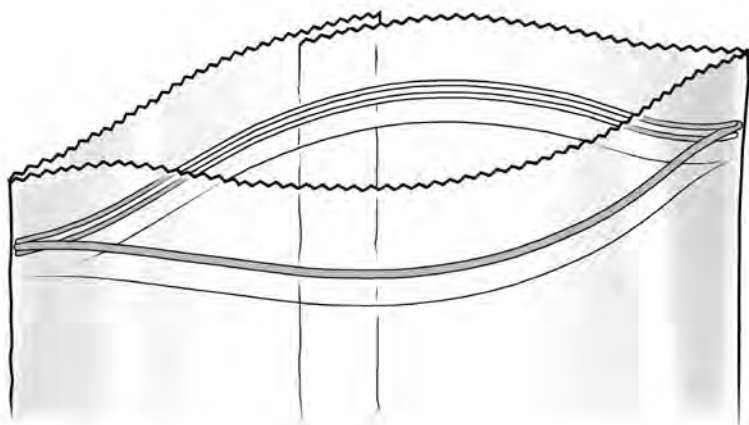
Resealable, Tape

Resealable tape can be used on bags as a reclosure feature. The strip of tape is placed under an overlap of film that is formed at the top of the bag. The strip has adhesive on both sides with a layer of film over the side that will be in contact with the film overlap. Once the bag has been opened, the covering film is removed and the bag can be simply closed by pressing the overlap onto the sticky strip. These packages are printed so that the longitudinal seam forms the top of the bag with the cross seams forming the sides of the bag. One of the many applications is a bag with a block bottom filled with candy.



Zipper closure

A zipper closure, or zipper, is used for such items as recloseable packages for frozen vegetables and grated cheese. A zipper closure is a plastic profile added to the interior of the seam that can be opened and closed like a zipper. Specially equipped machines can add the zipper closures to the film web, but there are also suppliers who incorporate these closures already in the film. With the required adaptations and a special formatting set, such a film can be processed on a normal VFFS machine. The packaging speed and the efficiency of the machine are considerably lower than they are with the machines built specially for these reclosable packages.



A zipper closure or zipper

Tin Tie

The tin tie is a recloseable system that can be found on block bottom bags used for coffee, for example. This is an approximately 8 mm (.3") wide, thin aluminum strip that is adhered under the top seam. The strip is slightly longer than the width of the bag. If the top of the partially emptied bag is rolled up, the ends of the tin tie can be folded around it, effectively keeping the packaging material from unrolling.

Tear strip

The tear strip is mainly known from the packaging of cassettes, minidisks and biscuits, but the tear strip included in the film is also used in bag packaging.

Clip

The clip, one of the first aids for reclosing bag packaging, is still used for candy, brown sugar and other products packed in conical bags. The VFFS machine seals the top seam only at certain points, after which the bag continues on to a clip aggregate. There it forms a lock top in the packaging material at the top of the bag creating a tuft where a clip cut from a roll is folded around it. The over pressurization of the bag that is created in forming the tuft in the bag can escape through the interrupted top seal seam.

Metal detector

The original clip consisted of two metal wires connected to each other by paper. These days, predominantly plastic clips are used. The sharp points of the metal wire can create minor injuries, but it is also important to consider that packages often are checked with a metal detector. In packages with a metal clip, such an extra safety inspection is of course not possible.

8. SYNCHRONIZATION

In order to have a VFFS machine work at its optimum, the production of the bags must be perfectly synchronized with the dosing of product. If that is not the case, then so-called synchronization losses can occur.

If there is proper synchronization, the dosing of the VFFS machine receives a signal at the proper moment to dispense the product, or vice versa; the machine receives orders from the dosing in order to create a bag at the proper moment.

The right moment

With products that are free-falling (not dispensed by a pump, auger or dosing cup), it is important that the first product falls into the bag at the time that the cross seam jaws have just closed. Then the product is not caught by a sealing seam, but rather by the top of the jaws that have just closed. If the product ends up in the bag too early, it can end up between the sealing jaws, or in extreme cases even in the sealing seam that is still hot from the previous cycle when it was made. This can be avoided by an electronic connection that ensures that the dosing releases the product at the right time. That time is determined by the moment that the cross seam jaws are closed, combined with the falling time of the product.

Master and slave

In the synchronization, a choice must first be made whether the doser is oriented to the VFFS machine or vice versa. In most cases, the doser is driven by the VFFS machine. The VFFS machine is then the master; the doser is the slave. The VFFS machine lets the doser know by a signal that it is time to dose the product. This signal can be issued earlier or later in the machine cycle. The determining factor is the falling time of the product.

Determining the falling time

The falling time of a product is determined by trial and error. Trial and error testing is usually conducted at a low machine speed, and often with a transparent film. The transparent film allows for observation of the product reaching the bag as well as the seal jaws closing. If the product comes down too early, the signal needs to be given later. If the product is slower than expected, the signal needs to be earlier.

Synchronization losses

As soon as the doser issues the product, it sends a dosing finished alert to the VFFS machine. Then the machine knows that a product is on the way and that a new bag needs to be made. If no dosing finished alert is received, the machine does not make a bag but it starts the next cycle. This function is referred to in the jargon as “no filling – no bag”. It can also occur of course that the doser is not ready in time to dose the product for the next bag. The doser must then wait one machine cycle and no bag is made: in the output, one machine cycle is lost. Both types of loss are called synchronization losses.

The doser as master

If the master function is played by the doser, the VFFS machine receives orders to make a bag at the time the doser is ready to dispense product. The big benefit of this type of synchronization is that less synchronization loss occurs. The dosing can however only be set as the master in machines where the different machine movements can be driven (in contrast to VFFS machines with a fixed cycle driven by a central main shaft), such a machine can make the next bag immediately after a bag is made, when it receives the next signal.

Central main shaft

Machines with a central main shaft start immediately on the next cycle. Therefore, the next order can only be accepted once the previous cycle has been completed entirely. This does not mean that a bag actually has to be produced. For example, the sealing jaws can complete the vertical movement driven by the fixed main shaft, but not subsequently close. Then no bag is made.

Packer

If for example, there is an automatic case packer set up behind the VFFS machine, then it is advisable to involve this machine in the synchronization as well. Then the VFFS machine will always check whether the case packer is ready to receive bags. For example, if there is a disruption to the case packer, then the production of bags is interrupted until this disruption has been remedied.

Carton Machine

If gusset bags are packaged in a surrounding carton (see page 9), then it is possible to have the carton machine call for the next bag. In that case, the carton machine is the master, and both the VFFS machine and the dosing play the role of slave. Such a complex synchronization is only possible if all of the machines in the packaging line are equipped with servomotors and microprocessors, so delays and accelerations can be adequately signaled and compensated for.

Asynchronous

If one or more machines are not equipped with servomotors and microprocessors, the carton machine will have to be set at a speed approximately 10% higher than the VFFS machine, in order for the carton machine to keep up with the bags coming out of the VFFS machine. In this case, it is an asynchronous link.

9. TIPS AND TRICKS

This chapter has various practical tips and tricks for making the packaging process easier, quicker or without any disruptions. Most topics dive more deeply into components of the process that were already discussed in previous chapters.

The topics that will be the focus of the next pages are, in order:

- Optimizing the funnel design;
- Avoiding the hour glass effect;
- Improving dust suction to prevent poorly closing seams;
- Using catch plates to slow down sharp products or to break the fall of breakable products;
- Printing;
- Coding;
- Labeling.

FUNNEL DESIGN

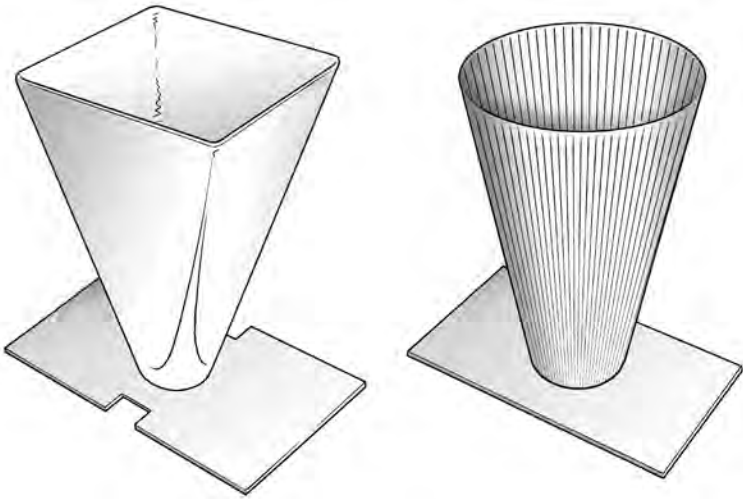
Filling scales, counting machines and cup fillers (see chapter 5) have a funnel that connects the outflow opening of the dosing with the inflow opening of the forming tube. The design of this funnel is very important for packaging speed.

From small to large...

The optimum funnel shape would have a smaller opening at the top than on the bottom. Such a reverse funnel is of course a utopia, but one that illustrates what one can aim for. With a reverse funnel, the batch is always smaller than the inflow opening of the forming tube. The batch can accordingly fall straight downwards, which means that the product stream remains as short as possible. In addition, the air displaced by the falling product can easily escape upwards along the product (downwards is not possible, the bag closes off the bottom of the tube). This keeps the falling product from sealing off the forming tube with suction.

... from large to small

In practice, the outflow opening of the dosing is of course larger than the inflow opening of the forming tube, and so the funnel has to progress from large to small. It is very important that the model of the funnel is selected in such a manner that the funnel does not slow the speed down too much, so product does not get stuck.



....of great importance to packaging speed....

Slide

If the inflow opening of the forming tube is considerably smaller than the outflow opening of the dosing, it is often better to not select a round funnel, but rather a rectangular model with three straight sides and one slanted side. Then the dispensing happens on the slanted side, functioning as a slide. The longer the slide (or the higher the product is placed on this side), the more the batch is pulled apart; the slide lengthens the product stream, which helps prevent clogs.

Test Funnel

In addition to round and rectangular funnels, there are also parabolic funnels. If a high packing speed is the objective, it is often worth it to take the effort to experiment with the funnel shape. Acetate film is excellent for this purpose: with this sturdy material, it is easy to shape different funnel models. Because it is transparent, it is also possible to clearly see how the product is moving through the funnel. The experimental model can also be supported by a steel framework.

HOUR GLASS EFFECT

If there is a large product volume and a small inflow opening of the forming tube, the hour glass effect easily occurs because at the end of the funnel, the product is slowed down greatly. This effect can be prevented in different ways:

- If the product does not fall in the middle but on the slanted sides of the funnel, it is pulled apart. When this happens, a compact product ball turns into a product stream.
- By placing a thin rod suspended in the middle of the funnel the product is prevented from forming a bridge that blocks the funnel hole.
- By dividing the inner wall of the funnel with vertical strips into a number of segments, slides are created that keep the product from spinning around.

DUST SUCTION

When packing “dusty” products, poor seal seams can be created by dust that blows around downwards in the forming tube and ends up in the sealing seam when the cross seam sealing jaws close. It is not an option to wait until all the dust is in the bag because this would severely decrease the packaging speed.

Air up

As described above already, the falling product displaces the air in the bag and forming tube upwards. This rising air allows the dust particles in the product ball to be released and to drift downwards slowly, instead of falling with the product. This problem compounds when the space between the wall of the forming tube and the product ball is tight. As the space gets smaller, the air flow will propel through the product with greater force.

A second tube

This problem can be solved by offering the escaping air a different route, for example with a second tube mounted in the forming tube. The product falls through the inner tube into the bag, while the air between both tubes is pushed upwards.

Dust suction

The flow of the escaping air can be improved more by adding a suction system at the opening of both tubes. If this additional suction is too strong, then the risk develops that a vacuum is created in the bag that is about to be filled. To prevent this, the space between the forming tube and inner tube can be divided in half. On one side, the air can be suctioned away from the bottom, no vacuum is created in the bag because the air is sucked up along the other side from the top of the tube.

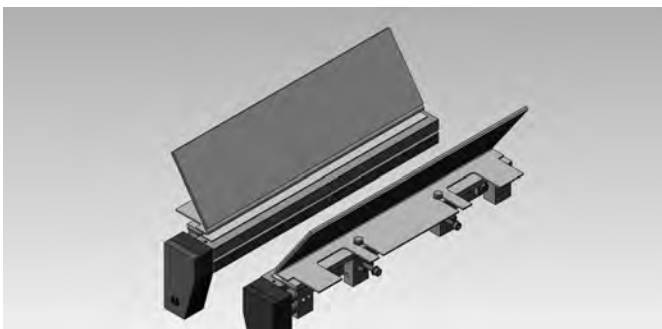
Incorrect

This technique is called “dust suction”. Given the above description, this name is actually incorrect: no dust is suctioned, but the dust belonging with the product ends up in the packaging together with the product. To be clear; if there is no disrupting air flow, the dust falls just as quickly as the product itself does.

CATCH PLATES

For frozen products with sharp edges, such as fish and french fries, there is a risk that the falling product will cut and break the bag as it falls. This can be prevented with catch plates that slow the fall of the product.

These plates can also have a soft coating, so they can be used for cookies and other products subject to breakage. The catch plates are mounted in a V-shape above the cross seam sealing jaws.



Catch pans

PRINTING

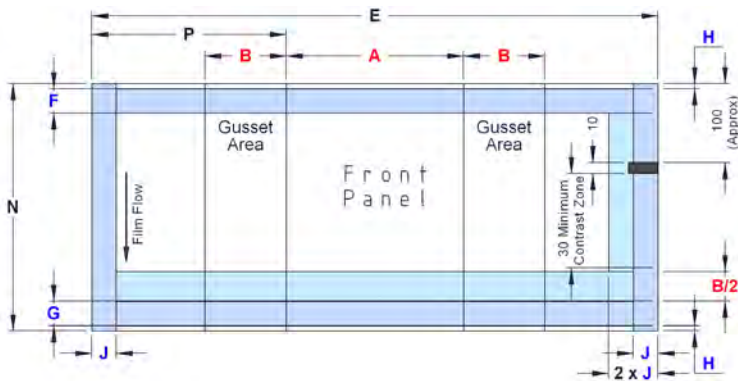
When designing the printing of packaging film, there are many factors to be taken into consideration. It is important to have your machine supplier provide you with a bag drawing to start with. Such a drawing will show you exactly where printing is possible and where it is not.

Bag drawing

The example below shows the space of the laid out material that is taken up by the longitudinal and the cross seams. The two extra spaces where no “text or figures” can be placed are the spaces that will later fall within the corners of bags with a block bottom.

Examples

It is beyond the scope of this book to list everything that must be taken into account when designing and carrying out printing. The following examples adequately illustrate various factors.



A block bottom bag drawing displays the most important dimensions of the bag.

- Color differences on the transition between two bags should be avoided because they emphasize the unavoidable length differences between bags.
- Horizontal lines on or immediately under the cross seams also give away the slightest misalignment of the packaging material.
- If pictures and words do not continue onto the longitudinal seam, the printing will match up properly even if there are deviations.

- For bags with an overlap seam, the exterior of the packaging material at the cross seam is not pretreated for printing, a good seal is made impossible by such pretreatment.
- If the exterior of monofilm is printed, heat-resistant ink must be used.
- Laminates often are given a sandwich printing, the printing is between two film layers. This prevents damage to the printing during sealing, as well as during transport inside the machine and in the processes before and after that. This technique can also be used for monofilm. In that case, two layers of monofilm are used.

CODING

Virtually every bag must be furnished with one or more codes or other data: an expiration date, for example, or barcodes, production codes, ingredient lists or a filling weight. Different types of printers are used for this type of printing.

- Thermotransfer printers print the data with a printing stream and a heated print head.
- Ink jet printers have a sprayer head with which minuscule ink drops are sprayed on the film.
- A laser printer burns the desired data into the top layer of the film.

Thermotransfer printers

The thermotransfer printer is currently used the most. Wording, logos and even barcodes can be printed with hair-fine accuracy and quickly with such a printer. Running film can also be printed, which is of course very important with continuous machines. Thermotransfer printers are installed in the film path of the machine. The built-in sizes of the printer are important, a large printer often means extending the film path (see page 16).

Ink jet printers

Ink jet printers can be used if the text can or must be printed along the length of the packaging. Because the jet is connected by hoses to an ink tank and an operating unit, the jet is still while the film moves underneath it, so it is not possible to print crosswise from the running direction of the film. It is also possible to move the jet over the film that is not moving, but in VFFS machines this option is rarely if ever used. A benefit of the ink jet printer is that the jet takes up considerably less space to build in than does a thermotransfer printer.

Laser printers

Laser printers are still rare in VFFS machines. The most important difference with the ink jet printer is that laser printers do not use ink, but “print” by burning the top layer of the film. In order to have the result be visible, there must be adequate color contrast between the top layer and the lower layer. A second requirement is that the underlying layer can take over the protective function of the top layer.

LABELING

Increasingly often, bags must be furnished with stickers. This could be for example for additional advertising or special sales, but there are also packages of unprinted film where all the product information is on the sticker.

On the forming tube

Labels are the easiest to stick on the bags under the forming shoulder. The forming tube then provides a hard surface, so the label is stuck on without wrinkles and securely. Unfortunately, many machines have little space there for what is usually a fairly large labeling machine. A second drawback is that the choice of position of the label is limited to a small portion of the front of the bag.

In the film path

That is why the label is increasingly often placed on the flat film, after which the film is pulled over the forming shoulder. In practice, this does not cause many problems. It is important that the label be of good quality (the cutting edges of the label cannot exhibit any glue residue for example). Also the run-in angle of the forming shoulder cannot be too steep.

On the exit conveyor belt

The third possibility is to wait to attach the label to the exit conveyor belt as the bag is leaving the VFFS machine. Then the size of the labeling device does not play any role and both this device and the VFFS machine remain optimally accessible. The drawbacks are that positioning of the label is difficult (the bag is loose on the belt) and of course it is difficult to label a filled bag without wrinkles.

10. PURCHASE RECOMMENDATIONS

VFFS machines are complicated, versatile machines with a long life, where their ultimate cost depends on a complicated set of factors. All the more reason to take good advice when purchasing or replacing such a modern and costly piece of technology. This chapter focuses on some important elements.

The prices of VFFS machines range from around 50,000 to over 400,000 dollars. The most affordable VFFS machines are intermittent machines with limited output possibilities and a relatively small format range. The film transport is provided by one or two friction belts (see page 21) and the sealing system has a limited maximum pressure and control precision. On the other side of the price spectrum are the high-end continuous machines with vacuum-supporting film conveyor belts that can produce the most wide-ranging bag shapes, whether or not combined with various recloseable and easy-opening-packages. A higher price generally means greater flexibility, a higher speed, and more possibilities for expansion. When purchasing a new machine, it is of the greatest importance to carefully consider what the machine has to be able to do and what is expected in the future.

Complicated set of factors

Because the subject matter is so complex, often certain aspects are given so much attention that other, equally important elements are disregarded. For example, it is of course important to give close attention to the different sealing systems for heat-sealable and non-heat-sealable (polyethylene) materials, but it is just as important to know the choice of the film transport, the length of the film path, the mechanical sealing pressure and the control of the sealing temperature is directly related to the quality of the materials that can be processed. The lower the quality of the packaging material, the higher the requirements that are for all these subsystems.

Higher and smaller

A higher packaging speed demands tighter machine tolerances. This not only plays a role in the production and choice of the components (material, model and other factors), but also in the composition and setting of the machine. A high packaging speed demands extra precision, assembly time and detail engineering.

Total cost of ownership

The most important element of all of course is the total cost of ownership. Only an experienced advisor can provide you with detailed information. To start with, it is good to know that the initial investment in the machine is spent many times over on the packaging material to be processed. Losses caused by the machine, for example for size changes and disruptions, have a much greater effect on the total production cost than the depreciation of your machine investment.

Quality and susceptibility to maintenance

The quality of the components used in the machine directly relates to the susceptibility to maintenance. If that quality is not optimum, then maintenance can become a relatively high cost item. This is just one of the many elements that demand a good understanding of the service organization, and the know how and the experience of your supplier. Finally, undesired machine downtime is a cost that makes many other expenditures pale in comparison.

Where, what, when

Other factors that play a role in the purchase of a VFFS machine include the environment in which the machine is used, the products to be packaged and the production time. The completely continuous packaging of frozen vegetables requires a very different machine and a different machine quality than the eight hour per day packaging of Legos.

Flying and diving

Because VFFS machines are so flexible and offer so many expansion possibilities, there is the danger that they become some kind of flying submarine. It is wise to take a somewhat restrictive approach. Many of the expansion possibilities can be supplied later and built on. That also means that you can start with as clean a machine as possible, and that you only purchase options and install them once you really need them.

Software

The emergence of servo-driven equipment has sharply simplified the mechanical structure of the VFFS machines. The complexity has been relocated from the mechanics to the software – and the quality of that is unfortunately much more difficult to evaluate. So the risk of a mispurchase has increased.

Advice

It should be clear that you should preferably gather information from a respected supplier or advisor who knows what you need before purchasing a VFFS machine, someone who has the expertise, experience and time to adequately map out and analyze that. We hope that the knowledge you have gained in the preceding chapters will allow communication with such an advisor to proceed easily and effectively.

GLOSSARY AND INDEX

Air-tight See: Gas-tight.

Auger dosing (9, 50, 54-55) Volumetric dosing that issues a certain amount per auger movement or rotation.

Backing (40) The bearing layer of a laminate.

Bag spreaders (11, 22, 27) “Fingers” made out of spring steel that prevent pleats in the cross seams in pillow bags.

Bag with a block bottom (9, 11-13, 43, 63, 72) Bag that can stand on a rectangular or square bottom. Also known as a stand-up bag.

Batch (36-37) The content of one bag. Also known as the portion or bag filling.

Belt pick-up principle (20) System with which the packaging material is propelled along the forming tube by running conveyor belts.

Bottom seam (6-7) The cross seam that closes the bottom of the bag.

Catch plates (68, 72) Plates mounted in a V shape above the cross seam sealing jaws with which to reduce the falling speed of “sharp” products.

Clip aggregate (64) Recloseable packages that close with clips.

Coding (73) Virtual every packaging must be furnished with one or more codes. Different types of printers are used to do this.

Cold-seal coating (39) Sealing under pressure without heat.

Collar (23 - 26) Part of the forming shoulder the packaging material passes over.

Continuous machine See: Intermittent machine.

Counting machine (8, 50, 52-53, 68) Dosing for products packaged in specified quantities.

Cross seams (6, 11, 27, 30-32, 44, 62, 72) The top and the bottom seam of a bag.

Cup filler (50, 53, 55-56, 68) Dispensing system with containers varying in size.

Cutting edge (44, 59, 74) Unsealed film edge for the top or bottom seam.

Dancer arm (16) Arm mounted on torsion springs that helps regulate the tension on the film.

Dispensing pump (50, 55) Dispensing system for liquids.

Dosing (8, 50-56, 65-66, 68-69) Dispenses the product in doses ie. Different products require different dosings, such as a cup filler for granulates, an auger filler for powders or a dispensing pump for liquids.

Doypack (11) A bag with a flat bottom sealed on three sides.

Drag longitudinal seam (34) A longitudinal seam created by a longitudinal seam anvil. See: Longitudinal seam.

Draw bar principle (19) Here the packaging material is moved forward by the sealing jaws acting as pinchers or draw bars.

Dust suction (68, 70-71) There are different ways to improve dusty product packaging.

Easy-opening (42, 59-64, 75) There are different techniques for being able to have packages open more easily.

Expiration date (16, 73) Best if used by.

Falling time (36-37, 65) The time a batch is dropping from the dosing to packaging.

Filling scale (8, 50, 52, 68) Dispensing system based on a filling weight/ bag.

Filling tube (25, 55) Because the packaging is filled through the forming tube, the forming tube is also called the filling tube.

Film roll (3, 5, 11-12, 14-15) The packaging material is supplied on a roll. The packaging process starts with the film roll.

Film web (5-6, 10, 14-16, 18, 22, 25, 63) The length of film material between the roll and the forming shoulder.

Film width (13, 15, 29) The film width is connected to the bag width and the type of longitudinal seam.

Fin seal See: Fold-over seam.

Flat bag See: Pillow bag.

Fold-over seam (8, 28-29, 40, 43) Longitudinal seam where one side of the packaging material is folded over, after which sealing can occur (fin seal).

Forming shoulder (3, 5, 8, 22-29, 74) Heart of the VFFS machine. Together with the forming tube forms the flat film material is formed into a tube that the bags are made from.

Forming tube See: Forming shoulder.

Free skirt (60) The loose overlap with which a peelable seam can be opened.

Free-falling product (65) Product that is not dispensed by a pump or auger filler.

Friction belts (20-21) Conveyor belts that work on the basis of friction in machines with the belt pick-up principle.

Funnel (37, 52-53, 68-70) If the size of a batch is larger than the diameter of the forming tube, a funnel is required to guide the product into the forming tube.

Funnel shape (68, 70) Of great importance to the packaging speed.

Gas-tight (40-42, 58, 60) For certain products, packages must be gas-tight.

Gas tight is a higher requirement than air tight.

Gusset bag (9, 11, 20, 27, 67) Bag that is folded on both sides. Makes optimum use of the space possible in a cardboard box.

HDPE film (34) High-density polyethylene film. Is used for such applications as packaging breakfast cereal.

Heat sealing (10, 38, 40, 47) Sealing by a combination of heat, time and pressure.

Heat-sealable (34, 38, 40, 75) Most laminates are heat-sealable. Materials that melt too quickly (such as polyethylene) must be sealed in a different way.

See: Polyethylene sealing systems.

Horizontal notch (59, 60) System to make packages easy-to-open.

Horizontal serration See: Serration.

Hot air longitudinal seam (34) Longitudinal seam formed with hot air for non-heat-sealable packaging materials.

Hot-tack (46) If there is a poor hot-tack, the sealing seam is not stable quickly enough.

Hour glass effect (37, 68, 70) Effect that occurs in funnels.

Impulse system (49) Poly-ethylene sealing system with the power wires receiving a brief, powerful electrical impulse for each bag

Intermittent machine (31-32, 39, 75) In an intermittent machine, the packaging material does not move while the longitudinal seam must be sealed: so that is once per machine cycle. In a continuous machine the material is – as the name suggests – transported continuously.

Labeling (71, 74) Bags can be furnished with a sticker or label at different times in the process.

Laminate (4, 9-10, 28, 34, 38, 47, 59-60) Material (for packaging) composed of different layers, for example consisting of a separate backing, a barrier film and a sealing medium (usually polyethylene).

Lap seal (8, 28) See: Overlap seam.

Laser cut (60) Technique to allow packages to open more easily by implementing a laser score in a layer on the packaging film.

Lightning strike (25) Diagonal fold in the packaging film caused by an overly narrow gap between the forming shoulder and tube.

Linear filling scale (52) Dispensing system that works with coarse and fine dispensing.

Lock top (64) Closes and forms the tuft of bags that reclose with clips.

Longitudinal seam (6, 8, 13-14, 22, 28-34, 40, 43-45) The seam that closes the length of the bag.

Longitudinal seam anvil (34) Makes a longitudinal seam in the packaging material as it moves underneath it.

Machine cycle (6, 17, 19-20, 22, 25, 34, 39, 45, 65-66) The time and steps required to make one bag.

MAP See: Modified Atmosphere Packaging.

Marker (or eye spot) (17) Marking that is read by a photo cell to determine bag length.

Master (65-67) During synchronization, the dosing can drive the VFFS machine, or vice versa. One device is the master, the other the slave.

Metal detector (64) Is often used to detect metal parts that have gotten into the package.

Modified Atmosphere Packaging (57-58) Replacing the air in the package with gas. Prevents oxidation and lengthens the shelf life of the product.

Monofilm, monomaterial (9) Material (for packaging) consisting of one layer.

Multihead weigher (50-53) Weigher that works simultaneously with multiple weighing hoppers. Yields precise weighing results.

Overlap seam (8, 28-29, 40, 43, 73) Longitudinal seam where one side of the packaging material is placed over the other side, after which sealing can occur (lap seal).

Packaged under protective atmosphere See: Modified Atmosphere Packaging.

PE sealing system See: Polyethylene sealing systems.

PE See: Polyethylene.

Pealable film (60) Film where two of the layers can be separate from each other (peeled).

Perforation (60) Bags can be made easy-to-open by a perforation under the top seam.

Photo cell See: Marking.

Pillow bag (9, 11, 20, 27) Simple bag shape. Also called flat bag.

Pitch (41-42) The distance between the ribs of the serrations.
See: Serrations.

Polyethylene (PE) (7, 9-10, 21, 28, 34, 38, 40, 47, 49) Plastic that melts at a relatively low temperature. It is used extensively as a sealing medium in laminates, and also as monofilm.

Polyethylene sealing systems (38, 47) The low melting temperature of polyethylene requires special sealing systems.

Polypropylene (PP) (9, 28, 59) A reasonably well sealable, clear and easy to rip open monofilm, often used in candy/ pasta application.

PP See: Polypropylene.

Pre-modified atmosphere packaging (58) “Rinsing” products with gas that have a large dose of oxygen inside them.

Product stream (36-37, 45, 68-70) The distance between the first and the last product from a batch.

Quantity designation (56) This designation must meet the Quantity Designation Decree.

Reclosable (59-64) Resealable packaging.

Resealable tape (62) Recloseable easy-opening bag.

Residual oxygen value (58) Percentage of oxygen that remains in the packaging after modified atmosphere packaging.

Restrictor (55) Ring or screen which prevents certain products from flowing out of the dispensing tube.

Run-in angle (23, 74) The angle of the wings of the forming shoulder. This largely determines the tracking behavior of the film web.

Sandwich printing (73) To prevent damage to printing, it is often applied between two layers of film.

Sealing (7, 38-49) Bringing materials together under the influence of heat, pressure and/or time.

Sealing jaws (7, 10, 19, 22, 30-33) The jaws that create the end seal in one of the two polyethylene sealing systems.

Sealing jaws (7, 19-20, 25-27, 30-33, 36, 39-49) The jaws that seal the packaging material; divided into profiled cross seam sealing jaws and flat longitudinal seam sealing bars.

Sealing medium (7,9-10, 28, 31, 40) Material that easily melts and congeals again, so that in a short time and at a relatively low temperature a stable seam is created.

Sealing profile See: Serration.

Sealing tape (61) A piece of tape attached to the packaging with which the bag can be reclosed multiple times with.

Sealing unit (5, 7, 30, 44) Housing of the sealing jaws.

Sealing wire (47-49) Metal wires coated with Teflon for sealing polyethylene.

Serration (40-42, 44-45, 59) The sealing profile on the cross seam sealing jaws. A horizontal serration is used for packages that must be gas-tight. A bag with a vertical serration is easier to rip open.

Shaping parts, formatting set (22, 27) The required combination of forming shoulder and forming tube for each bag width . Also collectively called the shaping parts or forming set.

Signal (65-66) The VFFS machine lets the dosing know that it is time to dispense the product by sending a signal.

Slave See: Master.

Standing bag See: Bag with a block bottom.

Synchronization (65-67) The link between dosing and sealing jaws.

Tear strip (63) A strip included in the film making the packaging simple to open. Especially well-known from the packaging of biscuits or cigarettes.

Tear zone The bag rips only along a tear zone indicated with an arrow, and not on the opposite side.

Teflon cloth (47-49) Prevents easily melting polyethylene from melting onto the sealing system.

Temperature window (38) Range limited by the minimum melting temperature and the burning temperature of a material (for packaging).

Tendency control (56) System where a control weigher alerts the dosing that the dosing must be increased or reduced.

Tin Tie (63) Reclosure system with an aluminum strip.

Top seam (6-7, 30, 44, 60, 63-64) The seam with which the bag top is closed.

Tracking behavior (20, 22-23, 29) Tendency of the flat film to move straight ahead, or to deviate from this track.

Tuft (64) The packaging material bunched together at the top of bags that are reclosable with clips.

Ultrasonic sealing (45) New sealing technique which uses high frequency movement of the film to create friction and heat to seal the film layers together.

Vacuum belts (20-21) Conveyor belts where the packaging material is suctioned against the belts, making film transport friction-free.

Vertical notch (59) System to make packages easy to open.

Vertical serrations See: Serrations.

VFFS machine (1-6) Vertical form, fill, seal machine.

Vibration feeder (51-52) Important part of different dispensing systems.

Volumetric filler (55-56) Dosing that dispenses for each set volume, such as cup fillers and auger fillers.

Wings (23) The film passes over the wings of the forming shoulder towards the forming tube.

Zipper, zipper closure (59, 61, 63) Zipper made from plastic that makes the packaging recloseable.

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