

## Producing Quality Packages on Vertical Form/Fill/Seal Baggers- The Basics

This technical paper discusses the key basic principles of bag forming and sealing on vertical form-fill-seal packaging machines. Discussion of the design, function and adjustment of forming sets and sealing jaws is organized sequentially, following the film from the roll as it is formed into a tube, back-sealed, filled with product, and end-sealed.



Produced in association with:

**KENRAY®**  
FORMING LTD

## Introduction

The criteria used to determine whether a package produced on a vertical bagger is of acceptable quality or not will certainly vary, but in any situation it can be said that the bag must be properly formed and well sealed. In order to accomplish this, the design, set-up and adjustment of the forming set and the sealing jaws are critical factors.

A simple visual inspection of a package can often reveal much about the forming set quality and installation. Are the packages consistent in size and shape? Is the printing correctly oriented? Are they without unwanted folds, wrinkles, or other cosmetic blemishes?

Assessment of end seal design and adjustment can be more complicated. Some problems are obvious and can be easily seen-- splits in the film or open seals, for example. But a seal that looks good may still not possess the required strength or integrity, and some form of additional testing is required. This can range from a simple squeeze of the package to more sophisticated methods such as gas detectors and vacuum creep or burst tests. Ultimately, any way you measure it, a quality seal must be strong enough to hold the product in the package and hermetic enough to keep it fresh for the term of its intended shelf life. And the basic equation for *obtaining* a good seal—heat +time + pressure—is the same no matter what type of test you use and no matter what shelf life you require.

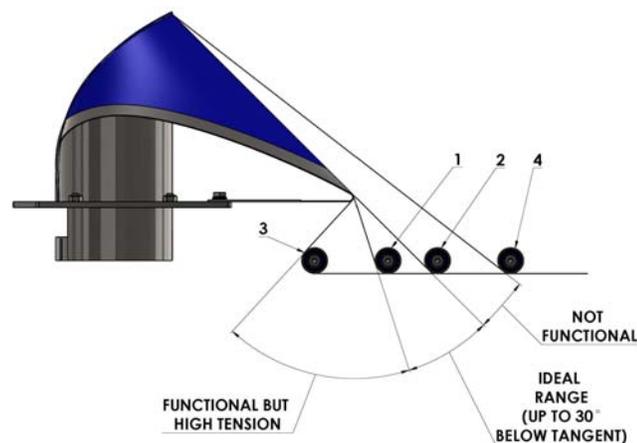
# Bag Formation

## 1. Film Contact with the Former

The forming set guides a flat sheet of film off the roll and into the shape of a tube. The collar (or shoulder) must completely support the film throughout this process. The film must flow over the collar and the lip at the top with even contact and tension, otherwise the resulting puckers, folds and wrinkles in the film can translate into poor appearance, malformed bags and bad seals. Proper forming set design, construction and adjustment are critical here.

### Roller Positioning

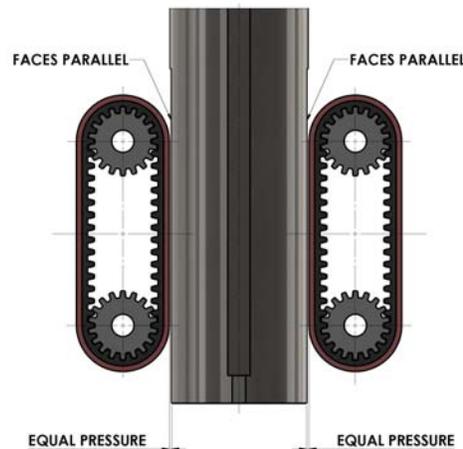
The standard roller position is tangent to the plane of the forming wing (position 2 in the graphic below). If experience dictates that additional tension is required, then positioning the roller up to 30° below tangent may also be acceptable. If film feeds onto the forming collar at angles greater than 30°, the excess tension can impede the flow of film through the machine. Conversely, any position above tangent will lift the film off the shoulder and will likely result in poor tracking and wrinkles caused by inadequate tension.



Rollers must also be positioned parallel to the leading edge of the former wing, so that film tension is even on each side. Misaligned rollers can create horizontal creases in the bag and misalignment of graphics, and can cause uneven and excessive wear on the forming collar.

## 2. Drive Belt Alignment

The drive belts, one on each side of the forming tube, draw the packaging film through the bagger. The belts must be synchronized, so that they pull the film with equal tension, and the face of each belt should make full contact with the film and exert consistent pressure.



Belt drive misalignment can result in slippage, uneven belt wear and inconsistent contact between the film and the forming collar. Symptoms include inconsistent bag lengths, horizontal wrinkles, back seal problems and packages that are not square.

In order for the drive belts to exert equal, consistent pressure, the forming tube should be:

- properly aligned with the forming collar, so that the tube is vertically straight when it mounts in the machine and the top and bottom ends of the belts make equal contact with the film.
- centered and properly oriented (not twisted) so that the full face of each belt is aligned with the corresponding flat section on the forming tube.

If necessary, drive belts can usually be adjusted to help fine-tune these principles. However, properly constructed forming sets minimize the need for readjustments when formers are changed.

## 3. Back Seal

The back seal on the package will be either a fin seal or a lap seal, and the former will be designed accordingly. There are various methods used to make the back seal, but, whatever process is used, it's important for the forming tube to be correctly positioned in order to help ensure a quality seal.

## **4. Product Flow**

The geometry of the tube must be designed for the specific bag specifications and product type to avoid bottlenecks that slow the speed of production or blockages that cause machine downtime. In addition, improperly distributed product can get caught in the end seal area, causing inferior seals or product jams.

## **5. Design and Construction**

Forming sets are designed for specific packaging machine models according to the desired bag size, the need for either lap or fin seal, the product to be packaged, and special options such as block-bottomed bags and gas flushing. These specifications dictate the forming set's geometry, which includes the shape and size of the collar, the bending curve at the lip, and the alignment and shape of the forming tube. Proper design and consistent replication of this complex geometry speed forming set installation and are vital for the formation of smooth, consistent quality bags.

As forming sets run, damage or wear can alter the geometry and cause poor quality bag formation. This is particularly important on the shoulder and the lip. Damage can largely be prevented by properly handling and storing the forming sets, and durable coatings can be utilized to help to reduce the rate of wear.

## **6. Impact of Bag Forming Issues on Seals**

As previously stated, many problems associated with improper forming set design and adjustment cause wrinkles and folds to occur in the packaging film. These imperfections are cosmetically undesirable, but they can also result in seal integrity problems. If they occur in the end seal area they create a much greater prospect for leakers because of the difficulty in transferring heat and pressure through the extra layers of film. The impact that proper bag forming has on seal quality is often overlooked and can improperly focus problem solving on the symptoms rather than on the true root cause of the problem.

## End Seals

The basic equation for sealing flexible packaging film is:

$$\text{heat} + \text{time} + \text{pressure} = \text{seal}$$

These three factors are closely related—an increase or a decrease in any one will have an impact, positive or negative, on the others. For example, if line speed is increased (and dwell time reduced), then an increase in heat or pressure is often required to maintain seal integrity. The design of the sealing jaws is critical in assuring that these factors are optimized and that a quality seal is achieved.

### Heat

The films used on vertical baggers are typically composed of multiple layers, each designed to achieve a specific purpose. The inside layer, a heat-activated sealant layer, is bonded to other materials that are usually not heat sealable on their own, such as oriented polypropylene (OPP). Each film has a *Seal Initiation Temperature* (SIT), at which the sealant layer is activated (melted) enough to provide a minimally acceptable seal, and a *Maximum Temperature*, beyond which the film becomes distorted or damaged. The temperature range between the seal initiation temperature and the maximum temperature is the *Operating Window*.

The objective is to transfer enough heat from the sealing jaws, through the outer layers of the film, so that the sealant layer reaches at least the Seal Initiation Temperature. The composition of the film, the style of the package, and the quality of the formed bag can impact the ability to drive heat through to the sealant. A higher heat setting may be required for thick or metalized films, for instance, or for packages with extra layers of film from gussets or wrinkles.

Inadequate heat can result in unsealed packages, channel leaks, and weak seals. If too much heat is transferred, the film will distort or shrink, melt, fracture, and/or have inadequate hot tack (the maintenance of seal strength and integrity when the seal is still warm and subject to the weight of the product after the jaws open).

Regulating heat is, unfortunately, not as straightforward as simply adjusting the temperature setting on the controller so that it is within the operating window. Temperature controllers vary in accuracy and responsiveness, and their readings indicate the jaw temperature at the thermocouple—which is typically buried somewhere inside the jaw—not at the sealing face. This face temperature can also vary along the length of the jaws, since heat dissipates more quickly near the ends.

If you suspect that you have heat issues, use a pyrometer to check the temperature at multiple points along the sealing jaws, on a flat surface as close to the serrations as possible. If you find

inconsistencies, an upgrade of heaters or sealing jaw materials can help. Preferentially wound heaters, which are hotter near the ends, can help improve the consistency of the temperature profile along the sealing face by compensating for typical heat loss. Jaws made from highly conductive materials are also effective at transferring heat evenly across the sealing face and maintaining a consistent temperature. And in some cases the use of these materials also allows for reduced temperature settings and associated energy savings.

## Time

The accurately measured temperature of the sealing jaw face still does not accurately indicate the amount of heat that is transferred to the sealant layer. This heat transfer depends partially on the amount of time available for heat to penetrate to the sealant layer while the jaws are in contact. This is referred to as *dwelt time*. If line speed is significantly increased (and dwell time reduced) then the temperature setting might also have to be raised in order to reach the required seal initiation temperature. Conversely, a significant reduction in line speed may create problems if temperature settings are not reduced and the jaws get too hot.

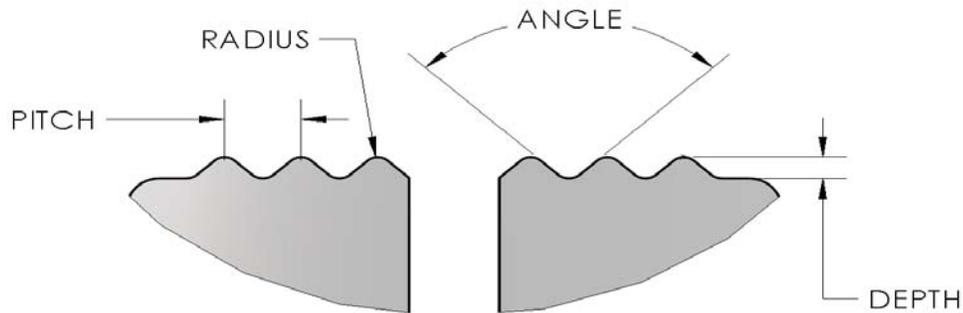
## Pressure

The relationship between heat and time is fairly straightforward. It's the pressure factor that causes the most confusion, and in turn it is often the most overlooked. As average line speeds increase, the pressure adjustments become more critical and the margin for error shrinks.

Pressure at the jaw faces can be difficult to measure, and proper adjustment is often dictated by experience and results. For example, if there is a poor serration impression on the package or if seal quality is inadequate, there may be too little pressure. A heavier impression on one side could mean that there is uneven pressure. If the film is being fractured then the pressure might be too high. However, a misdiagnosis often occurs because these problems can also be caused by other factors, such as improper heat or jaw misalignment, which makes it difficult to determine for sure whether pressure is set properly or not.

Depending on the machine make and model, pressure is exerted by springs, pneumatics or some other mechanical means as the sealing jaws are forced together. In addition, pressure is applied and concentrated by the action of the serrated sealing faces on the jaws. Also referred to as *shear*, this plays a key role in the seal making process. The objective is to increase the effective area of the sealing surface in order to "stretch" the film, enhance pressure and heat transfer, and force the sealant layer to flow into the gaps that would otherwise cause leaks.

Serration pattern geometry—the angle, pitch, depth, radii, and direction—has a big impact on pressure, and can be altered to suit specific film types and bag styles.



Package design also affects the application of pressure. The extra layers of film created by fin seals, lap seals, gussets and folds may produce an uneven pressure distribution across the width of the end seal and cause pressure voids that are a prime location for leaks. The primary tools used to overcome these issues are serration designs specifically engineered to compensate for varying film thickness.

Pressure, as well as jaw alignment, can be checked with carbon paper, carbonless paper, foil or pressure-indicating film. The impression should be consistent from end to end and the same on both the top and bottom seal. Generally speaking, the goal is to increase the quantity and the quality of the pressure without going beyond the point where the film begins to fracture.

---

A basic understanding of bag forming and sealing will help you to specify forming sets and sealing jaws that have been optimized for your requirements, to refine set-up and adjustment, and to trouble-shoot if problems do occur.

Copyright © 2011 Greener Corporation  
Copyright © 2011 Kenray Forming Ltd.

**Greener Corporation**  
4 Helmlly St.  
Bayville, NJ 08721  
USA  
Telephone: 732-341-3880  
Email: [custserv@greenercorp.com](mailto:custserv@greenercorp.com)  
Website: [www.greenercorp.com](http://www.greenercorp.com)

**Kenray Forming Ltd.**  
Telford Way  
Coalville, LE67 3HE  
United Kingdom  
Telephone: +44 (0) 1530 400 100  
Email: [enquiries@kenrayforming.com](mailto:enquiries@kenrayforming.com)  
Website: [www.kenrayforming.com](http://www.kenrayforming.com)