# Consumables - The Basics

A presentation from:

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## Introduction: Consumables - Part of the Identification System

You have spent many hours researching, selecting, and getting approval for your new data collection system. The scanners and software management system will be installed any day. There's only one small task left on your list: selecting the consumables. But wait, you open the catalog and discover that you are faced with many choices. What should you select? Where do you begin? Maybe this is not as easy as you first thought. Relax. While there are a variety of issues to consider when selecting a label, this paper will address many of them and will provide some insight into questions that should be asked when selecting consumables.

It is important to remember that consumables are part of a *total system*, and the entire system needs to be taken into consideration before a selection is made. For example, one needs to consider what will be labeled, when it needs to be labeled and how long the label needs to last. While this may seem like a large task, the benefits that can be attained by understanding the complete solution will pay off in the long run.

Consumables are typically characterized as tags, labels, printing inks and ribbons. Tags and labels differ in that labels have a layer of pressure sensitive adhesive while tags are typically constructed of a **facestock** and a **topcoat** and are attached using some form of mechanical fastener.

## Label Construction

Pressure sensitive labels typically consist of five components: a release liner, pressure sensitive adhesive, facestock, topcoat and an image, as detailed in Figure 1.

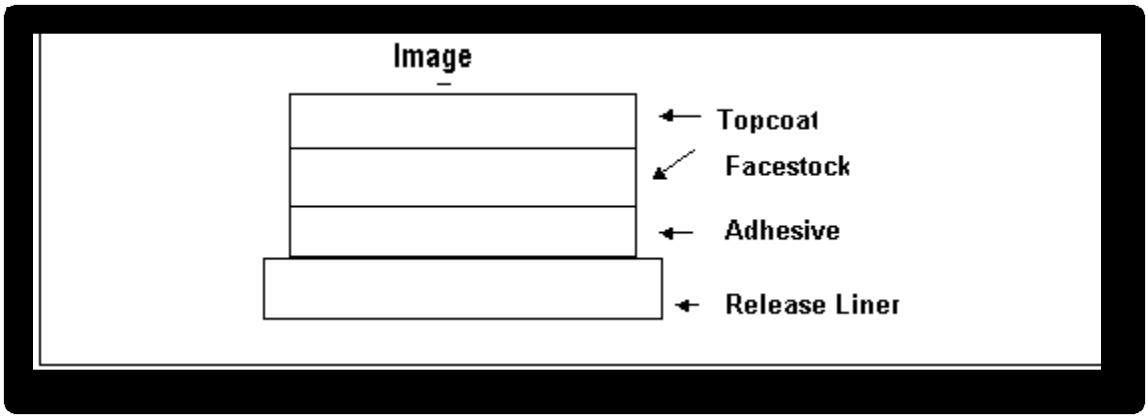


**Figure 1: Cross Section of a Pressure Sensitive Label**

The release liner is typically a paper or plastic film that is used as a carrier for the labels and also protects the adhesive from picking up dust and debris. The pressure sensitive adhesive is the layer that will ultimately make contact with the surface that needs to be identified. The facestock can be thought of as the backbone for the label. It provides a surface for both the adhesive and the topcoat. The topcoat is that portion of the label that will provide the background for the image. And finally, there is the image itself.

## Label Components -- Adhesives

### General Considerations

Among the first things to consider when selecting a label stock is the type of pressure sensitive adhesive that is required. There are many issues to address during the selection process.

A beginning list of questions is given below:

- To what type of surface will the label be required to adhere - glass, plastic, metal?
- What are the surface characteristics - smooth, rough, flat, curved, clean, or dirty?
- To what type of environment will the label be exposed? Humidity? Sunlight?
- What are the application and service temperatures?
- Will the labels be exposed to any chemicals?
- Does the label need a permanent, removable or repositionable adhesive?
- Will the labels be automatically applied?
- Are there any regulatory requirements for the label - UL, CSA, FDA?
- What type of printing process will be used to image the labels - laser, thermal transfer, impact, ink jet, other?
- Are there any visual requirements for the adhesive?
- Are there any chemicals that are contamination concerns?

While this is not a totally inclusive list of considerations, it should provide the reader with a basic understanding of the common considerations necessary in adhesive selection.

### Adhesive Performance Characteristics

Label manufacturers will typically refer to three characteristics about the adhesive: adhesion, tack and drop shear. The adhesion is a measure of how tightly the label adheres to the surface. Adhesion measurements are typically done under the ASTM D1000 test procedure. Test results are reported in lb/in or oz/in. The test involves laminating a one inch wide test strip to a panel (usually stainless steel but the exact nature of the test panel may vary for specific applications), allowing the test strip to dwell on the panel for 20 minutes and then reproducibly removing the test strip from the panel while the force required to accomplish this task is recorded. In order to make the best use of this type of information, be sure that the test surface listed on the data sheet is comparable to the surface that the label will contact in the specific application. Adhesion values can vary widely depending on the type of surface. It is common to see typical values of 30 - 50 oz/inch for permanent acrylic adhesives on stainless steel test panels.

The tack of an adhesive is a measure of how "sticky" the adhesive is. Everyone at one time or another has pressed a finger against a pressure sensitive adhesive and subjectively measured the tack of the label. For example, many people have pressed their fingers against the adhesive surface of duct tape and masking tape. Duct tape feels very sticky or tacky to the touch while masking tape does not feel as sticky. In one of the standard tack tests, a small stainless steel probe is slowly brought into contact with the adhesive and is allowed to maintain this contact for a specified period of time (1-5 seconds). A test machine then measures the force necessary to remove the probe from the adhesive. Tack values are typically measured in grams, and common values may range from 300 - 1500 grams/cm2. It is important to note that tack measurements may also depend on the nature of the probe

material; however, this dependency is not as strong as the effects observed with adhesion measurements.

The final common measurement is that of drop shear. Again, there are standard industry tests designed to measure this property. This test is designed to measure the cohesive strength of the adhesive. The test involves laminating a small test strip (1/2" x 1") to a stainless steel panel and then applying a shear force to the test strip. This force is applied by physically suspending a 500 gram weight from the test tape. Unlike the adhesion and tack tests, this test does not measure force but rather the time that it takes for the adhesive to separate from the test panel.

**Classes of Adhesives**

There are three general classes of pressure sensitive adhesive: rubber, acrylic and silicone. Each class of adhesives can be further divided into permanent, removable and repositionable adhesives.

Rubber-based adhesives are the oldest type of pressure sensitive adhesives (PSAs). Typical characteristics include good wet out on surfaces, high initial bond strength, limited temperature resistance, poor UV resistance, less solvent resistance than acrylics and low cost. Typical applications that are well serviced by these adhesives are names plates on textured plastics and curved surfaces as well as wire and cable markers.

The family of acrylic-based adhesives is a large class of adhesives and is probably the most widely used due to their broad range of properties. While the adhesive wet out may not be as good as rubber-based adhesives, the aging, weathering, clarity and temperature resistance greatly outperform rubber-based products. Typical applications include industrial tapes, product ID, graphics labels, and many work in process applications.

The final class is that of silicone adhesives. Silicone adhesives have excellent solvent/water resistance, high temperature stability (up to 350oC), UV resistance and good performance at very low temperatures. However, in addition to these benefits, they are also accompanied by a high price tag. Typical applications are those that involve high temperatures including work in process applications.

## Label Components - Release Liners

The release liner can be thought of as a carrier for the pressure sensitive labels and it does not come into contact with the object that the label will identify. Therefore, the general requirements for a liner are slightly different than that of an adhesive. Release liners are commonly paper or plastic films. Within each of these classes there are several sub classes. Typical liners range in thickness from 2 - 5 mils. Paper densities have been modified to provide the end user with products specific for improved die cutting and for automatic application characteristics.

It is critical to consider the interaction between the adhesive and the release liner when selecting a release liner. The label must release smoothly from the liner without tearing or stretching this protective sheet. Label manufactures will have already identified the appropriate adhesive / liner combinations and the end user will be able to select a system that meets their needs. However, keep in mind that if a new liner is required, it may be necessary for the label manufacturer to perform aging stability tests to determine if the adhesive / liner combination will be stable.

The printing technology selected for use with the label will also help to steer the liner selection process. For example, some plastic film liners can not be used in laser printers due to the fact that the film will melt when it encounters the high temperatures required at the toner fusion roll. Additionally, some paper liners may be unacceptable in specific applications such as clean room environments.

The recent past has seen the introduction of "linerless" labels. No release liner is required with this technology. Here, the label material is self wound, eliminating the need for a separate release liner. While this put up eliminates the need for the liner, the technology is not yet capable of supporting many high performance materials.

**Label Components - Facestocks**

In many applications, the facestock selection is critical. This component of the label can be thought of as the skeletal system of the product and it will determine the tensile properties. One needs to consider a number of factors including:

Service temperatures that the label must endure

Chemical resistance, what chemicals at what concentration

UV and humidity stability

Abrasion resistance

Type of printing system that will be used

Surface to which the label will need to adhere (smooth, rough, flat, curved)

Tear resistance

Method of dispensing desired

Cost

There are a very wide range of facestocks on the market today. In general they can be grouped into paper and film types. In the paper category there are coated and uncoated types, as well as natural and synthetics. Paper's advantages are that it can be easily printed using a variety of inks and is relatively low cost. However, paper has poor tear strength and abrasion resistance. Typical applications for paper-based labels include shipping and some warehouse identification labels.

The film category is much more diverse. They are a number of plastic materials that are available as films such as vinyl (PVC), biaxially-orientated polypropylene (BOPP), polycarbonate (PC), high density polyethylene (HDPE), low density polyethylene(LDPE), polyester (PET), polyethylenenaphthalate (PEN), polyvinylflouride (PVF), polyetherimide (PEI) and polyimide (PI) to name a few. The performance characteristics and cost of these materials is very wide spread. Table 2 contains a comparison of some of the common facestocks available today.

On the lower end of the performance and cost scale there is polyethylene. This film has good tear strength, chemical and abrasion resistance; however, the film stretches easily and can be difficult to die cut. Polyethylene labels are often encountered in packaging applications.

Polyester is towards the middle of the price scale. It has good tear strength and abrasion resistance, long term UV stability, dimensional stability and is available in clear, white and metalized versions. Polyester is a very common facestock in the industrial and medical labeling markets. Typical examples include, component ID, asset ID, and work in process.

Polyimide completes the high end of the price scale. This high performance film has excellent high temperature resistance and can typically be used for applications that require exposure to temperatures up to 600o Fahrenheit. It has good tear strength, chemical resistance and dimensional stability; however, it has an amber color. One of the most common applications for this facestock is in the area of work in process for printed wiring assemblies.

| Facestock | Tensile Strength | Chemical Resistance | Heat Resistance | Cost |
|---|---|---|---|---|
| Paper | Poor | Poor | Poor | Low |
| Polyethylene | Very Good | Very Good | Good | Low |
| Polypropylene | Excellent | Very Good | Good | Moderate |
| Vinyl | Poor-Good | Good | Fair | Moderate |
| Polyester | Excellent | Very Good | Very Good | Moderate |
| Polyvinylflouride | Excellent | Excellent | Good | High |
| Polyimide | Excellent | Excellent | Excellent | High |

**Table 2: Relative comparison of typical facestocks.**

### Label Components - Topcoats

Three components of a label have been discussed, the adhesive, the liner and the facestock. If the discussion were to conclude with these elements, the user would be able to purchase a label that would adhere to the desired surface, withstand the exposure to the environment but it may provide little or no value to the end user. This is due to the fact that many times in order to be useful, the label must be printed with some information. The topcoat is that portion of the label that allows for the information to be added to the label.

Topcoats can range from very thin clear coatings to rather thick pigmented coatings. In some cases the topcoat may be used to apply a color to the label background; however, in most cases the primary purpose of the topcoat is to provide a receptive surface for the image. Just like the interaction between the adhesive and the release liner is critical, the topcoat and printing technology must be compatible. For example, a thermal transfer topcoat must be relatively smooth so that it can accept the THT ribbon ink, while an ink jet receptive topcoat needs to be porous to allow for controlled ink penetration.

Overall, many of the same considerations that were encountered for the facesheet selection are appropriate in this case as well.

Service temperatures that the label must endure

Chemical resistance, what chemicals at what concentration

UV stability

Humidity stability requirements

Abrasion resistance requirements

Type of printing system that will be used

Surface to which the label will need to adhere (smooth, rough, flat, curved)

Additionally, there are several unique considerations that must be addressed such as the print contrast, resolution and opacity.

## Print Technologies

It may be surprising to learn that the type of print technology that one wishes to use is often a key driving force in label selection. One must consider the range of questions that have already been addressed. For example, will the label be exposed to any chemicals that could attack the image? What temperature does the image need to withstand? And how long does the image need to remain legible?

One of the first decisions that needs to be made is one of printing on demand versus purchasing preprinted labels. In the case of preprinted labels, the labels are typically imaged by the label manufacturer using any one of a variety of techniques. Preprinted labels have the advantage that the end user does not need to worry about installing a printing system in house. This option is often beneficial to the end user if there are a high volume of labels being consumed, the information content is static or serialized, multipart labels are needed or if very high quality bar codes are required. The down side to purchasing preprinted labels is that the end user will have little control over the information on the label once the labels are received and that high volumes of numerous labels may need to be stored in inventory. Additionally, if a problem occurs with a serialized label, that number may need to be skipped.

Many end users are opting to use print on demand technologies. Typical methods include impact, laser, thermal transfer, direct thermal, and ink jet. Technological advances have allowed for on site printing of high resolution bar codes from many of these print technologies. These print on demand solutions allow the user to print the exact number of labels, with the required information, at the time there are needed.

Impact, or dot matrix, technology is one of the most mature printing techniques. In impact printing, an image is created on the label through the use of pins (as in a typewriter) that are used to apply the ink to the label surface. Impact printing requires a mechanical force in order to cause the ink to transfer to the label surface. While the images that are produced by this method are typically low in resolution, the durability is very good. Dot matrix technology is often used in wire marking and component ID applications.

Labels that will be imaged using a laser printer will need to be able to withstand the high temperatures encountered in the toner fusion process. It is important that the adhesive not bleed out and adhere to the fusion roller since this can cause label pick off. Additionally, the liner must have good lay flat characteristics, otherwise the label sheet will curl severely after printing. The topcoat needs to be such that it does not build static, otherwise the printed images will have poor edge definition. Finally, the labels will need to be provided in a sheet format so that they can be fed through the printer. Laser printing is a good option for labels that can be batch-printed.

Thermal transfer printing is a process in which a coated ribbon contacts the label surface and through a combination of energy and pressure, an image is transferred to the label surface. The key to successful thermal transfer printing is to remember that the label surface and the ribbon ink need to be matched. This information is typically provided by the label manufacturer. For example, it is possible to produce a very durable image on one label stock and then change label stock only to find that the second label stock may not print at all or it may be very easy to abrade the image away. It is important to follow the manufacturer's recommendations in this area for compatibility, burn temperatures and printing speeds. Thermal transfer labels are typically provided on a roll and can range from one up to multiple across. Thermal transfer printing is a technology that can be utilized in a wide array of applications such as shipping labels, asset ID and work in process. One added feature of this technology is that it can easily be combined with an automatic applicator for high volume applications.

In direct thermal printing, the label material is imaged without the use of a ribbon or ink. The image is achieved through a reaction between the specially formulated topcoat and heat. The resolution of the images created by direct thermal is typically not as high as those that result from a thermal transfer process. Direct thermal imaging is often encountered in temporary ID and point of sale applications.

One of the more recent technologies to enter into the label world is that of ink jet printing. Ink jet technology has the challenging requirement that the label material must be porous enough to allow the ink to flow into the topcoat, yet not too porous so that the ink bleeds into the topcoat. Paper labels were the first type to take advantage of this technology. Today it is possible to purchase polyester, polyolefin, and woven cloth facestocks as well. Ink jet inks are available in both dye and pigment based formulations. It is important to know which type is being used. Dye-based inks will tend to have limited UV stability and may bleed when images are exposed to water, while pigment-based inks will hold up to many of these stringent conditions. Ink jet printable labels are provided in a sheet format. Typical applications include asset ID labels, product ID and office ID.

## Overlaminates

If the imaged label will be exposed to severe chemical or abrasive environments, an overlaminate can be used to add durability. Overlaminates are typically a 1 mil thick, clear film with a clear pressure sensitive adhesive. The overlaminate is applied by the user after the label has been imaged.

## Label Manufacturing Process

There are several steps in the manufacturing process for labels and the order of these steps may vary from one manufacturer to the next. One of the first steps is to apply the topcoat to the facestock. See Figure Two. Topcoats are typically fluid mixes that can be coated onto the facestock using a variety of coating techniques such as slot die, reverse roll, gravure, or flexographic coating. This coating is dried and cured onto the facestock.

The pressure sensitive adhesive is then applied to the opposite side of the facestock. This may be accomplished with a wet coating process using any of the techniques outlined above. Additionally, many manufacturers may use a process in which a previously dried "transfer adhesive" is laminated to the facestock. Both the topcoat and the adhesive coating processes are usually performed on material that ranges from 24" to 60" in width. Once the adhesive and topcoats are applied, the wide roll form material is slit or cut into smaller width rolls that will fit onto standard converting equipment. Typical widths are 4" to 18" depending on the material and equipment.

The process of converting the narrow web roll form material into small labels is called die cutting. These presses can be rotary or flat bed. In this operation, a die is used to cut the labels into the desired dimensions. The labels remain on the release liner while the matrix or waste is removed. Many presses of this type also have the ability to add background color, constant copy, or serialization to the labels.

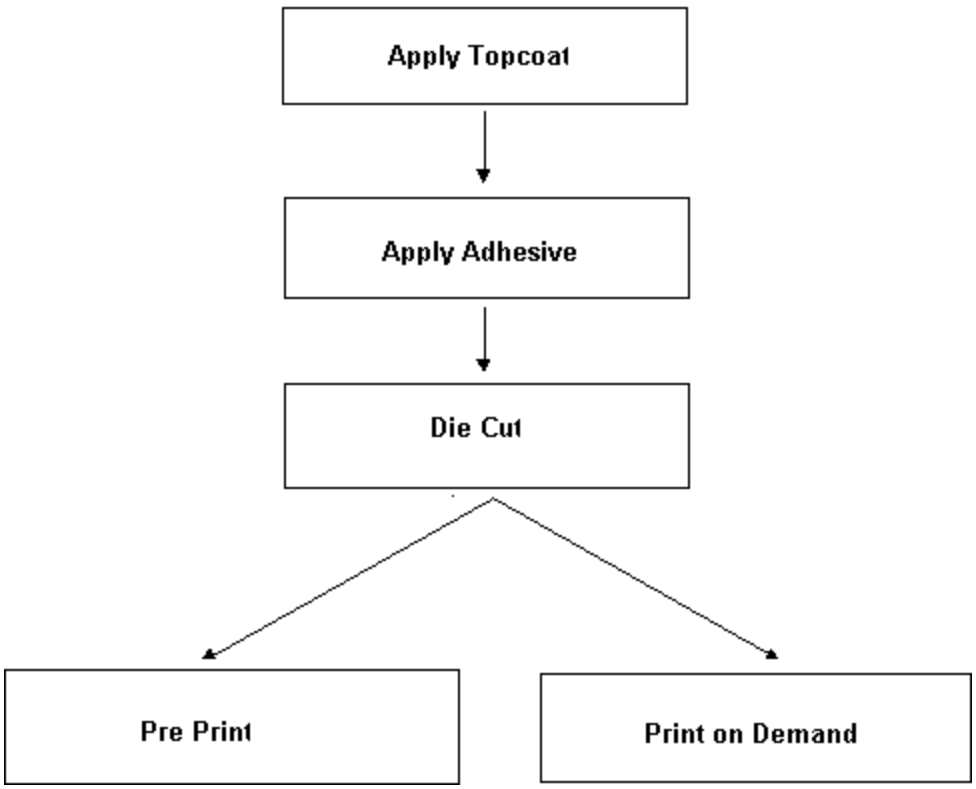


**Figure Two: Flow chart of the typical label manufacturing process.**

The type of converting process that is used will depend on the end user's application for the label. In some cases, labels may be die-cut so as to allow the label to be used more effectively in automatic application equipment. In other cases, the labels may be sheeted so that they can be used in a laser printer.

After conversion, the labels are inspected, packaged and shipped to the distributor or end user. If the end user is going to be printing labels on demand, the end user will complete the manufacturing process by running the labels through a printer to apply the required identification information.

## Conclusion

A label is comprised of five key components:

- liner,
- adhesive,
- facestock,
- topcoat and
- image.

Label manufacturers have developed products that match these components for optimum performance. There are a wide vary of products on the market today that will meet many of the applications typically encountered in the industrial sector.

There are many factors to consider when selecting a labeling system. The good news it that there are many experts in this area who will know what questions to ask and can help guide you through this process.

The key issues to consider are:

- The characteristics of the application surface
- The environment to which the label with be exposed
- The life cycle that is required from the label
- The print technology that is being used
- The cost of the labeling solution.

Due to the many factors that affect label selection, and the unique nature of many applications, please be sure to test any labeling products prior to specifying them for specific applications.