KEY PROPERTIES USED TO SELECT PAPER RELEASE LINERS FOR PRESSURE SENSITIVE TAPE APPLICATIONS

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Introduction

Pressure sensitive tapes are designed to offer a specific adhesive performance. The release liner comes along for the ride. However, the choice of release liner can enhance or sink the best adhesive technology. The purpose of this paper is to bring to light key properties of paper release liners that can help tape manufacturers bring to market successful products, while minimizing set-backs in the product development process.

For purposes of discussion, a paper release liner is defined as a paper core coated with silicone. See figure 1.

There are three (3) segments to this treatise: Base Paper Selection, Silicone Selection, and examples where the right choice of properties led to successful products.

Base Paper Selection

Working for a paper company, I can’t help but start with the paper core.

Sheet Strength
As a carrier for adhesive, sheet strength is a vital consideration - important to the tape manufacturing process, as well as to the end-use application. While primarily controlled by basis weight (weight per unit area), fiber selection, refining level, and moisture content of the release liner all play an important part. For example, a “high tear” 53# base can be made to have the same tear strength as a 60# “standard tear” sheet. In a similar manner, tensile strength can be affected by refining level and formation (how the fibers are aligned).

A close cousin to the basis weight of a paper is the thickness or caliper. Caliper control is critical in building finished rolls to consistent sizes. In combination with basis weight, an apparent density can be calculated for a given grade (basis weight / caliper). The higher the apparent density, the better an anvil one would expect a sheet of paper to be for die cutting.

Texture
The texture of a release liner is primarily controlled by the base paper. This quality is often measured in terms of Sheffield smoothness units and Parker smoothness values. Since the adhesive will mirror the release liner’s surface, there can be a large impact on adhesive performance. For example, a very smooth release liner will impart a glossy look to the adhesive and might be expected to provide a better rolling ball tack than a
A rougher surface. On the other hand, a rough surface may be necessary for tracking in auto-dispensing equipment or providing the right “feel” to a user.

**Surface Treatments and Repulping**
A papermill’s best kept secret is the surface treatments it uses. A combination of film-formers and clays, most manufacturers have the ability to apply differential treatments to a given paper. The primary purpose of a surface treatment is to act as a primer for silicone coating – reducing the amount of silicone needed to achieve sufficient coverage. So, it is critical that the coatings used do not inhibit / poison silicone cure. The right selection of surface treatment can also help to control adhesive bleed.

The selection of surface treatment can also have an impact on the ability of a release liner to be re-pulped. Of course, silicone selection is also vitally important to the process of re-pulping a tape. But, I am getting ahead of myself.

One might think that paper comes in only two colors – white and brown. The truth is that several tape manufacturers have used color, both of release liners and of adhesives, to help them differentiate their products from competitors. As paper manufacturers become more adept at producing a variety of colored papers and release liner manufacturers become increasingly clever in applying print and / or tinting, this offers a great opportunity for product distinction. Crepe tape is a great example of where color has been used for product identification.

**Dimensional Stability**
While perhaps not as big a factor in P-S tapes as in the roll label industry, dimensional stability can be pretty important in some applications. There are at least two (2) schools of thought regarding layflat of release liners. One theory is to lock up the paper fibers using clay or a polyolefin coating. In both cases, there are restrictions to processing temperatures. Others would prefer a porous release liner that can be easily remoisturized in order to bring the sheet back to its equilibrium moisture level and to balance curl.

**Silicone Selection**
While I pride myself in being a silicone chemist, the truth is that we depend upon our silicone suppliers to provide innovative polymers, crosslinkers, and catalysts which we can formulate to provide solutions for our customers. Much like a papermaker’s surface treatments, silicone formulas are a release liner manufacturer’s tightly held “secret”. What is not a secret is how the release coatings should perform.

**Peel Force and Release Profile**
The most basic of requirements is that the release liner provide the desired peel force from the adhesive used. Sadly, there is no “one-size-fits-all” release coating. Peel force is driven by the adhesive used – the more aggressive the adhesive used, the “easier” the release coating needed. The reverse is also true. The level of release a coating provides is primarily influenced by the polymer selection and the amount of release modifier used.
Catalyst amount and crosslinker selection are also important. For example, at our house removable stickers are very popular with my family. A “tight” or high CRA (controlled release additive) coating is used to prevent the labels from pre-dispensing or falling off the release liner.

Generally, peel force is measured at a controlled speed – 300 or 400 inches / min. But in real life, tape converting and dispensing equipment run at much higher speeds. Each combination of release coating and adhesive in turn has a release profile that is a function of peel rate. In the case of our prototype release liner, if the profiles of silicone 1 & 2 overlap at high or low speed, the tape will become confused at varying peel rate. Figure 2 depicts a differential release paper with no overlap in peel force for the two release sides regardless of peel rate. Contrast this with Figure 3 which shows an overlap in peel force, and potential adhesive confusion, at high peel rates. Where a differential release must be maintained, a quick screening of target adhesive against release coatings can be done to maintain the desired differential.

**Silicone Stability**

Once the adhesive is in contact with a release liner, most manufacturers would like the peel force to remain stable during the life of the product. A variety of accelerated aging tests are used to simulate product life. The most “deadly” of problems is acrylic lock-up – a chemical reaction between the adhesive and residual crosslinker. This problem can usually be overcome with the right selection of catalyst, crosslinker amount and process conditions.

When a tape is unrolled and applied, the expectation is that the adhesive technology will perform to its full potential. A poorly cured release coating can only mess this up. Silicone transfer is the enemy of most release liner manufacturers. Platinum-catalyzed silicones gained popularity many years ago due to the much faster reaction kinetics when compared to the older tin-catalyzed systems. Since the platinum catalysts commonly used are sensitive to electron-donating poisons, the trick is to develop robust coatings and manufacturing processes, while avoiding problematic substrates.

**Blending Papermaking and Silicone Coating to Solve Problems**

The following are three (3) examples of where the right blend of papermaking and silicone technology were used to advance tape development.

**Problem 1** – “My adhesive doesn’t wet out properly on the release liner I am using today.”

This problem usually starts out with a finger-pointing exercise between release liner manufacturer and adhesive manufacturer. Surfactants can sometimes be added to the adhesive to aid in wet-out, but not without a performance trade-off. Likewise, the surface energy of a release coating can be increased by increasing the CRA loading, but not
without increasing the release level. What we found is that surface smoothness of the release liner can have a huge impact on wet-out of adhesives.

**Problem 2** – “My product looks “old” before its time because the adhesive bleeds through the release liner and “stains” or transparentizes the paper.”

A heavy loading of plasticizer can flow through the release coating and transparentize the underlying paper. There are a number of surface treatments that can be used to “repel” the specific plasticizer used, while still providing an excellent surface for silicone coating. Taking the adhesive in question into the lab, a quick screening of surface treatments can be conducted to find the right one for the job.

**Problem 3** – “I need to cut some cost from my current product.”

Beyond the obvious of a supplier dropping price and margins, there are a number of options that can be mutually explored. The basis weight / yield relationship is often taken advantage of. For example, if a 40#, 2.5 mil sheet can be used in place of a 42#, 2.5 mil liner a yield advantage of 5% can be achieved. Likewise, the selection of silicone coating can have a significant impact on coating cost and manufacturing efficiency.

**Conclusion**

Taking into account the properties listed above, developers of tapes should be in a better position to work with release liner manufacturers to select the right combination of base paper and release chemistry to unleash the full potential of your adhesive technology.
Figure 1. Schematic of differential paper release liner

Figure 2: Example of differential paper liner with good release profile at varying peel rates to prevent adhesive confusion

Figure 3: Example of differential paper liner with poor release profile at varying peel rates, leading to possible adhesive confusion
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