

Slitting Technology for Film Substrates

In 1950, plastic film was relatively uncommon, today it is everywhere. Back then (and I speak from experience), we had only a handful of film varieties. Today, the number of film types is almost uncountable and new films come onto the scene almost daily. Slitting such a bewildering variety of substrates requires a consideration both the slitting process and the material being slit. If we have a choice of slitter types, it may be possible to schedule production to use the optimum slitting system (razor, shear, crush/score) for the film being slit. If, however, we're limited to only one type of slitting, (razor, for example) achieving slit edge perfection on every possible type of film will be an elusive goal.

The three most common film slitting methods are razor, shear, and occasionally, crush/score slitting. Each method separates web materials by distinctly different principles which must be understood before deciding which method to use for optimum results with a given material.

Characteristics of Three Slitting Methods

Razor Slitting is simple and cheap, the most common method for slitting films today, and is easily adapted to almost any machine, in almost any location. A "cutting" or "slicing" action is created by pulling the material past the stationary blade, inducing fracture stress in a tensile mode. The resultant edge depends on the characteristics of the material, thickness, density, rigidity, plasticity, coating, bonding, and other factors which will be discussed later.

Razor Slitting creates a "controlled

crack" immediately ahead of the blade edge. The mechanical properties of the material and the shape of the blade edge determine how and where this crack forms. If the crack forms close to the blade edge, the process is relatively stable. If the crack forms far ahead of the tip, the process may become unstable, edge flaws may develop, and uncontrolled tearing or splitting may occur. Slit edge quality may display a typical "raised edge;" surface coatings may be disrupted; and filaments, dust and debris along

limit. Web tension must be equal on both sides of the blade to avoid asymmetrical tension forces which can cause a wavy slit line, film splitting, or the trim strip merely turning down under the blade, refusing to slit at all. Razor slitting a narrow waste strip of film without providing adequate tension to the trim strip is a sure recipe for frustration.

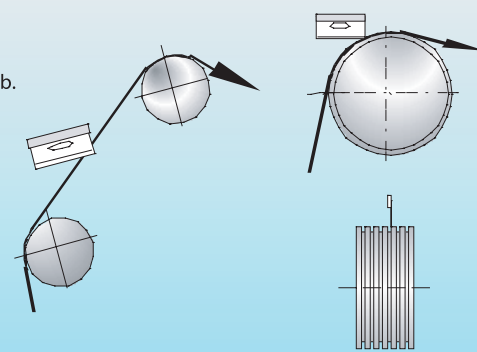
Razor blade angle of incidence to the web will influence slit edge quality, depending on web characteristics and mounting geometry. A low angle uses

RAZOR SLITTING

Method of slitting:
Creates lateral tensile stress at blade tip, "slicing" the web.

At issue:
Blade Life
Slit edge Quality
Safety

Suitable Materials:
Low caliper
Low elongation
Low tensile
Low abrasiveness

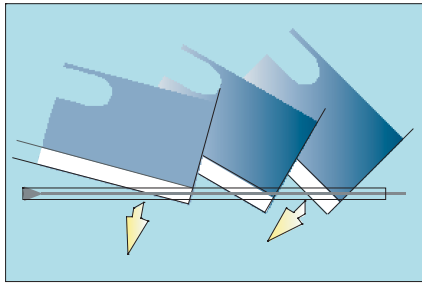


the slit edge may form.

When razor slitting plastic films, the ratio of web tension to the materials' yield stress threshold is significant. Since the blade is dragging against the web, its resistance must be added to the tension force, and has the potential for exceeding the materials elastic limit at the slit, stretching or deforming the edges. A general rule of thumb is that the web tension in the slitting zone should not exceed about 10 percent of the material's elastic

a longer slitting edge, has less blade cross-sectional area, and less slitting drag on the web, but more tendency to deflect the web away from the blade edge. Steep blade angles present a shorter slitting edge and a thicker blade cross section. Drag resistance is increased, the web is deflected less, but slit edge deformation is more likely.

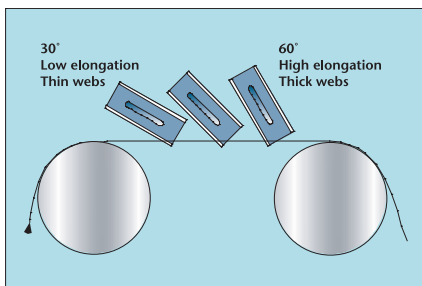
To spread the wear over a longer edge, many razor slitting systems oscillate the blade holders, but the oscillation should not induce "flutter"



into the web. Obviously, wrap configured systems are immune to such flutter, compared to oscillating razors in long open spans which have great potential to cause

flutter. To delay wear, razors may be hard coated with TiN (Titanium Nitride), ceramic, or DLC (Diamond-Like Coating). Solid tungsten carbide and ceramic blades are also available for extreme duty applications. Low cost utility razor blades may have a coarsely ground finish which can create more friction, dust, and will blunt quickly.

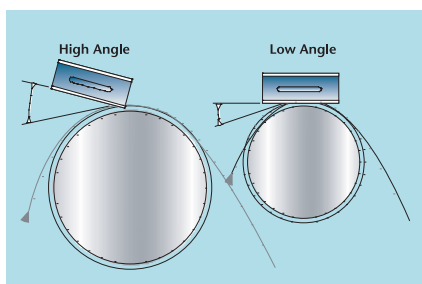
Shear Slitting is the most versatile method, and can accommodate a wider variety of materials than any other method. A true shear stress is created as the material passes through the slitting nip formed by the upper blade and the lower slitter ring. Establishing the correct nip (cut point) is



more complex and not generally well understood. Proper nip configuration must consider factors such as: the web path (wrap vs. tangent), blade edge profile, shear (cant) angle, blade

overlap, slitter overspeed, and the trim removal path. When the shearing nip is properly configured, slit quality is unsurpassed.

A properly sheared slit edge, when viewed under a microscope, displays the effects of a true shearing stress in the web material. Subtle differences will be observed, however, between the two edges. The edge which has been supported by the lower slitter ring will be the more perfect edge, while the unsupported edge (which has been slit by the upper blade) will display evidence of being displaced by the blade as it passed through the slitters



When slitting film, this is usually the only edge that might have an edge bead ("raised edge"), depending on blade profile, etc. Minimizing the effect of this displacement is the key to optimizing

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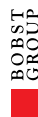


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shear slitting quality.

Narrow, acutely pointed blade edge profiles are contrasted with wide, low grind angle blade profiles. Choosing the appropriate profile must take into consideration the web path, (wrap or tangent), the characteristics of the web material, and how it reacts to the presence of the upper slitter blade in the web path.

Crush/score slitting is the least common method of slitting films. Compressive stress creates the slit in the crushing nip between the anvil roll and the slitting wheel. This is the most dusty of the slitting methods, delivering the poorest edge quality. Slit quality is variable and depends on the material being slit, the blade edge profile, edge finish,

and anvil roll smoothness. Under a microscope, the resultant edge is ragged and frequently displays a ridge formed by material which has been displaced by the blade tip. Extremely dense or thick materials may need nip forces beyond the yield strength of the blade steel, making crush/score slitting impractical.

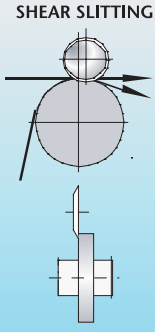
The Crush (Score) Slitting Blade Profiles chart illustrates typical blade profiles used for various web materials. Some experimentation may be necessary to find an optimum profile.

Characteristics of the Material Being Slit

To effectively slit today's films, we must identify the dominant properties of any given film in order to select the optimum method (razor, shear, crush/score). From a slitting standpoint then, we must consider each of the following properties and how materials having such characteristics react as they are being slit:

Caliper (thickness). How thick or thin is the film? For extremely thin films, razor is the obvious choice. As caliper increases, slitting resistance increases, and edge quality decreases. The upper and lower caliper limits for shear slitting depend on blade profile and slitter system nip geometry.

SHEAR SLITTING	
Method of Slitting:	Creates a true shear stress (vertical displacement) within the material.
Important parameters	<ul style="list-style-type: none"> Blade diameter and profile Blade overlap Shear angle Installation geometry Slitter overspeed
Suitable materials:	Almost any "Flexible web"



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Density. Low density materials will “compress” or “extrude” in the shear slitting nip, but razors are not immune to “extrusion” either. Extremely low density films may be successfully crush/score slit if edge quality is not

an issue. High density materials are effortlessly slit using the shear slitting method.

Elongation. Low elongation films fracture “abruptly” under stress; when razor slitting the fracture may be

uncontrollable. Shear slitting low elongation films is a very stable process. High elongation films are easier to slit with razors, but “raised edges” may be easily formed. Web tension may influence razor slit edge quality in high elongation films.

Stiffness. Extremely stiff films will generally act similar to low elongation films, and are easily shear slit. Stiffness will become a problem as thickness increases where conflict with slitter blades can become severe, limiting the ability to slit with conventional methods.

Tensile Strength. Aramids are at one end of the tensile scale, polyethylene is at the other end. High tensile materials are generally best shear slit, especially as thickness increases. Crush/score slitting is best confined to low tensile materials.

Abrasiveness. For extremely abrasive films, nothing beats the shear slitting process, whereas razors must be carbide or ceramic coated. Crush/score may be possible if poor edge quality can be tolerated.

Compressibility. Compressibility of thin film is usually not an issue when razor slitting. With highly compressible substrates, shear slitting may cause a convex/concave slit edge profile as caliper increases. Low compressibility (high density) films are easily shear slit, but poorly crush/score slit.

Matching the Material to the Best Slitting Method

As noted, it is necessary to identify the dominant properties of any given film in order to select the optimum method (razor, shear, crush/score). Some of these properties are tolerant of almost any slitting system, especially with thinner films. But for optimum slit edge quality, the following guidelines will be useful...

■ Razor slitters are well suited if the film has low values in caliper, density, elongation, tensile, and abrasiveness.

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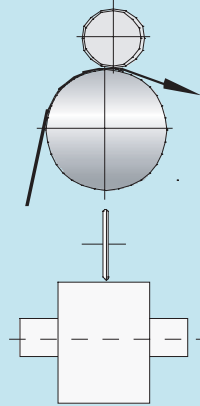
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CRUSH SLITTING

Method of slitting:
Creates compressive stress between the slitter disk and anvil roll.

Suitable materials:
Low Caliper
Low density
Low stiffness
Low tensile
High elongation
High abrasiveness
High compressibility



■ Shear slitters can successfully slit any material classified as a “flexible web”, regardless of the properties listed above. Obviously, a shear slitting system must be designed to accommodate the web material according to its dominant property.

■ Crush/score slitters are general

limited to films having low values in caliper, density, stiffness, tensile, and high values in elongation, abrasiveness, and compressibility

A Variety of Variables

In many instances, where only a few variety of similar films are being slit,

only one kind of slitter may be needed to handle the few variables. In some instances, a much larger range of products are being slit, and it may be necessary to modify the existing slitting equipment to handle a broader range of web materials. Adding a shear slitting system to an existing razor slitting machine has proven to be a viable tactic where machine design permits. The pace of film evolution over the past several decades is an indicator that the future in film evolution will continue, and that we need to keep informed and prepared to meet our customers’ demands for ever higher quality products.

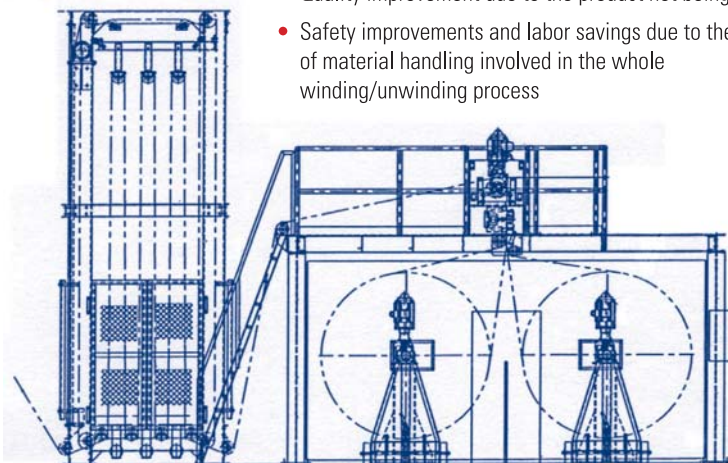
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