Four factors to consider in razor slitting

It may be the simplest and cheapest method available, but razor slitting still requires close attention to blade life, edge quality and operator safety.

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The three most common methods of slitting flexible web materials are shear, crush (score), and razor. Of these three, razor has the lowest installed cost, being the simplest and cheapest method. It can be easily adapted to almost any machine, in almost any location. It is potentially the cleanest method of slitting, assuming the appropriate materials are being slit.

A "cutting" or "slicing" action is created by pulling the material past the stationary blade. The resultant edge depends on the characteristics of the material, its thickness, density, rigidity, plasticity, coating, bonding and other factors. At issue are blade life, slit-edge quality and safety.

1. Safety

While the potential for bodily injury is not as great as with shear or crush (score) slitting equipment where rotating nips are involved, razor-slitting equipment is notorious for cuts and slashes that can be severe. Razors installed in the open span, tangent position are difficult to guard, compared to installations where razors are slitting against grooved rollers. Even with effective guarding, the simple act of changing blades exposes operators to a scalpel-like edge all too frequently. Use of premium blades (hard coated, carbide, or ceramic), to reduce the frequency of blade changes, will also improve safety.

2. Principles of separation

Razor sitting is, in essence, the creation of a "controlled crack" immediately ahead of the blade edge. The mechanical properties of the material and the shape of the edge determine how and where this crack forms. If the crack forms close to the edge, the process is relatively stable, if the crack forms far ahead of the tip, the process may become unstable where edge flaws may develop, and uncontrolled tearing or splitting may occur.

Other factors that influence razor-slit quality are the amount of material displacement by the blade, stretching due to tension problems, web flutter and web temperature, etc. Edge quality for thicker, denser materials may display a typical "raised edge," surface coatings may be disrupted, filaments, dust, or "whiskers" along the slit edge may form.

When razor slitting plastic materials, the ratio of web tension to the plastic's yield stress must be considered. Since the blade is dragging against the web, its resistance must be added to the tension force and has the potential for exceeding the material's elastic limit immediately adjacent to the slit. Stretched, deformed edges are the result. 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 limit.

What are appropriate flexible-web materials for razor slitting? Razor slitting has found wide acceptance in slitting flexible packaging films, and, paradoxically, for slitting extremely thick polyethylene films. Household aluminum foil is also commonly slit with razor blades. Razor slitting of fiber-based products, however, is usually disappointing due to rapid blade wear. In general, it is usually possible to use razor slitters successfully if the material has low values in caliper, density, elongation, tensile, and abrasiveness.

3. Installation parameters

The razor blade may be located in any one of several locations in the web path. The simplest is to slit in the open span between supporting surfaces, as is common on film extruders (Figure 1). Another location is in the valley between two closely spaced rollers. The advantage here is that the web is relatively taut, and does not "flutter" as severely as in a long open span. Both of these locations create a tangent slitting geometry, with little or no support for the web.

The third location is to slit using a grooved roll, which supports the web as it wraps around the roll to

Figure 1: *Tangent slitting in an open span. A low blade angle is better suited to thin webs that do not deflect under the blade. As webs increase in thickness and strength, the tendency to deflect may be countered by increasing the blade angle.*

Figure 2: *Wrap slitting using a grooved support roll. Large rolls require that only the blade tip be used for slitting. Oscillating of the blade to distribute wear is not possible. Small rolls permit slitting to be done along the length of the blade edge, making oscillation possible.*

Figure 3: *Without support, low-incident blade angles will deflect thicker webs down, away from the slitting edge. The blade must, therefore, be inserted deeper into the material, causing more edge distortion. Increasing the blade's angle of incidence reduces downward deflection of thicker webs. However, the thicker blade increases slit-edge deformation. The abrupt trailing edge of the blade may also "scrape" along the slit edges, creating dust.*

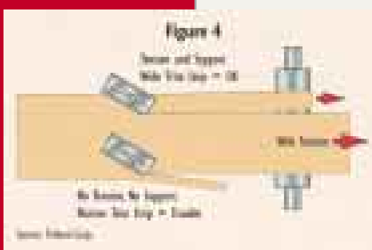

Figure 4: *Trim slitting using razor blades poses a special challenge. Web tension must be balanced on both sides of the slitting blade. The narrower the trim strip, the more critical it is to have tension and support for the strip.*

some extent (Figure 2). Accuracy is much improved, many multiple narrow slits can be done, and web control is assured because the web wraps around the grooved slitting roll. The diameter of the grooved roll has some bearing on the blade's angle of incidence relative to the web. Larger rolls (over about 150-mm/6-in. diameter) limit the slitting zone to the extreme tip of the razor blade. Thus, the blade must be "tilted" into the roll, creating a relatively high angle of incidence. Small rolls (below about 120-mm/4-in. diameter) permit the blade to be held tangent to the roll, creating a relatively low angle of incidence.

The blade's angle of incidence to the web is dependent on web characteristics, as well as mounting geometry, A low angle relative to the web presents a longer slitting edge, less blade cross-sectional area and less slitting drag on the web (Figure 3). However, there is more tendency to deflect the web away from the blade edge. On the other hand, steep blade angles present a shorter slitting edge, and a thicker blade cross-section. The web is deflected less, but drag resistance is increased, and slit edge deformation is more likely.

It is extremely important to recognize that razor slitting requires equal web tension on both sides of the blade (Figure 4). Otherwise, asymmetrical tension forces can cause problems such as a wavy slit line, film splitting or, in the case of edge trimming, the trim strip may merely turn 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.

4. Blade parameters

Since a very small portion of the razor is engaged in the slitting zone, wear of the extremely thin edge is rapid, and frequently fails at critical times, causing interruptions (downtime) in the process lines (Figure 5). To delay wear, the blade may be mounted on an oscillating blade holder in an attempt to spread the wear over a longer edge zone. The oscillating motion can, however, create "flutter" in some webs, complicating the slitting function.

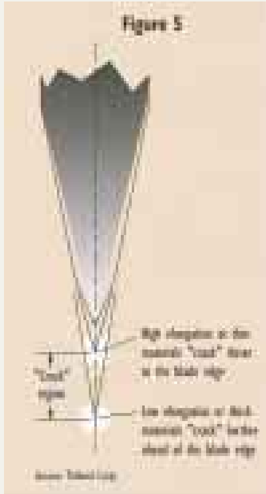

Figure 5: *Razor slitting is, in essence, the creation of a "controlled crack" immediately ahead of the blade edge. The mechanical properties of the material and the shape of the edge determine how and where this crack forms. If the crack forms close to the edge, the process is relatively stable. If the crack forms far ahead of the tip, the process may become unstable.*

Another tactic to delay edge wear is to coat the blade with a hard surface, such a TiN or other proprietary ceramic coating. The most durable blades are made of tungsten carbide or ceramic (usually zirconia), and may be the most practical choice when slitting high-abrasive films on extruders, where machine downtime due to a loss of slitting can be extremely costly.

The included angle of the razor-blade edge is a fixed constant, but the "point" at the extreme tip abrades to a constantly increasing radius as wear progresses. It's this blunt tip that determines the end of the blade's useful life. Slowing the rate of tip erosion increases blade life. To spread the wear over a longer edge, many razor-slitting systems incorporate oscillation into the blade holders. This is effective provided the oscillation does not induce web flutter. Obviously, wrap-configured systems are immune to such flutter, but oscillating razors placed in a long open span between rollers have the potential to cause flutter, depending on the extent of the deflecting forces the web encounters at the blade edge.

To delay wear, razor blades may be hard-coated with TiN, ceramic, or a DLC (Diamond-Like Coating) material to significantly extend blade life while reducing friction between the material and the blade. Solid tungsten carbide and ceramic blades are also available for extreme-duty applications.

A typical utility razor blade may have a rather coarse grind finish, which rapidly polishes smoother during slitting. Unfortunately, this also means that the extreme tip is rapidly blunting at the same time. Thus, smoother blades will have a longer service life compared to rough blades. TiN or ceramic edges are the smoothest of all and give better service for the same reason.

Razor slitting is simple; no doubt about it. For many products and applications, it's the best way to get the job done. But like any technology, it's important to understand how it works, what its limitations are, how materials react "under the knife," and what to do to make it function properly when things go wrong.