Four factors to consider in razor slitting

Safety

Knifeholder adjustment controls should be away from the rotating nip. The knifeholder’s engage and disengage actions should not be sudden, rapid movements which may startle an operator, or be too fast to get a hand out of harm’s way during setup. The knifeholder easy to repose without placing hands close to the blade? Tools, shims, spacers or jigs should not be needed when making pattern changes. Blade guards should be robust and able to tolerate the occasional snarl that occurs during a web break. In some instances, automatic self-retacting, full coverage blade guards may be required. Is the system integrated with the E-stop control, so the slitters will automatically disengage in an emergency? Does the lower slitter shaft have a brake to arrest free-wheeling in an E-stop?

By Reinhold Schable, Applications Technology Manager, Tidland Corp.

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 clearest method of slitting, assuming the appropriate materials are being slit.

A “cutting” or “slitting” 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, tangential position are difficult to guard, compared to where installations are 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 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 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, flammants, dust, or “shrinkers” 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’s 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 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...
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.

Figure 3:
Trimmer slitting is a process of synchronizing the creation of 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 in the slitting zone, wear of the extremely thin edge is rapid, and frequently fails at critical times. The oscillating motion can, however, create “flutter” in some webs, complicating the slitting function.

Another tactic to delay edge wear is to coat the blade with a hard surface, such as 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 is 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. Usually, wrap-configured systems are immune to such flutter, but oscillating razors placed in a long open span between infeed and outfeed conveyors have the potential to cause flutter, depending on the extent of the deflecting forces the web encounters at the blade edges.

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 and increasing tool life compared to rough blades. TiN or ceramic edges are the smoothest of all and give better service for the same reason. A typical utility razor blade may have a rather coarse grind finish, which rapidly polishes smoother during slitting.

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The simplicity of score slitting is one of its main attractions, but slit-edge quality is highly dependent on important variables that must be addressed. By Reinhold Schable, Applications Technology Manager, Tidland Corp.

Score slitting, often referred to as “crush” slitting in international markets, is a common method of separating the web. Basically, a hardened steel disk is pressed against a rotating, hardened steel cylinder, creating a crushing nip into which the material is directed. The resultant nip force exceeds the ultimate yield of the material, and the material is severed along the nip line. Changing slit widths is relatively easy because only the sitter is repositioned over the fixed anvil roll. That’s all there is to it. Simple, or so it seems.

Slit-edge quality is variable and depends on the material being slit, the blade-edge profile, blade-edge finish and anvil smoothness. Because slitting is a “crushing” action in the nip between the slitter blade and the anvil surface, it is generally considered the dustiest of the slitting methods, delivering the poorest edge quality. Under a microscope, the resultant edge is ragged and frequently displays a ridge formed by material that has been displaced by the blade tip. Extremely dense or thick materials might require nip forces beyond the yield strength of the blade steel, making score slitting impractical.

Score slitting variables can be separated into at least five different factors that affect the performance of the process. They include web material characteristics; nip forces; their extent and effect on the blade and anvil roll; blade-tip profiles; metallurgy of the slitter blades and anvil rolls; and mounting geometry of the blade relative to the anvil roll.

1. The web

Every material has its unique nip force requirements. The density, ductility, hardness, thickness and “grain” of the web determine the force required for plastic deformation to occur to displace the web around the tip of the slitter blade. Depending on the physical characteristics of the web, it might crumble, shatter, extrude or wrinkle. In fact, it might exhibit all of these reactions at various depths along the slit line.

One thing is certain: the web material must be displaced in an amount equaling the volume of the blade tip. This displaced material might be in the form of debris (dust), a ridge along the slit edges, or even a large “crush” that exceeds the width of the blade tip itself.

2. The 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 (down-time) 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.

Another tactic to delay edge wear is to coat the blade with a hard surface, such as 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 is extremely costly.

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Four major points should be considered in selecting the appropriate blade material for any given web material: thickness and type of material; web nip force; the anvil roll; and the angle of the blade edge relative to the anvil roll.