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Converting operations: Troubleshooting slitter blade wear

A trouble-shooting guide for shear slitting systems can avoid application of unnecessarily costly solutions to relatively simple problems.

Part II: Web-to-blade wear

As slitter blades wear, distinct patterns develop on the blade edges depending on the nature of the wear mechanism. By examining these wear patterns, identification of how the blades interface with the web and each other is possible. Corrective action is then possible with minimum guesswork.

Blade wear fits into two broad classifications:

- Wear due to the material being slit
- Wear due to blade-to-blade interface.

Part I of this article, in the April 2003 *Solutions!* magazine, covered blade-to-blade wear. This discussion focuses on web-to-blade wear.

WEB-TO-BLADE WEAR

Web-to-blade wear is the result of abrasion from a relatively compliant web as it rubs against a blade, much like a polishing belt. The web erodes the extreme blade tip and blunts the edge. An upper blade is the most vulnerable since it projects into the web path and is far more subject to the abrasive properties of the web material. The "signature" of web-to-blade wear is a smoothly polished radius rather than a crisp edge at the blade tip. A highly polished region on the non-contact face of an upper blade corresponding to the amount of blade penetration into a web also indicates web abrasion problems.

Smoothly blunted blade edges are a reliable indicator of web abrasion. A more abrasive web blunts the blade more rapidly. Some solutions include the following:

- Judiciously limiting overlap to the minimum required to slit the web reliably
- Using a more abrasion-resistant alloy
- Increasing the cross sectional shape of the blade at the tip by reducing the grind angle
- Increasing ground edge smoothness.

EFFECT OF WEB

Abrasive content, such as titanium fillers, silicates, oxides, and many other web additives, will erode the extreme tips of upper and lower blade edges. As web density and stiffness increase, impact against the blade increases with a corresponding increase in blade wear. The extent of wear depends not only on the abrasive nature of the web—particle size, hardness, concentration, density, thickness, etc.—but also on the characteristics of the slitting system to tolerate the wear. Blade grind angle or profile, blade overlap, blade alloy, and blade finish are four characteristics requiring consideration.

GRIND ANGLE

Grind angle or blade profile has major significance in web-to blade wear on the upper slitter. The grind angle at the extreme tip of the blade and the width (thickness) of the blade portion that actually projects into a moving web require consideration. A high grind angle of 45° or sharper is very vulnerable to abrasion from the web since less metal is at the extreme tip edge. The amount of metal at the blade tip has a direct bearing on how durable the blade is under abrasive web conditions. A web becomes rapidly scuffed by a thin, razor-like edge that leaves a smooth radius instead of a crisp, sharp intersection at the tip. If reducing the grind angle is not possible, a higher alloy steel or hard coating may be necessary.

OVERLAP

In tangent configured slitters, the upper slitter projects further into the web as overlap increases. The slitter is then subject to more aggressive erosion from the web. As the blade profile or cross-sectional area in the web increases, the "wedging" action increases and abrasive pressures from the web against the blade escalate. As the blade penetrates further into the web, the blade-to-web contact angle increases, the effective slitting speed relative to the web speed slows, and abrasion increases. Smaller blades give the most trouble in this regard. This condition is especially significant in traction-driven slitter systems. Here, blade speed relates to the amount of blade overlap and actively driving the upper blade is not possible.

In wrap configured, traction-driven slitters, attempting to overspeed the lower slitter system to compensate for upper blade speed loss is impractical. This is because the lower system acts as a "pull roll" and disturbs web ten-

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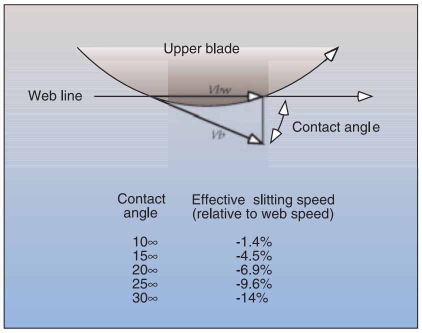

Figure 1: Effective slitting speed, relative to web speed at various contact angles (approximate values).

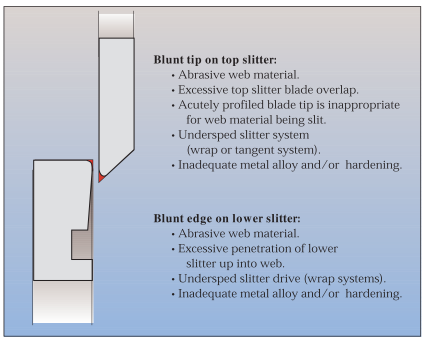

Figure 2: Slitter blade wear: blunt tips and edges.

sion. As overlap increases, blade speed (nip speed) therefore decreases. This makes the blade subject to increasingly more abrasion.

In dual shafted systems where the speed of upper and lower slitters can match the web speed, further increasing the speed of the upper slitter may be helpful. This compensates for the blade contact angle speed relative to web speed loss, as noted earlier.

BLADE ALLOY

High carbon steels such as 52–100 have moderate wear resistance and are useful for low abrasion webs such as unfilled polyethylene films, tissue, etc. As mineral fillers and other abrasive web content increases, the blades will benefit from higher percentages of more abrasion-resistant metals. Chromium is an economical additive. A 12% chromium steel, commonly known as D-2, is helpful in moderate abrasion applications. For high abrasion conditions, elevated tungsten or vanadium content steels are necessary. An additional benefit of these alloys is that they allow acute blade grind angles to operate longer under abrasive conditions despite their thin tip profiles.

Slitter Blade Wear: Symptoms & Causes

Straight (plane surface) wear band on top slitter:
Excessive overlap.
Coarse surface finish grind on lower slitter.
Web induced drag on slitters.
Aggressive grind angle on lower slitter.

Straight (plane surface) wear band on lower slitter:
Excessive overlap of top slitter.
Coarse surface finish grinding.
Web induced drag on slitters.

Elliptical wear band on top slitter:
Excessive run-out on top slitter only.

Concave wear band on top slitter:
Excessive sideloading.
Severe radial run-out and/or vibration.
Inadequate metal alloy and/or hardening.

Concave wear band on lower slitter:
Excessive sideloading.
Severe radial run-out and/or vibration.
Inadequate metal alloy and/or hardening.

Elliptical wear band on lower slitter:
Excessive run-out on lower slitter only.

Blunt tip on top slitter:
Abrasive web material.
Excessive top slitter blade overlap.
Acutely profiled blade tip is inappropriate for web material.
Unsdersped slitter system (wrap or tangent system).
Inadequate metal alloy and/or hardening.

Blunt edge on lower slitter:
Excessive cant angle on top slitter.
Abrasive web material.
Excessive penetration of lower slitter up into web.
Inadequate metal alloy and/or hardening.

Chipping and/or burring of top slitter:
Top slitter blade "Jump".
Steep (acute) top blade grind angle.
High side loading force.
Severe axial (lateral) vibration. (chipping)
Excessive cant angle of top slitter.
Debris in web. (chipping)
Inadequate metal alloy and/or hardening. (burring)

Chipping and/or burring of lower slitter:
Top slitter blade "jumping" over rim of lower slitter.
Severe axial (lateral) vibration. (chipping)
Debris in web. (chipping)
Inadequate metal alloy and/or hardening. (burring)

Figure 3: Symptoms and causes of slitter blade wear.

Hard coating blades with titanium nitride, ceramic, or diamond-like coatings (DLC) have a positive effect on web-to-blade wear resistance until the first blade regrinding. Regrinding the blade removes the coating from the most important area of the blade concerned with web-to-blade abrasion resistance—the primary grind face. Unless the base metal of the blade contains sufficient alloy, web abrasion will continue to remove the re-exposed metal with renewed vigor.

A tungsten carbide or ceramic inlay in lower slitter rings has a positive effect on upper and lower slitter blade life from the standpoint of blade-to-blade wear. From a web-to blade wear standpoint, carbide lower slitter edges provide a marginal benefit because they do not project into the web as much as the upper blade.

SURFACE FINISH

An abrasive web will blunt a coarsely ground upper blade more quickly than a smoothly finished blade. The relatively coarse surface irregularities that extend to the extreme edge of blades become rapidly polished until the surface area and cutting edge reaches a smooth equilibrium. Unfortunately, this means that the original, sharp cutting edge becomes blunted to a rounded profile too rapidly. A good test to determine if the blade edge is truly smooth and free of grinding induced irregularities is to wipe a tuft of cotton around the blade edge. Cotton fibers will hang up on projections caused by rough grinding. The ground surface finish should not exceed 16 micro-inches for utility slitting. Eight micro-inches offers a better choice for general applications.

Figures 1–3 identify the most common forms of blade wear and the most probable causes.

To determine the causes of slitter blade wear, look for tell-tale signature wear patterns on blades that differentiate between blade-to-blade wear discussed in the April issue and web-to-blade wear discussed above. After classifying wear patterns, solutions will be easier to recognize and implement without resorting to "a stab in the dark" or applying a costly solution to a simple problem. **S!**