High Speed Shear Slitting: Facing the Issues

By: Reinhold Schable, Tidland Corp.

Presented By: Mike Flannigan, District Manager
mflannigan@maxcessintl.com, 828-248-9582

AIMCAL Fall Technical Conference – October 27, 2004
Francis Marion Hotel – Charleston, South Carolina
What is “High Speed”?

- Paper mills: 3000m/min (9000fpm)
- Film Coater: 1500m/min (4500fpm)
- Metalizer: 1000m/min (3000fpm)
- Laminator: 800m/min (2400fpm)
- Flex-pack Printer: 500m/min (1500fpm)
- Thermoformer: 150m/min (500fpm)
- Flooring: 20m/min (60fpm)
High Speed?
High Speed?
I: Four Dynamics

I: Hardware Dynamics

II: Nip Dynamics

III: Web Path Dynamics

IV: Material Shear Dynamics
I: Hardware Dynamics

- Critical Speed
- Run Out
- Vibration
Critical Speed
Runout, Axial & Radial

Axial Runout
Upper Blade

Radial Runout
Upper Blade

Radial Runout
Lower Ring

Axial Runout
Lower Ring
Axial Runout

Axial "Wobble"

- Lower slitte ring too loose on shaft.
- Lower slitter ring too narrow.
- Debris under slitter ring or blade mount.
- Inaccurately ground blade edges.
- Knifeholder axle bent.
- Blade hub bearings worn.
- Warped blade.
Radial Runout

Radial "Loping"

- Slitter shaft bent. Surface inaccurately ground.
- Slitter shaft critical speed problem.
- Slitter ring or blade ID too large.
- Slitter ring or blade bore not concentric to OD.
- Debris under blade or hub.
- Blade hub ID too large (loose fit onto shaft).
- Blade hub bearings worn.
Runout, Slitter Rings

Axial run-out ("loping")

Radial run-out ("wobble")
Runout Evidence!
Shaft Runout

Check assembled slitter shaft and rings at operating speed

Check journals & bearings for straightness and wear.

Check body for straightness at several points across face.

Check body for roundness at extreme ends.
Vibration, from many sources…

Typical Vibration Patterns

- Out of Balance
- Unwind Rolls
- Shafts & Rollers
- Bearings & Gears

Time
II: Nip Dynamics

- Cant Angle
- Sideload
- Nip Speed
...The cant angle (toe-in, or shear angle) brings the edges of the sitters into contact, closing the nip at the cut point.
Cant Angle - vs - Speed Issues

- **Purpose:** “To close the nip”.
- **Compensates for blade “tilt”**.
- **A feature of individual knifeholders.**
- **Amount needed is material dependant, usually not more than 1°.**
- **As speed increases; cant angle is relatively unaffected, but *Sideload* may vary.**
Beware of the Cant Angle!
Sideload: 2-shaft slitters

Sideloading Twin-Arbor Slitters
Sideload: Spring Type, 2-Arbor Slitters
Sideload: Individual holders

- Axial Coil Spring
- Paralell Links
- Pneumatic
- Rigid Suspension
- Flexible Suspension
Sideloading: a modern system

...Shear slitting can involve a large, complex machine, or......
Sideloading: a primitive system

...Shear slitting can involve a simple “old timer”.
Nip Speed Must Equal Web Speed!

- Blade Overlap Influences Nip Speed on Traction Driven Slitters.

- Tangent Systems Can (and should) be oversped to compensate for Nip Speed Loss.

Nip Speed = Web Speed

Synchronized Nip

...The speed of the nip must be the same as the speed of the web...
…Overlap reduces the speed of traction driven slitters and creates a radial friction component.
…Nip velocity slows, blade wear accelerates with increased overlap.
…Actively driven upper slitters may eliminate the speed
### 8b. Overlap Influences Nip Speed & Blade Wear

<table>
<thead>
<tr>
<th>Blade Dia.</th>
<th>Overlap</th>
<th>% Speed Diff. of Top Blade</th>
<th>Radial Friction of Top Blade.</th>
</tr>
</thead>
<tbody>
<tr>
<td>4&quot;</td>
<td>.040&quot;</td>
<td>-4.0%</td>
<td>29%</td>
</tr>
<tr>
<td></td>
<td>.080&quot;</td>
<td>-7.9%</td>
<td>39%</td>
</tr>
<tr>
<td></td>
<td>.120&quot;</td>
<td>-11.8%</td>
<td>47%</td>
</tr>
<tr>
<td>6&quot;</td>
<td>.040&quot;</td>
<td>-2.6%</td>
<td>23%</td>
</tr>
<tr>
<td></td>
<td>.080&quot;</td>
<td>-5.3%</td>
<td>32%</td>
</tr>
<tr>
<td></td>
<td>.120&quot;</td>
<td>-7.9%</td>
<td>39%</td>
</tr>
<tr>
<td>8&quot;</td>
<td>.040&quot;</td>
<td>-2.0%</td>
<td>20%</td>
</tr>
<tr>
<td></td>
<td>.080&quot;</td>
<td>-4.0%</td>
<td>28%</td>
</tr>
<tr>
<td></td>
<td>.120&quot;</td>
<td>-6.0%</td>
<td>34%</td>
</tr>
<tr>
<td>10&quot;</td>
<td>.040&quot;</td>
<td>-1.6%</td>
<td>18%</td>
</tr>
<tr>
<td></td>
<td>.080&quot;</td>
<td>-3.2%</td>
<td>25%</td>
</tr>
<tr>
<td></td>
<td>.120&quot;</td>
<td>-4.4%</td>
<td>30%</td>
</tr>
</tbody>
</table>
Nip Speed Must Equal Web Speed!

- Blade Overlap Influences Nip Speed on Traction Driven Slitters.

- **Tangent Systems Can (and should) be overspeed to compensate for Nip Speed Loss.**

- **Traction Driven** Wrap Slitter Systems Cannot Compensate for Nip Speed Loss.
Slitter vs Winder Speed

Nip speed must not lag behind web speed
Nip Speed Must Equal Web Speed!

- Blade Overlap Influences Nip Speed on Traction Driven Slitters.
- Tangent Systems Can (and should) be oversped to compensate for Nip Speed Loss.
- **Traction Driven** Wrap Slitter Systems Cannot Compensate for Nip Speed Loss.
Web speed and *lower slitter* speed is synchronous.
Nip Speed is Slower than Web Speed

Undersped Nip

...If the nip closes slower than the web, slit quality is reduced.
Nip Speed Must Equal Web Speed!

...Both edges will be bad if nip speed is less than web speed
III: Web Path Dynamics

• Tangent Slit
• Wrap Slit
• Cross-Machine Symmetry
The Tangent System

"Cut Point". (Nip)

Arc of "Rub"
“Flutter”

Web "Flutter"

Tangent "Slitter Table"
“Flutter”: long web draw
Flutter is prone with...

- Tangent slitter systems.
- Long slitter tables (a long “draw”).
- Vertical web paths, or inverted slitters.
- Thin, low stiffness web materials.
- Turbulent air currents, static electricity.

...however....

- Wrap slitter systems suppress flutter.
“Symmetrical” Slitter Set-up
IV: Material Response Dynamics

Material responses at increasing speeds:

- Increased notch sensitivity.
- Increased shatter, fracture sensitivity.
- Increased delamination sensitivity
- Increased elongation effects.
- Increased rheology effects.
- Increased ”bow wave” effect.
- Increased ”shock wave” effect.
Shear Resistance

SHEAR RESISTANCE
As a function of material properties

Caliper (Thickness), Density, Rheology, Notch Sensitivity, etc....
Delaminated & Cracked edge
Summary:

Four Dynamic Issues when increasing slitter speed

#1… Hardware dynamics
#2… Nip Dynamics
#3… Web path dynamics
#4… Material shear dynamics
High Speed Shear Slitting: Facing the Issues

By: Reinhold Schable, Tidland Corp.

Presented By: Mike Flannigan, District Manager
mflannigan@maxcessintl.com, (-) 555-5550

AIMCAL Fall Technical Conference – October 27, 2004
Francis Marion Hotel – Charleston, South Carolina
CLICK TO RETURN TO LIST OF PAPERS AND PRESENTATIONS