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Todd Swinderman, Martin Engineering, USA,
explains how conveyor length and cost is being
reduced by a new design for transition zone loading.

A WELCOME TRANSITION

Loading a conveyor belt before it is in the fully
troughed position is generally considered bad practice.
The belt in transition is a 3D surface, and there is an
abrupt inflexion in the skirtboard angle at the first full
trough idler, making it difficult to seal the belt in the transition.
This difficulty in achieving an adequate seal results in the escape
of fugitive materials, and the abrupt change in angle creates an
entrapment point at the inflexion that collects fine material,
leading to belt grooving and leakage, which causes other
problems (such as seized rollers).

Despite these drawbacks, limitations imposed by a lack of
available space and the maximum incline angle for a given
material often motivate bulk handlers to accept loading on the
transition to reduce a conveyor's overall length. Others, in the
misguided belief that initial low price is more important than
lower long-term costs, look for ways to shorten the conveyor
even when not necessary. Unfortunately, operations pay for this
decision in many other ways, including increased equipment

maintenance, additional clean-up time and potential safety
hazards from personnel working in close proximity to the
moving belt, as well as long-term health risks from poor air
quality due to airborne dust. If a workable solution to loading on
the transition could be found, it would open up a large market
for retrofitting older conveyors that, due to space restrictions and
material flow issues, cannot be re-engineered to load after the
belt is fully troughed and for new designs to achieve a lower cost
of operation.

A new, patented concept has been developed to execute an
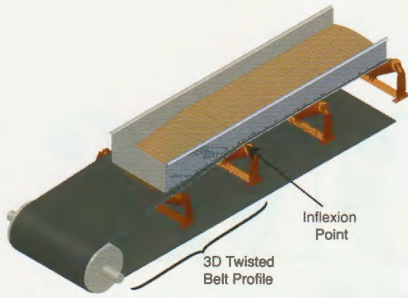effective trough transition in a short distance. This new approach

Figure 1. Conventional practice of loading on the transition.
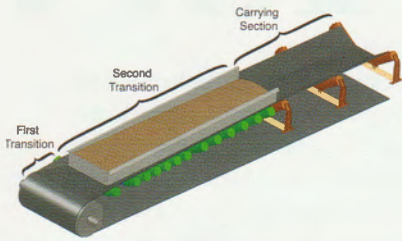

Figure 2. Two-stage picking transition.

Figure 3. Stacker reclaimers and bucket wheel excavators often use adjustable transition idlers to try and create a flat belt line.
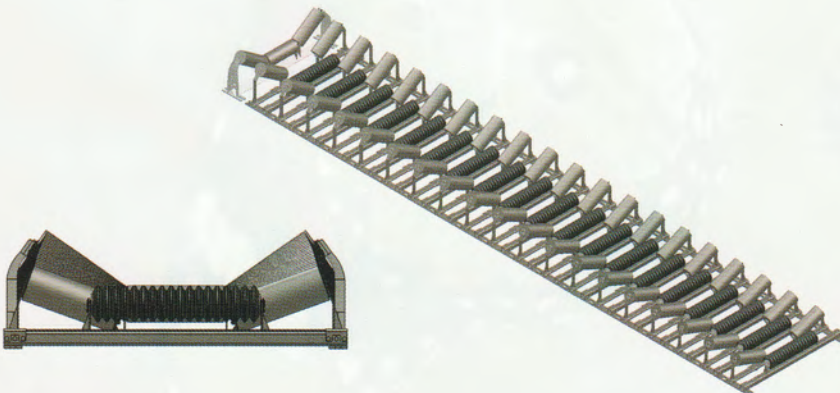

Figure 4. Picking transition idlers 20° to 35°.

is based on a two-stage transition, with the first going from tail pulley to 20° and then the full loading zone gradually transitioning from 20° to the full trough angle at the exit. As a result, operators could obtain several benefits, including loading close to the tail pulley, the ability to modify chute angles, reduced skirtboard grooving and a transfer point that can be effectively sealed.

A new solution is to transition the belt to a picking idler profile, with the length of the centre roll of the picking idler approximately the width that the skirtboards are spaced. A second transition from the picking idler to a conventional three equal roll troughing idler is constructed by gradually changing the wing roll angle and wing roll centre bracket height. With this approach, the belt is gradually transitioned through the loading zone to a conventional troughing idler at the end of the loading zone.

By transitioning first to a picking idler profile, the transition distance is dramatically shortened. The second transition can be engineered so the belt surface under the skirtboards is a straight line controlled by gradually increasing the trough angle and idler wing roll centre bracket height. Fugitive material release is significantly reduced, and the inflexion point is eliminated, along with the belt damage it causes. Proper skirtboard and wear liners can be installed, and sealing technologies can be applied effectively.

Among the perceived disadvantages of the picking transition loading concept is that each application would require custom engineering. Each idler will need either a special frame or a frame that can be engineered with adjustable angles and roll support heights to handle most applications. This disadvantage is minimised by using standard rollers in the custom frames. For those who have no choice but to live with loading on the transition and the problems it creates, the cost of engineering and fabrication will be easily offset by reducing belt damage and minimising fugitive material.

The ultimate objective is to build a second transition section that extends the length of the transfer point, transitioning from 20° to the final trough angle and creating a flat belt surface over the wing rolls to which a skirtboard with a straight bottom can be spaced parallel to the belt.

Design process

The basic design criteria for a two-stage picking transition are:

- The exposed portion of the centre roll of the 20° picking idler in the first transition is made equal to the chute width.
- The first transition from the tail to 20° is governed by DIN 22101 transition design formulas.
- The second transition starts at a 20° wing angle and the wing angle incrementally increases to the exit of the load zone at the final design trough angle (i.e. 30, 35 or 45°).
- The centre rolls are all the same length, and the wing rolls are all the same length. As the second transition progresses, more and more of the wing rolls are exposed until the

configuration is the equivalent of the final design troughing idler angle and roller/belt contact.

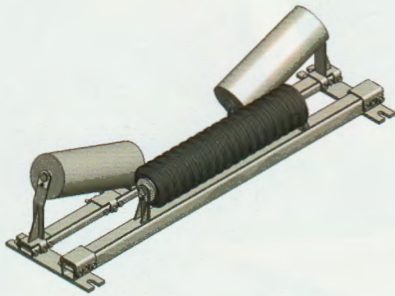- The centre roll height is the same as the final design troughing idler centre roll. The inside brackets of the wing rollers are gradually increased as the wing angle increases to create the flat belt line under the skirtboards.

- The number of idlers in the second transition is determined by the idler spacing. The wing angles are increased in equal steps based on the number of idlers.

- The last idler in the loading zone is a conventional three equal roll troughing idler of the final design trough angle.

Figure 5. Picking transition idler design allows the same length wing rolls and the same centre roll in custom frames.

$$W_s = 2 \times \cos(\lambda) \times \left(\frac{BW}{3} - 115 \text{ mm} \right) + \frac{BW}{3}$$

Figure 6. Free edge distance in load zone.

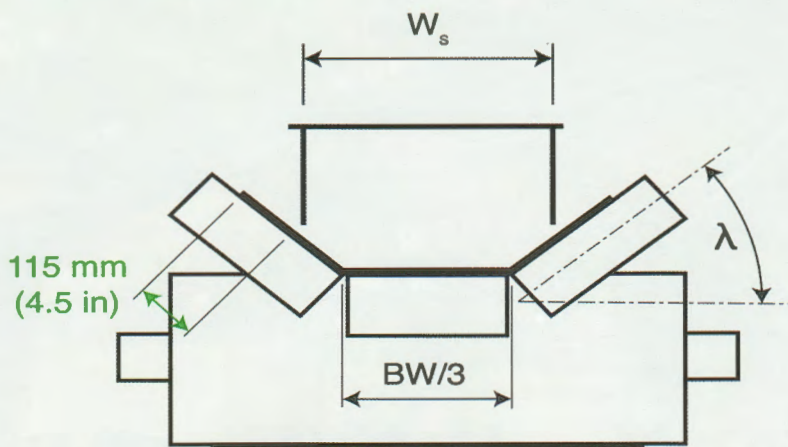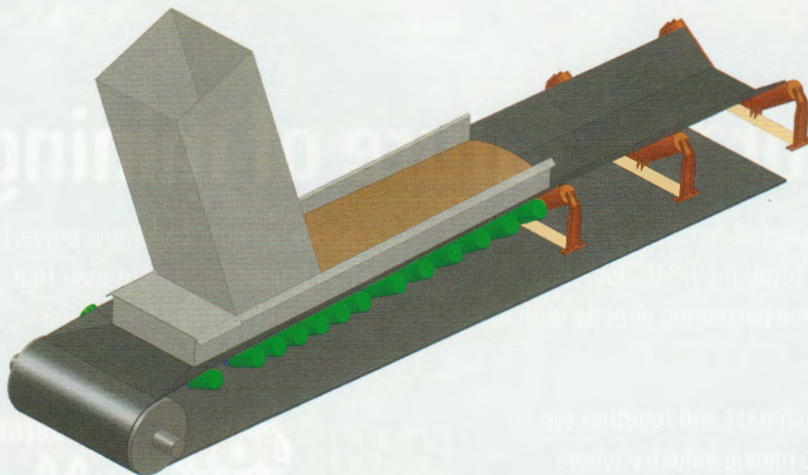Figure 7. Picking transition loading zone.

Step one

The nominal skirtboard width should be determined based on a de-rated design capacity, belt width and the final belt trough angle in the carrying zone. It is recommended that the skirtboard width be determined by the amount of free belt edge required for an effective sealing system installation and the expected belt wander. According to Foundations 4,[1] the free edge distance is at least 115 mm (4.5 in.) regardless of belt width, which includes 50 mm (2.0 in.) of expected belt wander. If more belt wander is expected, the free edge distance in the load zone should be increased. This distance should not be confused with the DIN or CEMA standard belt edge used in determining the design capacity of the carrying idlers outside the load zone.

Step two

Determine the length of the transfer point. The first transition to 20° is determined by the DIN 22101 formulas and generally requires only one specially-designed 20° transition idler.

The second transition length is based on the need for dust control, reducing material slip-back, controlling the turbulence of the material or other requirements of the application. An additional consideration may be the need to increase the chute angle for better material flow. Generally, the need for dust control will govern the length of the second transition, therefore the second transition length equals tailbox + loading section + skirtboard extension (two seconds of belt travel times the belt speed for dust control is recommended for the extension).

Step three

The final step is determining the idler spacing in the second transition, with a minimum of 330 mm (13 in.), based on the current picking idler design for 125 mm (5 in.) and 150 mm (6 in.) dia. rolls, and designing the custom idler frames. By dividing the length of the transfer point by the idler spacing, the required number of idler sets can be calculated, with the last troughing idler being a standard three equal roll idler. The wing roll angles are in equal increments based on the spacing. If variable spacing is used, it is recommended that it be a multiple of 330 mm (13 in.). For example, 330 mm spacing (13 in.) in the impact area and then 660 mm (26 in.) for the rest of the second transition.

The design of the wing roll brackets involves applying geometry to determine the heights of the wing roll brackets to create the flat belt line under the second

transition skirtboards. This is done by creating an imaginary trapezoidal surface with the two bases equal to the belt contact line on the first and last wing rolls in the second transition. Using 3D modelling, the height of the wing brackets necessary to create contact with the imaginary surface and create a straight belt line under the skirtboards can be determined. The result is each wing idler bracket in the second transition will be a unique design (but the rollers are all identical). The centre roll is always the same length and the bracket is always the same as the first transition picking idler.

Example

A 1200 mm (48 in.) fabric belt running at 2 m/sec. (400 ft/min.) and between 60 – 90% of rated belt tension may require only a 600 mm (24 in.) first stage picking transition before the tail box and load chute begin. The second transition is 4 m (13 ft) long plus the length of the load chute to accomplish the two seconds of belt travel after loading needed for passive dust control.

Completing the transition zone

Once the transition zone has been designed, the remaining conventional components can be put in place. Typical additions are engineered sealing systems, increased skirtboard enclosure height and dust curtains for passive dust control or air cleaners for active dust control.

Conclusion

The two-stage picking transition offers many benefits:

- Shortened conveyor length reduces construction costs on new installations.
- Existing conveyors can be retrofitted to reduce belt damage and spillage.
- Chute angles can be increased to reduce flow problems.
- The load profile deepens as the material flows through

the load zone, reducing pressure on the skirt walls to minimise chute plugging, wear and spillage.
- The individual idlers on custom frames can be removed from the side without lifting the belt.
- The offset picking idler design reduces idler junction failure.
- Replacement rollers are of standard design.

Precision Pulley and Idler (PPI) engineers each set picking idlers based on the trough angles and transfer point length, using CEMA idler load calculation methods. Martin Engineering engineers, install and maintain the containment elements of the transfer point.

The additional cost of the idler frames is estimated to be approximately 35% more than a conventional offset idler frame. In new construction, the cost is offset by having a shorter belt centre distance. On retrofits, the cost is quickly recovered by reduced belt damage from skirtboard seal grooving and reduced clean-up costs. *C*

Notes

1. SWINDERMANN, T., MARTI, A., GOL DBECK,L.,MARSHALL,D.,STREBEL,M., FoundationsTM: 'The Practical Resource for Cleaner, Safer, More Productive Dust & Material Control' (Fourth Edition), Copyright © Martin Engineering, (2009).
2. This technology is proprietary to Martin Engineering and Precision Pulley and Idler, with patents pending and issued.