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Ask Joe! Column

Designing a Belt Feeder Interface-Transition

by Joseph Marinelli, Solids Handling Technologies.

Introduction

In this article, we discuss proper belt feeder design technique so as to maintain reliable flow from bins and hoppers. Belt feeders are used to feed many types of bulk solids. In addition to their obvious benefits like simplicity and relatively low cost, they are one of the few feeder designs that can be used to feed product from a slot outlet. As well, cohesive and/or sticky materials and even materials with large particle sizes can be fed reliably. (photo: Feeder interface handling heavy ore product.)

As we have discussed in previous articles, there are benefits to using a slot outlet when mass flow is required. One of the most useful is the fact that for a given set of conditions (product, angle of friction) the slope at the sides of a slot can be significantly flatter than a conical mass flow hopper. A flatter mass flow hopper will always translate into lower headroom and a more economical design.

Interface-Transition

A critical aspect of a mass flow hopper is that the feeder must withdraw product from the full cross section of the hopper outlet. This can be difficult to achieve with a long slot. A belt or screw feeder under a slot will typically withdraw product from a small area at the front or back of the slot unless the capacity of the feeder increases in the direction of feed. If there is only a small flow channel within otherwise stagnant product there is no mass flow – no matter how steep the hopper.

To give a belt feeder an increasing capacity along its length requires an interface. A well-designed interface between the slot outlet of the hopper and the belt will progressively add more product onto the belt along its length. This will make the full cross section of the hopper outlet live and therefore support mass flow (if the hopper is sufficiently steep). An increasing capacity is achieved by controlling the position of the shear plane between the product in the hopper moving down and the product in the feeder moving horizontally.

A belt feeder interface design that has been used successfully for many years is shown in the figure below. The design slopes inward on the sides and is struck off at an angle along its length. The product flowing within the sloping sidewalls of the interface is converging from side to side as it flows down. This forces the major principle stress in the flowing product to align horizontally. The product below the cutoff line is resting on the belt and the major principle stress in this product is vertical. The shear plane between the product flowing down in the interface and the product flowing horizontally on the belt forms along the plane where the direction of major principle stress changes.

The major principle stress in the product flowing within the interface is not exactly a straight horizontal line between the sloping sidewalls of the interface but actually curved. This is due to the friction between the flowing product and the sidewalls of the interface and the internal friction in the product. Therefore, the shear ‘plane’ is shaped along this curve. The curved cutout in the front nose of the interface accommodates this shape.

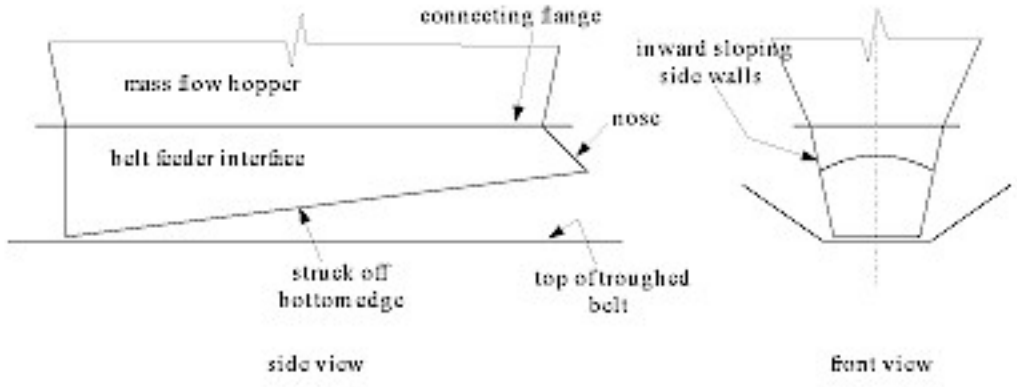
To achieve a true uniform increase in capacity along the length of the belt feeder, the strike-off of the bottom of the interface also has a curve from back to front. This is negligible if the rate of increase in capacity along the belt is small but significant if the rate of increase is relatively large.

Product Flow

As product flows down through the interface, since the major principle stresses are more-or-less horizontal, the vertical stresses acting through the shear plane are relatively low. This allows the belt to shear the product efficiently with a minimum amount of force. In addition, the vertical loads acting down onto the belt are relatively low and independent of the head of material in the hopper. Without a mass flow hopper and proper interface design, the loads on the belt would be high and a function of the head of material in the hopper. Therefore, the design of the hopper and the belt feeder and the loads on the belt are very much dependent and connected.

The interface design relies on a variable speed belt to achieve a variable product flow rate. There is no adjustable gate at the front of the hopper to adjust the cross section of product on the belt. Designs with adjustable gates can not feed material uniformly – especially from a long slot. Therefore, they cannot be relied upon to support mass flow. In addition, since there is no natural separation between the product moving down in the hopper and the product moving horizontally on the belt, the shear is achieved by brute force shearing the product under a head of material. In funnel flow the head of material acting on the shear plane is high.

Figure: Belt feeder interface



The figure shows an interface between a mass flow hopper and a troughed belt. The interface will deposit product onto the belt in a measured, settled bed. There is usually no need for special skirts to contain the product on the belt or to contain dust. The same design is used for a flat belt or apron feeder, but skirts are used in this case to contain the product. The profile of product on a flat skirted belt is different from that on a troughed belt so the shape of the struck off lower edge of the interface is different to give a uniformly increasing capacity along the length of the interface.

The nose at the front of the interface is projected out from the hopper area. This relieves the stresses on the product as it shears and also reduces the pressure on, and therefore wear of, the nose itself. Relatively modest amounts of wear resistant lining on the inner surface of the nose will usually provide a long wear life.

Conclusion

This interface design has been used successfully for many years for products with a very wide range of properties. Heavy, primary crushed ores to friable products and chemical powders have been successfully handled. The photograph above shows a heavy ore with large particles being handled reliably at a high discharge rate.

Comments, Suggestions and More!

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Contact our author

Joseph Marinelli
Solids Handling Technologies
1631 Caille Court
Fort Mill, South Carolina 29708
Telephone: 803-802-5527
Fax: 803-802-0193
E-mail: Joe@SolidsHandlingTech.com

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Welcome to Ask Joe!, a monthly column by our resident materials handling guru, Joe Marinelli of Solids Handling Technologies. Joe addresses the issues that bug you the most. And Joe knows!! Formerly with Jenike & Johanson, Solids Flow and Peabody TecTank, Joe is an expert on materials handling.

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Guest articles for the **Ask Joe!** Column are always welcome, for more information please contact Joe Marinelli directly at his email address: joe@solidshandlingtech.com.