CONVEYOR EQUIPMENT MANUFACTURERS ASSOCIATION

Respirable and Nuisance Dust – Passive Control

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There are several common design rules for sizing some of the skirtboard enclosure dimensions based on belt width and/or belt speed. None of the guidelines seem to have an engineering basis and appear to be developed from common practices in the early 20th century first documented in the New York City Health Department requirements for silica dust control.

Commonly applied rules for skirtboard enclosures include width equal to 1/2 or 2/3's of the belt width and length equal to either two (2) times the belt width or 1.2 m for every 1.0 m/s of belt speed. In recent years designing an enclosure average airspeed of less than 2 m/s has become common. There are no generally accepted rules for the height of the skirtboards and in many cases, the height is dictated by either the vertical distance needed for the sealing system or to minimize cost. A study was done using SolidWorks FLOW Simulation software. The software allows the study of turbulent particle trajectories in air streams as found in skirtboard enclosures.

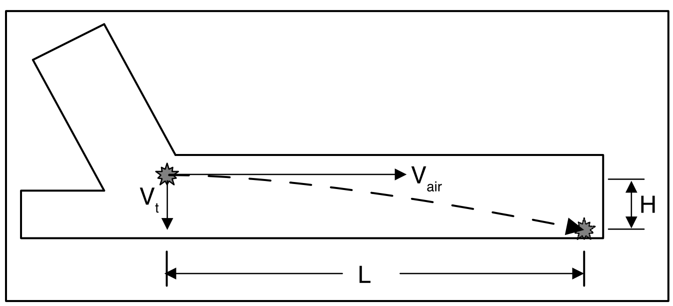

Figure 1. Dust particle trajectory

The basic concept is the trajectory of a dust particle can be modeled based on the terminal velocity, V_t, of the dust particle settling in still air and the velocity of the airflow in the transfer point, V_{air}. The resultant of these two velocities using the enclosure height, H, as the vertical drop distance indicates the length, L, necessary to settle the dust particle. If the terminal velocity, V_t, of the particle is very small and the transfer point airspeed, V_{air}, is relatively large the settling distance can be quite large. Using the commonly applied Stoke's Law, a 10 µm respirable limestone dust particle in an airstream traveling 1.0 m/s is predicted to take 75 m to settle by gravity alone! Air is very compressible and will find the path of least resistance. With current designs, the air is most often speeding up significantly to flow under or around a single exit dust curtain with narrow slits resulting in re-entraining the dust particles in the exhaust. Therefore, to reduce dust emissions from a skirtboard enclosure it is necessary to create recirculation regions inside the transfer point.

The best results for passive dust control were obtained with a configuration that includes a minimum of three (3) curtains the full width of the chute. The first curtain is located just after the turbulence from loading, the second in the center, and the exit curtain is placed inside the skirtboards before the exit.
A chute height of 600 mm and length of at least 3600 mm were found to be optimum. It was found that the curtains need wide slits of at least 5 mm to allow some airflow through the curtain to encourage some recirculation within the enclosure. Solid curtains or curtains with only razor slits cause the air to speed up to flow underneath and significantly increase the air velocity exiting the chute keeping the dust airborne.

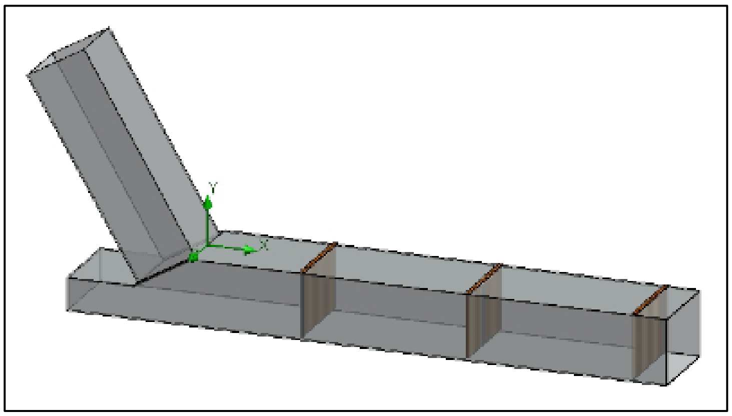

Figure 2: Preferred Inline Transfer

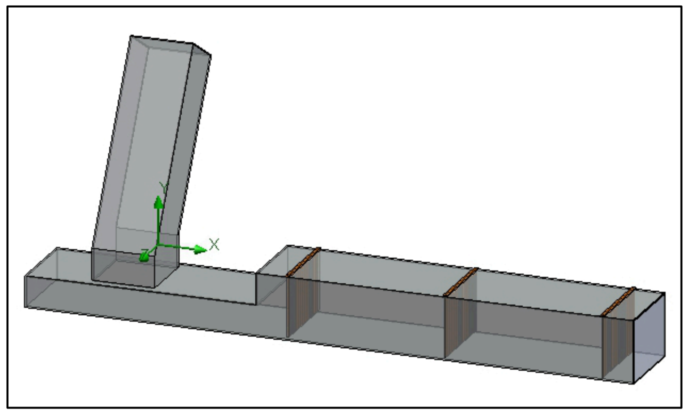

Figure 3: Preferred Angle Transfer

The junction between the discharge chute and the skirtboards is an important design detail for creating recirculation. Making the width of the discharge chute narrower than the width of the skirtboard helps to fold the airflow going into the first curtain and that encourages the distribution of the airflow toward the top of the enclosure rather than along the surface of the material. Slits between curtain flaps of at least 5 mm wide were necessary to prevent the dust curtains from acting as solid barriers which forced the air to speed up and flow under the curtains. Full-width curtains proved to be the most effective

Maintenance of the dust curtains is critical. Best results are obtained with the dust curtains maintained as close to the material flow as practical. It was found that a curtain worn more than 100 mm was the same as having no curtain at all for dust control. Maintaining the curtains to be as close to the cargo as possible is critical in achieving the ongoing performance of passive dust control enclosures. Placing the exit curtain inside the enclosure not only reduces “popcorn” spillage but also aids in reducing exit air velocities. A tail box extension allows for better sealing past the point of impact of the bulk material on the belt since wear liners and seals can be extended past this high turbulence area maintaining a seal.

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General Design Considerations

- Discharge chute cross-sectional area ≥ CEMA 100% bulk material cross-sectional area divided by 0.4.
- Discharge chute width across skirtboards < width between skirtboards
- Skirtboard width ≤ Belt Width – horizontal dimension of free belt edge = width of sealing system and wear liner. (FOUNDATIONS Method)
- Skirtboard height ≥ 600 mm
- Inlet to skirtboards air flow ≤ 0.50 m^3/s
- Length of skirtboard extensions for material loading turbulence ≥ 1000 mm
- Length of skirtboard extensions for dust settlement: Length for turbulence + ≥ 3600 mm
- Discharge chute typical connection to skirtboards. Figures: 2 & 3.
- Tail box extension: ≥ 600 mm with end seal. Figure 4.
- Skirtboard Dust Curtains:
    - Entrance (1st) curtain 300 mm past end of extension for material turbulence.
    - 2nd (middle) curtain centered between the entrance and exit curtains
    - Exit (3rd) curtain 300 mm from the end of skirtboards
    - Curtain clearance above the bulk material: 25 mm preferred, 50 mm max.
    - Curtain flaps: ~ 50 mm wide strips separated by slots ≥ 5mm
- Tailbox End Seal: folded overlap construction

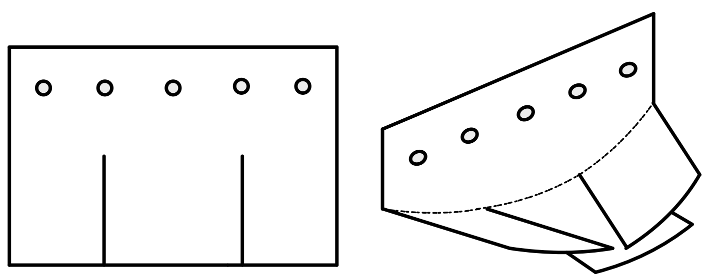

Figure 4. Tailbox End Seal