

Bulk Transport 2001
Air Supported Conveyors for Bulk Solids
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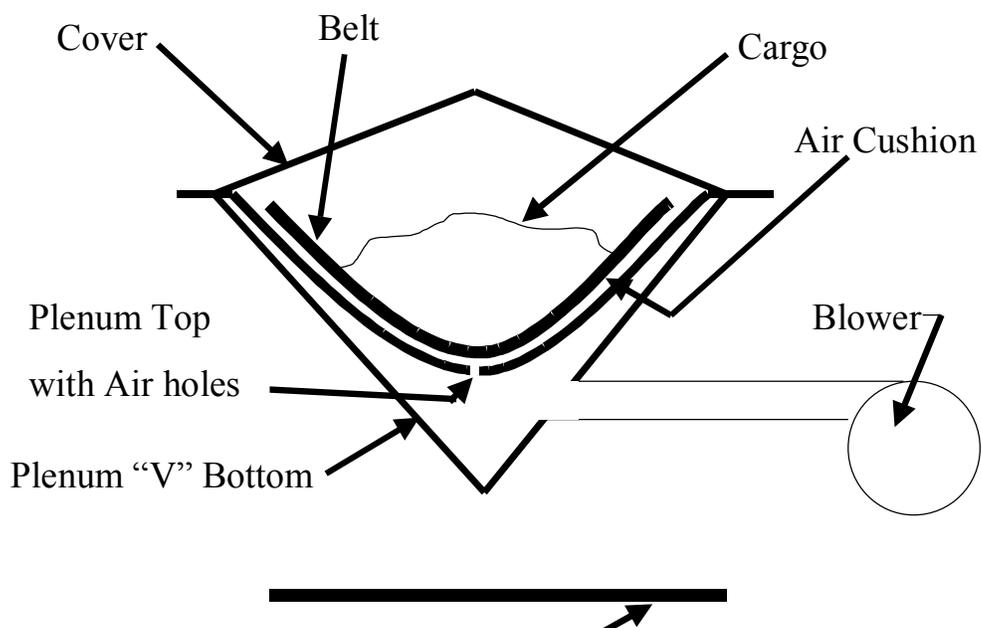
Purpose

The purpose of this paper is to discuss the application of air supported conveyors in bulk solids handling. Innovations in bulk solids conveying are slow to take hold in practice with major advances being accepted only after significant introduction periods that are as long as 20 or 30 years. Air supported conveyors were developed in Europe over 20 years ago and have since been used extensively in conveying unit handling for bottle and can conveying and in bulk handling primarily for unprocessed grain. There are many reasons for the slow acceptance of technology in bulk material handling. In the case of air supported conveying it was due in part to the counter intuitive operating principles and in part to perceived cost. The installed price of air-supported conveyors has traditionally been more than the price of conventional roller conveyors. The mention of “air” in most industrial facilities immediately creates a vision of expensive high pressure compressed air, which is frequently in short supply. In addition to cost concerns, air supported conveyors have not been marketed effectively due to the difficulty of effectively explaining the counter intuitive function and advantages of air-supported conveyors. Air supported conveyors can be used for most bulk materials and offer significant energy, environmental and safety advantages over roller conveyors. Air supported conveyors are becoming more popular because new designs make it cost competitive with roller conveyors and they are an ideal solution for applications where a high level of dust and spillage control is required.

How Air Supported Conveyors Work

A low-pressure film of air supports a conventional flat or troughed conveyor belt.

Fig. 1 Air Supported Conveyor Concept



Standard head pulleys, drives and tail pulley constructions are used. The load zone, carrying sections and return runs of the conveyor can all be contained in plenums that are pressurized with a low-pressure blower. The top of the plenums are shaped to the same profile as a normal belt conveyor and holes in the plenum allow a film of air to form between the belt and the plenum thus supporting the belt in place of the conventional rollers.

The pressure to support the belt and cargo is easily estimated by knowing the weight of the belt and cargo. For example, a system where the belt and cargo weigh 500 kg/m^2 (100 lbs/ft^2) requires only about 5 kPa (.7 psi = 19 in-wg.) pressure to lift the belt. Inches of water column, in-wg, are commonly used in designating fan output pressures. The volume of air required is minimal because the air film thickness required to minimize the coefficient of friction is less than 1 mm. Calculating the volume of air is more complex as it depends upon several factors such as the length of the conveyor, pressure distribution, hole spacing and diameter. The holes in the plenum are centered under the belt because this arrangement best matches the air pressure distribution with the weight distribution of a troughed conveyor belt and cargo. Generally speaking .2 to .3 m^3/min . per meter of belt length at 5 to 9 kPa (2 to 3 cfm per foot of belt @ 20 to 30 in-wg) is sufficient volume and pressure for most applications.

Advantages of Air Supported Conveyors

1. Lower power costs than conventional roller conveyors even when including the fan power. There is a substantial energy advantage of up to 30% on horizontal conveyors and 5% savings on inclined conveyors.
2. Cargo stability is greater on an air-supported conveyor because there are no idlers to cause a settling or compacting action as the belt and cargo travel along the conveyor.
3. Minimal maintenance is required compared to a roller conveyor because there are no skirtboard seals to adjust or idlers to lubricate or replace. Walkways can be eliminated on the span between the load zone and the discharge zone.
4. Higher incline angles are possible because there is no agitating action of the rollers to initiate the roll back of material on the belt.
5. Lower noise than conventional conveyors because there is no belt to roller contact. Noise levels for air-supported conveyors are typically 10 to 15 dBA less than roller conveyors.
6. Totally enclosed belt is an inherent feature that reduces spillage and wind erosion.
7. Reduced structure because of the inherent structural rigidity of the plenum conveyors can be self-supporting for spans up to 45 feet.
8. Improved tracking of the belt results from the self-centering action of gravity if the belt is centrally loaded because there are no idlers to steer the belt off center.
9. Reversing operation is more reliable because there are no idlers to align and the power requirements are lower so the effects of drive location on start up and shut down are less critical.
10. Belt sag in the load zone is eliminated resulting in less spillage. Spillage is contained within the plenum and eventually returns to the belt.
11. Dust free operation results from the inherently enclosed design.

12. Higher belt speeds can be obtained because the belt tensions are lower and there is less cargo turbulence.
13. Safer to operate because workers cannot come into contact with the belt between the tail and head pulleys.
14. Additional capacity (10 to 20 %) is possible through non-standard configurations such as deeper trough angles or semi circular belt profiles.
15. Belt life is increased because some of the degrading mechanical actions such as idler junction wear do not exist and belt tension is reduced.
16. Construction is modular so sections can be easily shipped and conveyors can be incrementally retrofitted or expended easily. The V™ Plenum design can be retrofitted into existing conveyor infrastructures without major structural rework. One conveyor can have multiple air-supported sections in combination with roller sections.
17. Less site work is required on new construction because the sections are modular and fitting up is more precisely controlled by the manufacturing tolerances.
18. Greater reliability because there is only one moving part, the fan.
19. Temperature and humidity control is possible by treatment of the air.
20. Fans can be sized for upgrading by installing the largest size fan needed and restricting the exhaust. One fan will typically support 180 meter (600 ft.) of conveyor.
21. The fan air pressure and volume can be easily controlled for variable load requirements.

Disadvantages of air supported conveyors:

1. Light duty impact applications are the best fits for the technology.
2. Central loading of the cargo initially is critical to proper belt tracking and preventing material spillage inside the plenum.
3. Visual access is restricted and while not usually a requirement it is a long-standing practice to visually observe the cargo on the belt at process critical locations.
4. Belt scales present a design problem requiring a break in the air-supported conveyor unless non-contact methods are used.
5. Mechanical fasteners require an increased level of workmanship over what is normal in the industry. The joints should be recessed and covered to prevent catching on the plenums and sparking. Vulcanized belts are preferred.
6. Air volume in the enclosed parts of the conveyor is increased due to the introduction of the air for supporting the conveyor. This requires increasing the size of dust collectors and/or the cross sectional area of the enclosure to keep the air velocity below the threshold for dust entrainment.
7. Design detail is more critical and design mistakes can be more costly to rectify than with conventional conveyors. There is little published on design standards and there are problem jobs in the market, which tend to increase the customer's perception of risk when using air supported conveyors.
8. Development of specialty components and solutions is limited to the carrying and return plenums. There are several details of construction that have not been developed and therefore the concept of the air-supported conveyor offered to the customer is not a comprehensive solution. Details such as load zone wear liners, dust

collection attachments, dust suppression, tracking devices, belt monitoring devices and so on are not as easily incorporated in the design and the industry does not seem to address these issues with solutions that are as simple as the carrying and return plenums.

9. The cost of air-supported conveyor VTM Plenum is slightly higher than conventional roller conveyors while the box plenum design is significantly more expensive.
10. The air supported conveyor operation Vs traditional roller conveyor is not intuitively obvious and must be explained logically and in detail.
11. The use of an additional motor and fan to supply the air is often considered a cost penalty because industrial air is perceived as expensive and fans are perceived as a maintenance problem.
12. Belt widths are limited to 12 to 72 inches.
13. Cold weather operation where the belt freezes to the plenum is often mentioned as a disadvantage as the common solution is to keep the belt running with a creep drive.
14. Starting under full load after loss of power can be more difficult than with a roller conveyor because of the full contact of the belt with the plenum in point load situations.
15. Start up drive sequences must be reprogrammed to allow the plenum to come up to pressure before starting the drive and loading the belt.
16. Workmanship is more critical as sections must be identical and air leaks are not permitted.

Typical Applications

The box plenum design is most cost effectively used when the carrying and return runs of the conveyor must be enclosed. The box plenum design requires a highly effective belt cleaning systems to prevent build up in the rum return run section. The VTM plenum design is most cost effective for retrofit or new construction when only the carrying run of the conveyor is enclosed.

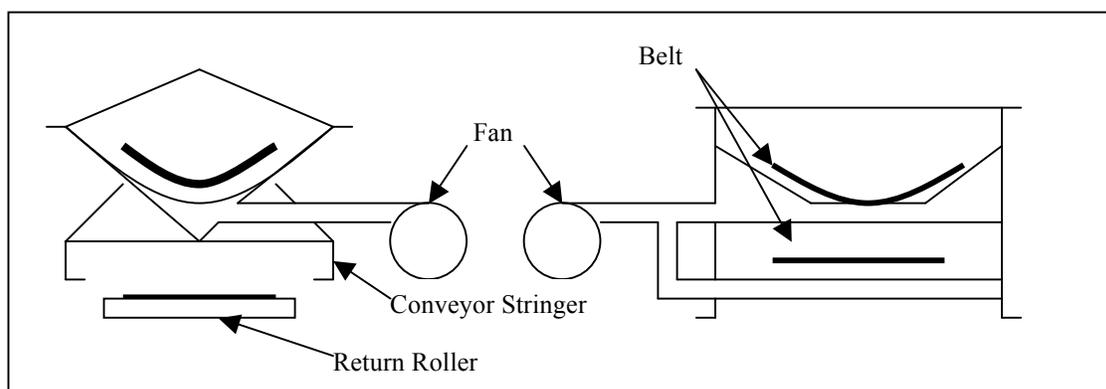


Figure 2 – VTM Plenum and Box Plenum Designs

Most applications require only the carrying run to be air supported. Bulk solids that are crushed to 2-inch and minus, degrade during conveying, contain significant amounts of dust or must be protected from contamination are ideal applications for air supported

conveyors Typical applications are crushed coal, cement, wood chips and grain. Crushed coal is a particularly attractive application as more and more power plants are looking for improved methods of controlling dust. The totally enclosed dust tight plenum improves dust control over the current state of the art methods of sealing roller conveyors. The elimination of rollers and skirtboard seals reduces maintenance. Both improved dust control and reduced maintenance are high priorities for coal handling.

Justifying Air Supported Conveyors

Air supported conveyors can be justified using savings from reduction in maintenance, energy and cleanup costs. In addition there are the intangible savings related to accident prevention, noise reduction and improved housekeeping that may be priorities for management.

Reduced idler maintenance and the elimination of skirt board seal maintenance generate maintenance savings. Typically where there are heavy dust and spillage problems 25% of the idlers on a conveyor are replaced every year. Skirt seal maintenance can be as often as once a week with seal replacement an average of twice a year. Energy savings for an inclined conveyor averages 5% and 30% for a horizontal conveyor, including the cost of running the fan. A 900-mm (36-inch) wide, 11-m (35 ft.) long, 500 mtph (550 stph) coal conveyor with a vertical lift of 3 m (10 ft.) requires 9 kW (11.6 hp) for the roller design Vs 6.5 kW (8.6 hp = 7.1 for the conveyor drive and 1.5 for the fan) for the air supported design. In the same system a 900-mm (36-inch) wide, 41-m (136 ft.) long, 500 mtph (550 stph) conveyor with a vertical curve and lift of 4.3-m (14 ft.) requires 13 kW (17.2 hp) for the roller design Vs 11.5 kW (12.5 hp + 3 hp =15.5 hp) for the air supported design. Often the maintenance and energy savings alone are sufficient to justify replacing a transfer point with air-supported conveyors.

Improved safety and housekeeping is hard to quantify. Clean up around the conveyors will not be totally eliminated because conveyors are not the only cause of dust and spillage in material handling systems. Leaks in hoppers and chutes and ineffective dust collection systems are significant sources of fugitive materials. Production problems do occur that result in plugged or overflowing chutes that require the bulk solids to be dumped and latter cleaned up or put back into the system. Generally the clean up cycle can be extended one order of magnitude by the installation of an air supported conveyor transfer point. For example if clean up is daily then it should be no more than once a week or if it was once a week then clean up should be no more than once a month. The latest MSHA statistics indicate that the average cost of a lost time accident is \$28,000. Powered haulage, which includes conveyors, is still the # 1 category of lost time and fatalities in material handling.

Conclusion

Air supported conveyors are a practical and economical alternative to the current state of transfer point containment. With the development of the VTM Plenum design they can be cost competitively retrofitted to existing conveyor structures and are cost competitive on new construction. When combined with effective dust collection systems, a conveyor

that is totally air supported is the best available engineering technology for the dust and spillage control of 2-inch minus bulk solid materials.

References

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