New Coal Handling Transfer Chute Technologies

Significantly Improve the Operation by Increasing Efficiencies, Reducing Maintenance, and Increasing Operating Margins

INTRODUCTION

The success of any bulk materials conveyor system is highly dependent upon the proper transfer of the conveyed material from conveyor-to-conveyor and into storage bins and stockpiles.

Figure 1. What can happen when transfers are not planned for.

Historically, conveyor systems design has focused on the structural integrity of the system and the selection of the mechanical components. The design of the transfer points has been left to the draftsperson and constrained by predetermined conveyor locations without any design analysis of the material flow characteristics and needs. This approach has resulted in innumerable transfers that are inefficient and expensive. The expense starts with the initial capital investment and continues as a maintenance cost and headache throughout the life of the system.

There are numerous problems that are encountered due to the poor transfer design that include:

- Oversized systems components required to handle poor material transfer.
- Additional system components needed to counteract the effects of poor material flow.
- Maintenance costs and man-hours due to component wear and failure.
- Costs and man-hours for clean up of material clogging in transfer chutes, spilling around the transfer area, and dust buildup on equipment and working areas.
- Excessive power consumption.
- Maintenance and repair costs to capture and process the visible and respirable dust generated.
- Belt damage and wear costs.
- Health risks associated with the higher noise level, spillage, and visible/respirable dust.
- Risk of governmental and conservationist actions caused by detrimental environmental effects due to visible/respirable dust and other contaminants.

Figure 2. Spillage due to improper transfer design.

There are a number of suppliers of transfer systems, which are Engineered to handle the material in a manner that reduces or eliminates the problems listed. While each of these systems can positively affect the material transfer in many ways, this paper will deal with the mitigation of the visible and respirable dust with reduced dependence on dust collection systems.

ENGINEERED TRANSFERS-REDUCED DUST APPROACH TO COAL HANDLING

There are a number of reasons why mitigation of the dust is important to any coal operation;

Figure 3. Dust plume due to improper transfer design

- The dust can build up on and in conveyor mechanical components requiring maintenance to and failure of components.
- The dust is in the air and can cause a haze that reduces visibility. This can result in accidents as well as create lower morale.
- The dust can settle in the working areas and create a personnel hazard unless regularly cleaned up.
- The dust needs to be removed from the environment. This can require expensive capital equipment such as bag houses with ongoing maintenance requirements.
- Dust buildup whether in the transfer chute, in the transfer area, or in a dust collector can result in an explosive situation. Explosions have cost lives as well as loss of equipment.
- Dust in the environment, particularly respirable dust, can be a long-term health hazard. Governmental organizations such as MSHA, OSHA, and NIOSH are increasing their monitoring of dust levels at coal handling facilities. Many power plants, as well as coal mines, are adopting the MSHA established dust levels per 30 CFR, Part 71.100 which states in part:

> “Each operator shall continuously maintain the average concentration of respirable dust in the mine atmosphere during each shift to which each miner in the active workings is exposed to at or below 2.0 milligrams of respirable dust per cubic meter of air.”

NIOSH, in particular, is recommending that the limit needs to be lowered even more.

The desire to use PRB (Powder River Basin) coal has further exacerbated the problems due to its tendency be more powdery and dusty.

Whenever a stream of coal impacts a stationary chute wall or is required to abruptly change speed and/or direction, forces are generated that degrade the material. This degradation reduces material particle size that may or may not matter to the operation. This does, however, create significant dust buildup. With the advent of Engineered transfers, there is a better way to deal with this dust. Instead of trying to seal up lengths of the transfer in both directions of material flow and then using dust collection systems to circulate the atmosphere and capture the visible and respirable dust, controlled material flow can dramatically reduce, if not eliminate the dust build-up by the reduced impacts and energy changes in the material flow during the transfer. Reduction of the visible and respirable dust levels reduces the demands on the dust collection system.

Flexco Engineered Systems Group, a subsidiary of Flexible Steel Lacing Company introduced the CFMTS, an Engineered control flow material transfer system, in North America in 2003. This particular system was originally developed in Australia where approximately two hundred transfers have been installed over the last ten years. In all cases the visible and respirable dust was reduced significantly. Unless customer requested, none of the Australian installations incorporated dust collection systems, skirt board, or baffle systems, and many did not incorporate sealing between components at transfers. The result has been lower capital investment, lower operating costs, and reduced maintenance. Yet, still dramatically lower dust levels were achieved.

ONTARIO POWER, LAMBTON, ONTARIO-CASE STUDY

One of Flexco Engineered Systems Group's Engineered transfer installations was in March, 2004 at Ontario Power's Lambton facility in Courtright, Ontario across the border from Port Huron, Michigan. The Lambton facility is a four unit power generating facility with each unit capable of 500 megawatts. The power is delivered to the Ontario power grid. This grid supplies Ontario customers as well as, on demand, other areas such as in Michigan and New York. This facility has a total of 48 conveyors feeding coal. The Parramatta Engineered chute was installed in the gallery. The gallery has six (6) bunkers for each of the four (4) units. There are a total of 32 conveyors in the gallery feeding coal. 100 % of the coal consumed in the facility is transferred through this new Engineered transfer.

Figure 4. Ontario Power's Lambton facility

Figure 5. View of discharge portion of original transfer at Ontario Power.

According to Dave Cushing, Site Project technician-Mechanical, the main driver for the controlled flow transfer was their concern about the respirable dust levels. Even though the current dust levels are acceptable, Ontario Power was concerned that future mandated levels would be lowered and that coal available in the future would have characteristics that would create more dust during its handling. With the existing transfers in need of repair or replacement due to wear after 36 years of use, a decision needed to be made on what direction to go.

Rather than repair/replace the current transfer and increase baffling, skirt board sealing systems, and the dust collection system with more, larger, and expensive components, one of their existing transfers was replaced by a Parramatta Engineered transfer.

The conveyor was shut down in early March for one week while the replacement was installed. The commissioning of the new transfer occurred immediately with all of the anticipated benefits.

Due to the engineered transfer design, the coal is being handled smoothly without the material turbulence and impact in the transfer chute or on the receiving belt. This has eliminated the effects caused by the degradation of the material in the old transfer. Specific results include:

- The transfer was commissioned from day one with the skirt board mounted at the transfer/receiving belt juncture, but without any sealing rubber installed. It was not needed because there was no spillage of material or visible or respirable dust generated at the transfer.
- At this transfer location, there are two identical conveyor systems each capable of conveying the 19,000 tons of coal per day (1000 tons per hour). Since the commissioning of this new transfer, the other conveyor has been run only a few hours because of the dramatically reduced clean up of spillage. Prior to the transfer installation, the spillage would reach 2-3 feet around the tail pulley and require 15 hours of cleanup every 12 days. Since the new transfer installation, a minor amount of clean up has occurred once. Assuming 15 hours of labor saved twice per month, Ontario Power is saving approximately $23,000 annually in clean up costs at this one transfer point alone.
- Ontario Power had independent readings taken of the respirable dust levels taken in Oct., 2003. They are in the process of collecting new respirable dust measurements for the environment with the Engineered transfer. While the numbers are not available for comparison, the apparent reduction in respirable dust levels has greatly reduced the need for respiratory aids. It is hoped that the measurements will also obviate any need of regulatory intervention either now or in the foreseeable future. The cost savings is difficult to quantify since it is cost avoidance. Not only is expensive capital equipment and associated maintenance cost avoided, but employee health and environmental problems are avoided. What price can be put on peoples' health and welfare?
- The reduction in respirable dust levels was achieved with no skirt board sealing rubber, and also with the dust collection system disconnected. While the direct maintenance cost savings are not significant, the need for the ducting, fan, motor, filters, etc. are no longer required. This eliminates the need for these components to take up space and be in the way of other operational needs, eliminates the need for maintenance and component repair and replacement, and the associated efforts to support those activities. Again, since this is one of ten (10) transfer locations in the gallery even relatively low costs and man-power requirements at each transfer add up to be significant for the facility.
- Other savings that are not documented at the Ontario Power facility are self evident since if the turbulence, spillage, and dust creation is reduced or eliminated, then there should be a reduction in other needed maintenance due to wear and failure, clearing clogged transfer chutes, belt damage and top cover wear, and undue power consumption.

OTHER CFMTS SITE APPLICATIONS

- Midwest Power Generating facility;
    - Two CFMTS systems installed in 2004.
    - Facility operates only one of these side-by-side transfers at a time.
    - Typical tons per hour 1,000-1,1000.
    - After the CFMTS installation, respirable dust readings were below the MSHA allowable level of 2.0 milligrams per cubic meter;
        - .8 mg per cubic meter at the hood (inlet to the transfer chute)

    - 1.8 mg per cubic meter at the spoon (discharge to the receiving belt
    - .8 mg per cubic meter approximately 15-20 feet downstream of the spoon at the end of the skirting section.
  - Maintenance has dropped dramatically. Instead of trucks required to haul away the spillage, maintenance personnel periodically sweep dust build up into the bunkers.

- Midwest Power Generating Station
  - Replaced a traditional chute system that was constantly plugging due to high moisture coal. This was constantly stopping production with significant maintenance costs incurred.
  - While buildup can still occur due to the high moisture content, removal of buildup can be planned for. Stoppages are eliminated with greatly reduced maintenance costs.

POTENTIAL OF ENGINEERED TRANSFERS

It should be noted that each application is different and that specific requirements and results are dependent upon the application conditions and conveyed coal characteristics. Several other coal handling power facility transfers installed by Parramatta have been successful in reducing the visible and Respirable dust levels. They have experienced at start up under no load conditions, induced airflow through the transfer, which has resulted in visible dust being generated. While this visible dust disappears after material flow is occurring, a dust collection system, and appropriate sealing around the transfer is needed in order to collect and filter this dust out of the environment. Once normal running of the material flow is attained after this start up period, the visible and respirable dust levels are significantly lower than prior to the Engineered transfer installation. Theses applications still have a need for the dust collection systems under the normal running conditions, but the amount of dust to be collected and filtered out of the environment is still substantially lower than prior to the Engineered transfer. This can translate into reduced size and capital cost of the dust collection and containment equipment. Also, the ongoing reduced maintenance cost and manpower is reduced along with a safer and healthier environment.

Figures 7, 8, 9, and 10 show discharges of coal from Engineered transfers without material turbulence or dust creation.

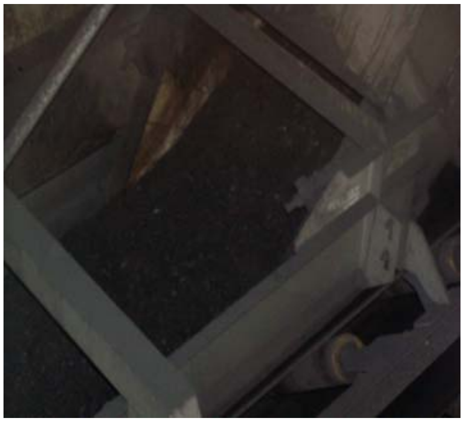

Figure 7

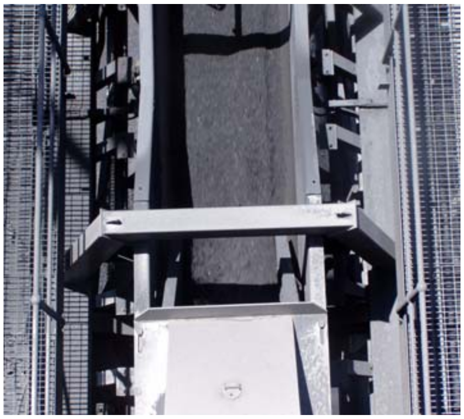

Figure 8

Figure 9

Figure 10

HISTORICAL DATA-BENEFITS OF ENGINEERED TRANSFERS

Unfortunately, there is little hard data to substantiate all of these described benefits to the Engineered transfer. Both the suppliers of these transfers and users of them need to collect the hard data that will validate their use and benefits. Following are benefits recognized in the Australian applications over the last ten (10) years. While some are qualitative, others have had hard numbers collected that support the use of these transfers. They are:

- <u>Skirt Savings</u>

  On average 12 man-hours would be spent adjusting and maintaining a typical load point skirting arrangement, in addition to $200 worth of materials such as replacement rubber, clamp strips, and bolts.
  (12 X (hourly labor cost) plus $200) X Number of transfer load points on site = Direct cost savings to the site.

- <u>Impact Frame Savings</u>

  On average eight man-hours would be spent changing out impact frames or slider bed components at a typical transfer load point, in addition to $400 worth of materials/rollers. Apply this to the number of impact beds/slider beds on site.

  (8 X (hourly labor cost) plus $400) X Number of impact beds on site = Direct cost savings to the site.

- <u>Maintenance Reduction Savings</u>

  Ceramic lined transfer chutes are capable of up to 200 million tons throughput without maintenance if they are correctly installed.
  A conventional transfer chute with wear plates has high wear and requires routine remedial maintenance. Assume each transfer point will require 20 hours maintenance per year on average to replace or repair individual liners, and this process would usually result in at least the equivalent of one complete liner change out in a ten-year period. Apply this to the number of transfer chute on site.

(20 X (hourly labor cost) plus the cost of a complete set of liners)/10 (years) X Number of transfer chutes on site = Direct cost savings to the site.

- Clean-up Savings

  Conventional transfer systems are prone to material hang-up, bridging, and blockages. Cleaning out blocked chutes after an emergency stop is a frequent event, and general clean-up costs are ongoing. Assume an ongoing average cleaning requirement of one man-hour per week, per transfer system on site.

  (1 X 52 X (hourly labor cost) plus the cost of a complete set of liners) X Number of transfer chutes on site = Direct cost savings to the site.

- Power Savings

  Conventional transfer points deposit material onto the receiving conveyor in an uncontrolled fashion and routinely as a vertical drop. Material has to be re-accelerated from a standing start after coming into contact with the receiving conveyor and contained in a skirting arrangement to stop spillage. Removal of friction at the loading point and removing the need to re-accelerate the load results in power savings.

  Controlled flow material transfer systems load material onto the receiving conveyor at low impact angles in the direction of the conveyor and at a similar speed to the receiving conveyor. In effect the controlled material stream helps the belt. In addition skirting and impact beds are generally not required, resulting in reduced friction. This combination of features results in reduced power consumption.

  Assume an average saving of 2% of the original power consumption, and apply this to all conveyor drives on site over a ten year period. Original operating power requirement of all drives on site per annum X 2% = Direct cost savings to the site.

- Reduced Dust and Material Degradation

  Dust generation around coal conveyor transfer points has always been a problem. The usual answer to this problem is a philosophy of material containment. Conventional, and even more modern transfer systems, where some curved components are used with little understanding of material behavior, do not address the primary cause. More often than not expensive enclosed skirting systems, baffle boxes, or dust collectors, are used to treat the symptom rather than concentrating on eliminating the primary cause. Controlled flow technology significantly overcomes dust generation and material degradation through scientific design of the material flow surfaces. Material is accelerated or decelerated and directed through the transfer as required, with active contact surfaces enclosed by the material stream. The result is very minimal dust generation and material degradation. In fact-

  - A dust collection system has never been fitted to a Controlled Flow Material Transfer System.
  - Many systems are in operation with absolutely no sealing between components or around the head pulley, although sealing arrangement can be fitted if this is a customer requirement.
  - It is normal to fit dust boards either side of the transfer discharge point to let any airborne particle settle back onto the belt.

These systems can be supplied with enclosed skirts if this is a customer requirement due to being located in sensitive areas, but this is only done when requested by the customer.

Savings = Initial cost of installing fully enclosed skirting arrangements, Baffle box's, and dust collection systems + associated ongoing maintenance costs.

- <u>Reduced Noise</u>

Due to the low angels if incidence used within Controlled Flow Material Transfer Systems, much lower level of noise is generated in comparison to conventional transfer systems. This is significant as it results in lower overall noise levels, and proactively contributes to providing a safer working environment, which assists operators in complying with occupational health and safety requirements.

Savings = Reduced risk of employee health problems

- <u>Reduced Belt Damage</u>

Controlled flow material transfer systems load material onto the receiving conveyor at low impact angles in the direction of the conveyor. Low impact incident angles result in material being deflected throughout the transfer process, rather than the severe impact common in conventional system. When material is discharged from the system it is laid onto the belt rather than vertically dropped onto the belt. Using this technique makes it nearly impossible for a foreign object such as a dozer ripper boot, crow bar, or piece of loose steel to damage the belt.

Although damage from foreign objects is not a daily occurrence, the damage to the receiving conveyor is usually major when it does happen.

Assume two events are experienced on a site every ten years-

Savings = Average cost of occurrence X 2

- Reduced Belt Consumption and Splicing Costs

  Controlled flow material transfer systems load material onto the receiving conveyor at low impact angles in the direction of the conveyor and at a similar speed to the receiving conveyor. One of the resultant benefits is extended belt cover life, and subsequent extended belt life. Independent NATA approved testing at a 35 MTPA Export Coal Terminal has indicated up to three times belt life on a ship loader boom conveyor.

  Annual production at BHP Billington Riverside Mine 3.9 million tons. 19 conveyors on site, totaling 35,899 feet in length, and $1,807,000 in replacement value. The average service life of these belts is 20,000,000 tons.
  Belt cost per ton is calculated as follows-

  Belt cost per ton = Total value of belt used on site / Average service life in ton
  = 1807000 / 20000000
  = $.09035 per ton

  If a conservative figure of 50% belt life increase is used, apply this to conveyor belt usage on site over a ten-year period.

  Belt costs per ton = 1807000 / 30000000 (20000000 X 1.5)
  = $.06023 per ton

  This demonstrates a saving of 3.012 cents per ton in extended belt life at current values, without taking into consideration associated belt splicing savings. Over ten years, the benefit at current productions levels would be calculated as follows-
  Total benefit = Total production X 3.012 cents X 10 years
  = 3900000 X 3.012 X 10
  = $1,174,680
  This saving represents deferred capital expenditure equivalent to 64% of the total cost of belts on site, or assuming an average cost of $115,000 per transfer chute installation, pays for over half (10.2) of the transfers on site.

CONCLUSION

In conclusion the use of an Engineered transfer is efficient, cost effective, environmentally friendly, with lowered employee health risk. The use of these transfers can reduce or, in some cases eliminate the need for a dust collection system while attaining these benefits. In the future, more hard data needs to be collected to support their justification.