M&A Research

CONVEYING MINING INTO THE FUTURE

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STRATEGY MERGERS ACQUISITIONS

Contents

Since the early sixties, the mining industry has implemented conveyor belt systems, resulting in economic improvements and more recently, carbon emissions and oil consumption. Consequently, there has been a new focus on more efficient mining methods such as IPCC (in-pit crushing and conveying) systems.

Background

Despite recent increased interest in-pit crushing, it has had limited to no success in deep, hard rock open pit mines, and trucks have continued to find application as operations get larger and pits deeper. While ore crushing has been used in specific conditions, few mines have successfully and economically implemented overburden crushing.

In Pit Crushing and Conveying

Continuous mining is not a modern idea. It has been implemented in many large production mines predominantly in the iron ore and coal sector. Bucket wheel excavators, continuous miners, longwall shearers and tunnel boring machines are a few of the many machines that implement auxiliary conveyor belt systems. However, the major problems with many of these systems are their lack of flexibility and need for homogenous geology. IPCC provides what experts say is "the best of both worlds" as blasted overburden can be directly shoveled into the in pit crusher and conveyed to the overburden pile. Thus, varying geology becomes less of a concern and the size of the truck fleets can be reduced, overall having the effect of reducing mining costs.

Conveyor transport requires a smaller size distribution than truck haulage. While some ores may be processed directly without crushing by leaching, the majority of ore mined for conventional processing generally requires crushing. On this basis, it is logical to consider that the primary crusher be located in the pit in order to process ore for conveyor transport. However, overburden does not require crushing for truck transport, but does require a size reduction for conveyor transport, and this is an additional cost of overburden conveying. Although, in large coal mines with high in pit volumes re-handle of overburden becomes a concern when using draglines or/and increased truck hauling routes. Conveying provides a more economical hauling system and allows for overburden to be located at a further distance from production, reducing dragline activity.

Truck and Shovel costs have always been a significant part of large open pit mining capital and operating costs ...

Transportation Costs

Truck and Shovel costs are variable depending on pit configuration and geographical location, but the haulage component is almost always above 45% of operating costs on a life of mine basis and about 40-50% of capital costs. As pits get deeper, so does hauling distance, thus hauling time increases. In order to maintain shovels at maximum operating rates more trucks need to be implemented. This causes bottlenecks at the shovel face due difficult scheduling conditions.

There are major advantages of IPCC against truck and shovel hauling ...

Truck and Shovel vs IPCC

After blasting the rock, loading is made by hydraulic excavator, rope shovel or by draglines. The truck usually is loaded by three or four shovel cycles. Truck fleet size used for haulage depends on the haul distances and height of overburden dump. For up to 500 m approximately three trucks are required and for up to 1000 m roughly six trucks are required per shovel. For distances exceeding 1000 m conveyor systems will be more economical.

The major advantages of IPCC against truck and shovel hauling are the following:

- Lower investment cost for very high capacities
- Allows for variable location of overburden piles
- Powered by electric energy instead of fuel
- Shorter haulage distance due to steeper ramps of the haulage route out of the mine
- Lower consumption of spare parts
- Longer lifetime, up to 50 - 60 years of operation
- Lower maintenance cost
- Highly reduced road preparation
- Less auxiliary equipment
- Fewer movements during operation
  Reduced injury down time
- Major environmental advantages due to
  - Electrically driven motors versus burned fuel
  - Prevention of dust on the haulage route
  - Reduced consumption of energy and water

IPCC crushers and their benefits

Figure 1. Palabora Crusher (1993)

Fixed (Figure 1)

- High capacity
- Typically gyratory/jaw crushers
- Commonly associated with transport tunnels

Figure 2. Escondida Crusher (1993)

Semi-Fixed (Figure 2)

- High capacity
- Relocation every 3-5 years
- Typically gyratory/jaw crushers
- Commonly associated with transport tunnels or wide truck ramp

Figure 3. Ramagundam Crusher (1995)

Relocatable (Figure 3)

- Medium capacity
- Typically twin roll crushers or sizers
- Relocation every 6-18 months
- Multiple crushing stations with conveyor ramps and conveyor distribution point
- Not common in deep hard rock mines

Figure 4. Goonyella mobile double roll sizer

Movable (Figure 4)

- Medium-low capacity
- Typically twin roll crushers or sizers
- Relocations as required to follow shovel
- Commonly feeds onto bench conveyor or conveyor bridge
- Currently no application in hard rock mines

IPCC crushers and their benefits

	Type	Typical capacity (kt/hr)	Typical speed (m/s)	Typical width (mm)	Comments
	Fixed	5-12	4-6	1800-2400	No flexibility, tunnel covered or open
	Relocatable	5-12	4-6	1800-2400	Poor flexibility, high relocation cost, stoppage of month for relocation
	Shiftable	5-12	4-6	1800-2400	Crawler mounted drive station, medium flexibility, but impact other operations. Frequent downtime for relocation
	Crawler mounted piggy-back	2-4	3-4	1200-1800	Slow relocation times, multiple systems, and interruptions at transfers. Common in leach operations
	Tyre mounted piggy-back	0.5-2	3-4	1200-1800	Application in quarries. Good floor conditions required
	Skid mounted piggy-back	2-4	3-4	1200-1800	Slow relocation time, support equipment required, interruptions at transfer, common in quarries
	Crawler mounted mobile bridge	5-7	3-4	1800-2400	High investment cost
	Crawler mounted belt wagon	5-12	4-6	1800-2400	Used with shiftable conveyors high cost short length (60-80m)

Figure 1. Excavation of pre strip with truck and shovel

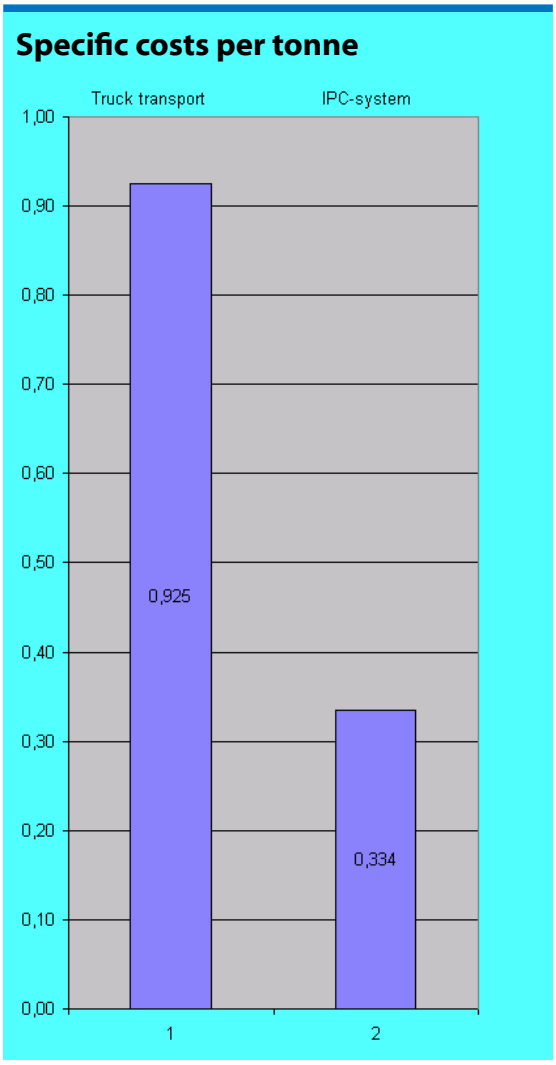

Figure 2. Cost per tonne comparison

Cost Saving Benefits

The depletion of medium to high-grade mineral deposits has caused mining companies to increase production volumes in order to make lower grade deposits economical. Similarly, in the coal industry stripping ratio continues to increase and since coal mining is a volumes games, minimal cost savings per BCM can be very profitable. A vast majority of metaliferrous and coalmines implement various fleets of truck and shovels (Figure 5), which have contract prices ranging between $3-5/BCM. An alternative method is using draglines, which have an average cost of $0.8-1.30/BCM. However, draglines require a complementary truck and shovel fleet to remove pre strips to the optimal dragline horizon.

The use of IPCC was compared to a truck and shovel operation with a mining capacity of 20Mt per year. The method of comparison involved labour costs, distance to stockpile and the cost differential of diesel to electricity. The results showed that the cost of truck and shovel and IPCC where 0.925/t and 0.334/t respectively as shown in Figure 6.

Implementation of IPCC Method

The use of IPCC mining method has been implemented in several different mining operations in order to provide efficiency in production. This method of resource transportation has shown favourable results with several different mining resources, as shown in the table below.

Company/ Mine Site	Resource	Information Reference	Comment
BMA/ Goonyella	Coal	http://www.bhpbilliton.com/bbContentRepository/Presentations/GyrvAnalystPresentationJune02.pdf	IPCC used for pre strip overburden removal. Currently 50% is removed using this method, however set to increase.
Chiengmai Constructions Co Ltd/Mae Moh	Coal	http://mine-planning.com/Homepage/publications_documents/maemoh.pdf	Used for overburden. Handles 4500t/h. 4 introduced to mine in 1998.
Sahakol Engineers Co Ltd	Coal	http://mine-planning.com/Homepage/publications_documents/maemoh.pdf	Processes 3600tph of overburden. 3 supplied in 1984.
Syncrude Mine/ Syncrude Canada Ltd	Oil Sand	http://mine-planning.com/Homepage/publications_documents/coaltrans_asia_2003.pdf	Two in pit crushers installed in 1997 with each having a 7500tph capacity.
BHP/Escondida	Cu	http://www.mining-technology.com/projects/escondida/	ROM is transported to two in pit crushers
Iluka/Jacinth	Mineral Sands	http://www.iluka.com/_uploads/documents/2011%20Documents/Jacinth-Ambrosia%20Investment%20Market%20Site%20Visit%20(1%20June%202011).pdf	One in pit crusher implemented with dozer push capacity of 1400tph
Rio Tinto/Clermont	Coal	http://www.cabinet.qld.gov.au/MMS/StatementDisplaySingle.aspx?id=72057	Implemented an in pit crusher to reduce haul time and minimize the mines carbon foot print
Xstrata/Ulan Coal	Coal	http://www.gwa.com.au/ProjectDetails/08-07-08/Ulan_Coal_Mine.aspx?ReturnURL=%2FMining%2FCoal.aspx&CntPageID=1	In pit crusher used to transfer coal to CHPP with 1.9km conveyor system.

Acknowledgment

This general note was prepared with the assistance of Alejandro Nunez, a Research Intern with LCC's Sydney office

Conclusion

Although careful analysis needs to be conducted as this method is site specific there is enough evidence for cost saving benefits from implementing IPCC. The selection of IPCC is influenced by the following key parameters:

- Geology
- Size, shape and depth of deposit
- Hardness and abrasiveness of material
- Annual production
- Initial investment
- Operating costs
- Life of mine

In addition, due to the high capital expenditure involved in mining projects, there is a market for mining service companies to contract out IPCC mining equipment to increase productivity and early cash flow.