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BELTCON 3

Maintenance on Belt Conveyors - A practical approach to this vital link in continuous production

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MAINTENANCE ON BELT CONVEYORS - A PRACTICAL APPROACH TO THIS VITAL LINK IN CONTINUOUS PRODUCTION

Maintenance of belt conveying systems in South Africa today is of vital importance where the belt conveyor system is the primary mode of transporting a bulk material and there are no systems in parallel. Where this situation exists, any break-down of the system results in a reduction of the tonnage output and a resultant loss of profits. It thus behoves the management of such a mine to make a critical appraisal of their maintenance program with a view to preventative maintenance rather than "crisis maintenance". My experience in the field of belt conveying systems has been mainly focused on South African collieries and I am going to draw on this experience to show that, in many cases, a more practical approach to the structure of the belt conveyor maintenance team should benefit the mines through increased availability of the belt conveying system and thereby increased output and profits.

In BELTCON I, it was stated in a paper on Belt Conveyor Drives, by Messrs. Rall and Staples that "The ever increasing rate of consumption of the earths raw materials, has brought with it a need for a faster movement of these raw materials from the point of extraction, to the point of process, or usage, and transporting these materials through the processing plant and disposing of the waste in the shortest possible time." [1] This has become particularly so in the South African Coal Mines, with the fact that the outputs of many of our mines are now approaching, what can only be termed, 'mega tonnages'. One considers for example, one of the largest mines in this country, currently producing coal for a petrochemical extraction process, which is approaching a world output record of 1 million tons of coal in one month. The 1982 figures for output of coal show that the South African total production was in the region of 146 million tons, this being saleable coal and this figure has been on the increase ever since. With a demand for increased output, many of the mines are steadily going to ever wider belts, travelling at ever faster speeds and requiring as a result, increased levels of maintenance. However, the majority of mines have not changed their operating procedures to keep pace with the new technologies in belt and fastener manufacture and in drive and idler manufacture. A quick examination of the mines in South Africa reveals that, in the great majority of instances, there is a split responsibility for maintenance and operation of the belt conveyor systems.

A common organisational structure is such that the engineering function takes

1. BELTCON 1 - Belt Conveyor Drives - a consideration of some design aspects. J.H. Rall and P. Staples

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responsibility for the drive section of the belt conveyor (this includes all parts of the drive, ie. scrapers, chutes, actual drive mechanism itself including gear-boxes, the start up and take up area). The mining function on the other hand has the responsibility for the installation of the structure, the structure itself, the maintenance of the idlers and return idlers, the belting, the installation and removal of belting, the splicing of belts and any breakdowns which occur on the belts.

Some of these breakdowns which have to be seen to by the mining function, may be caused by poor engineering installation. An analogy which springs to mind is that of a motor car; if one were to purchase the vehicle body components, including suspension, from one manufacturer and the engine and gear-box from another. No one company would hold responsibility for anything that went wrong with the vehicle. A similar situation often exists with belt conveying systems at present.

The belt conveyor system is a relatively simple piece of equipment. Its basic design is often such that it will convey material under the most adverse conditions, i.e. the system will continue working whether it has been installed correctly, whether it has been flooded with water, or whether it has been overloaded. The difference however, between a correctly installed belt conveying system and an incorrectly installed or abused system, lies mainly in the operating and maintenance costs. Again, quoting from BELTCON I, but in this instance from a paper on Operating and Maintenance Costs of Underground Colliery Conveyors, by Messrs. Vogel and Roberts, we can see from the two tables reproduced, (Table 1 and 2) that on a 1500mm wide belt, the cost per ton/km of operating a conveyor from 100% full capacity down to 15% full capacity, varies from 1,75 cents per ton/km to 7,65 cents per ton/km. It thus pays to run the system at full capacity. These costs are also affected by breakdowns and breakdowns reduce the total tonnage that can be transported out of a mine. As a result this immediately increases the cost per ton/km. An analysis in the same paper, as shown in Table 2, shows that for a 1350mm wide belt of 1000m length, running at 50% of full capacity, the major cost component is the belt replacement. Our experience has been that the majority of stoppages caused on a belt conveying system are belt breakages. In most instances these breakages could have been avoided by proper maintenance schedules. The proportion of the operating and maintenance cost of the belt conveyor allocated to maintenance is only 2%. Assuming that the cost of maintenance is proportional to the time spent on maintenance, I submit that this percentage reflects the low priority given to maintenance programs.

Causes of Stoppages

Bearing in mind what has been said about system maintenance, we now turn to look at the actual conveyor belt itself. As stated previously, the system will normally run even though it is poorly maintained and/or badly abused. However, there may come a time when excessive demands are placed on the system. This can take the form of the belt running off the idlers through mis-alignment with resultant snagging on the side of the structure. Alternatively, problems can occur through the tensioning unit at the drive being incorrectly adjusted with resultant high stresses on the belt; through a poorly adjusted scraper snagging a belt joint or through any one of the other reasons which can lead to belt breakage.

In most cases, the belt is the single item which is taken as the cause for the stoppage and normally this is because the belt has broken or torn. When one examines the tear, in nine cases out of ten, it will be at the joint. The basic reason for this is not hard to see - in any 'overstressed' system, in which failure occurs, this will occur at the weakest point. Today's mechanical conveyor belt fastening systems are such that they can achieve very high belt fastener holding strengths. Tables 3 and 4 relate conveyor belt fastener holding strengths achieved through the use of MATO U37 and MATO U38 clips to nominal conveyor belt strength. As can be seen, strengths of up to 80% of conveyor belt tensile strength are achieved. Further development in the Southern African field indicates that there is the possibility of the future use of vulcanised splices. This will entail vulcanising the solid woven PVC conveyor belts commonly used in South Africa with a 'finger splice'. The splice strength will still however be less than the nominal strength of the conveyor belt itself.

In many cases when the mechanical fasteners do pull out of the belt, or the vulcanised splices come apart, the mine management immediately points a finger and says that this is a 'joint failure'. However, in most instances, it is not the joint itself that is the cause of the failure.

In my experience, when conveyor belt fasteners have been 'pulling out' of the conveyor belt on a regular basis, the only solution to the problem is for someone with knowledge of belt conveying systems to go and walk the length of the belt conveyor and find the extraneous factor which has caused the belt joint to fail. In the list which follows are some of the factors which can lead to belt splice failure.

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Some Common Problems leading to Splice Failure

Some of the items which have been seen to be malfunctioning are:

1. Idlers which have jammed or been worn away. This creates a sharp leading edge on the roll, which then snags the fasteners, damaging the conveyor belt through stress.

2. Belt scrapers which are badly adjusted. The scraper is then so tight against the belt, that there is no freeplay. This also overstresses the system.

3. Alternatively the belt scraper packs up with fine coal and jams solid, achieving the same effect.

4. The structure is often badly aligned which causes the conveyor belt to run off the idlers on one side or the other and either the edge of the belt snags on the structure or the clips snag on the structure. Once more the fasteners tear out of the conveyor belt.

5. If the tensioning system is not functioning and the belt has too much slack, this immediately snags somewhere. This can be in the drive section of the system and can result in a break in the belt.

6. Should the system be over tensioned or if the tensioning drive comes in too rapidly, there will be an excess of strain on the conveyor belt, again resulting in a breakage.

7. The multi-stage drive coupling is often incorrectly adjusted and puts stresses on the belt for which it was not designed .

8. Floor build up of water, slurry and dirt with the return section belt running through it either causes the return idlers to jam, or the belt itself has too much drag on it.

9. An instance where the joint itself can rightly be said to have failed is when the lacing pin of a hinged joint is broken within the joint. This results in uneven loading on the clips themselves and they begin to wear or tear out of the conveyor belt.

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A short examination of all of these points, reveals that they are all maintenance orientated. In other words, if there was adequate maintenance carried out on the belt conveying system, then most of the listed problems could be rectified before they create a splice failure.

Prevention of Stoppages

The major causes of belt stoppages can be attributed to poor maintenance programs. I am grateful to Len Barnish who provided me with a valuable source of information. One such document is an analysis by himself, which has revealed 100 areas of any belt conveyor system that requires continuous inspection. These 100 areas involve 35 pieces of equipment. Many mines buy their belt conveying system in 'kit' form to save on the capital costs. However, the repercussions as far as running of the system are concerned, are many and far reaching.
When each part of the belt conveyor system is supplied by a different manufacturer, where there is specialised knowledge available for each piece of equipment, this is often 'lost' as there may be no overall planning and co-ordination to ensure compatability of all the system components.
Responsibility for the system as a whole is abdicated in favour of an individual component guarantee. Further, no single manufacturer stands to benefit from costly long- term in depth research and development work on conveyor belt systems.
Thus as conveyor belts increase in length and are driven at higher speeds than at present, there may be very little experience of the overall effect on the system of installing and operating the system under these conditions.

I have already stated that on the collieries there is often a split responsibility for the belt conveying system and this can also result in the same abdication of responsibility. There is often a lack of technical expertise on the part of the operators, with a large number of people operating the various different sections of the conveyor system and no single co-ordinating head for all of these various bodies. Each group of operators tries to develop expertise in their particular field, but do not realise that their often sub-standard workmanship may affect other sectors of the conveying system.

What then is my recommendation?
I would recommend that there should be a single person who is head of 'Materials Handling Department', and has sufficient foremen, supervisors and labourers working for him to enable him to take overall responsibility for all the belt conveying systems in a single mine. In this way, he can co-ordinate the joint efforts of all the various departments within his section to ensure that they

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are all aware of how their particular speciality affects the working of the other departments. He should have sufficient people to ensure that the maintenance and operation of the belt is kept at a high level of efficiency. He should also have sufficient people that when an installation needs to be done, his team can do it. This would ensure that the installation of the belt conveying system is correctly completed. In this manner, maintenance, installation and the knowledge necessary to ensure the belt conveying system runs at as close to 100% capacity, as possible, would be collected in the area of responsibility of one person.

Financial justification for this system would obviously be required by the management of the mine if it was to convert to this system. Consider these examples:

1. Assume that a conveyor belt has, due to mis-alignment, snagged at some stage of its running life and had a large section of the belt torn from one of the edges of that belt and that this piece is sufficiently large that it deposits 5kg of coal each time it is loaded with coal and that the belt is doing 20 cycles per hour. Until that piece of belt is renewed, 100kg of coal will be deposited on the mine floor per hour. Added to this, the deposit of coal will build up around the structure and is likely to cause further problems with return belt, scrapers, drive and tensioning units.
2. Assume that a wing roller has been jamming and has been removed from the structure but not replaced. Every time the conveyor belt travels over the void created in the structure, it is going to deposit coal on the floor and again there will be a build up of coal on the mine floor. The total tonnage deposited multiplies rapidly and added to that there has to be somebody there to manually re-load the belt. This coal build up will lead to similar problems as those detailed above.
3. Assume that there is a badly adjusted belt scraper that fouls a splice and tears the conveyor belt. Initially there is the cost of replacing the torn belt and at an assumed price of approximately R70,00 per meter for a 1220 PVC solid woven, class 1000 belt, this can become very expensive.
   Most modern conveyor systems have an automatic cut off system which stops the belt in the event of such a tear, but there is always some time lag between the tear and the belt stopping. At an average speed of 5m/sec. this can result in a large section of belt being torn plus a considerable deposit of coal on the mine floor.
   Additional costs that one must take into account include the time the belt is stopped, loss of production and the time that the belt crew take to replace the

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belt. Also, more often than not, whilst the mining maintenance team is replacing the belt, the engineering team has not had time to re-adjust the scraper. It is merely lowered from the surface of the belt and there has to be further maintenance carried out at a later time. Added to all this, there is the power cost of starting and stopping belts.

Common to all these examples is a 'snowballing' of the cost to the mine as a result of an error which could be obviated by preventative maintenance programs. I mention these examples so that the meeting can appreciate just how much a breakage of this nature can cost the mine and to reinforce the proposal that the mine management would be justified in having one section leader in charge of a complete maintenance team. These problems are by no means uncommon and I am sure, everyone in the meeting today could add others which they have experienced.

Another advantage to having a single body of operators maintaining and operating the belts would be in the area of training. Today's equipment suppliers do not really have the incentive to improve either their product or their training. We have had to become merchandisers because of 'cost squeezes' and our responsibility in most cases for development and research has been abdicated in favour of a University. This can create financial burdens on the finances of that institution. The suppliers themselves normally are prepared to train the staff of the mine in the limited area orientated towards their own product and thus the perspective gained by the operators at mine level of the systems that they are running is normally limited. If there were one manager with a team totally involved with belt conveying, it might be possible to improve the training of the crew as a whole with regards to the total system for which they are responsible.

In Vogel's paper in BELTCON I, one of the factors which was highlighted by this study into the costs of conveying systems was that "For conveyors of equal length, carrying coal at the same percentage of capacity, the cost of conveying decreases with increasing conveyor width."[2] Mine managers may thus in most cases be justified in deciding to increase their belt conveyor widths to reduce the cost of conveying material. It further stands to reason that by increasing the length of the conveyor one reduces the number of cost areas, eg. drives, transfer chutes etc. and by increasing the speed of the belt one can extract more ore in the same period of time. Most mine managers are aware of the savings attainable through implementing wider, faster and longer conveyor systems. However, the benefits gained through

2. BELTCON 1 - Operating and Maintenance cost of underground colliery conveyors.
R. Vogel and P.R. Roberts

such conveyor systems may be negated by poor maintenance programs.

My intention is to bring to the notice of these decision makers the value of a properly structured maintenance program implemented by a section leader whose responsibility is soley in the field of the belt conveying systems of that particular mine.

KEN TUCKEY

TABLE 1

Percentage capacity related to costs per ton kilometer

On the 1500mm wide belt, the following table shows the increasing costs at lesser % of full capacity

" % FULL CAPACITY	c/t.km
100	1,75
75	2,02
50	2,68
25	4,79
20	5,86
15	7,65 "

BELTCON 1 - Operating and Maintenance cost of underground colliery conveyors.
R. Vogel and P.R. Roberts

TABLE 2

Cost Component breakdown

" For a 1350mm wide conveyor of 1000m length at 50% of full capacity the following applies:

COST COMPONENT	c/t	% of total cost
Power cost	0,45	14
Operating labour cost	0,32	10
Idler replacement cost	0,54	17
Belt replacement cost	1,64	52
Fastener replacement cost	0,07	2
Mech. and lube cost	0,09	3
Maintenance labour cost	0,06	2
TOTAL COST	3,17	100

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BELTCON 1 - Operating and Maintenance cost of underground colliery conveyors.
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TABLE 3

STRENGTH VALUES OF THE MATO U38 FASTENER WITH DIFFERENT TYPES OF BELTS

TYPE	NOMINAL STRENGTH N/mm	FASTENER STRENGTH N/mm	%
1250/1 PVC	1250	960	76
1250/1 PVC	1250	1010	81
1250/1 PVC	1250	928	74
1600/1 PVC	1600	1121	70
1600/1 PVC	1600	1158	72
2000/1 PVC	2000	1585	80
2000/1 PVC	2000	1449	72
2000/1 PVC	2000	1426	71
2000/1 PVC	2000	1257	63
2500/1 PVC	2500	1419	57
2500/1 PVC	2500	1482	60
3150/1 PVC	3150	1750	57
3150/1 PVC	3150	1750	55

TABLE 4

STRENGTH VALUES OF THE MATO U37 FASTENERS WITH DIFFERENT TYPES OF BELTS

TYPES OF BELTS	NOMINAL STRENGTH N/mm	FASTENER STRENGTH N/mm	%
800/2 Gi	800	750	94
800/2 Gi	800	786	98
800/2 PVC	800	732	92
800/2 PVC	800	795	99
800/1 PVC	800	670	84
1000/2 Gi	1000	831	83
1000/2 Gi	1000	773	77
1000/2 PVC	1000	946	95
1000/2 PVC	1000	863	86

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TABLE 4 (contd)

TYPES OF BELTS	NOMINAL STRENGTH N/mm	FASTENER STRENGTH N/mm	%
1250/1 PVC	1250	1024	82
1250/1 PVC	1250	956	76
1250/5	1250	930	75
1600/2	1600	1250	78