Increasing efficiency of conveyor belt transporting system 4 Belt Lonmin

by G.G. le Roux*

Paper written on project work carried out in partial fulfillment of BSc (Min. Eng.) degree

Synopsis

The purpose of the investigation was to assess various options for increasing the efficiency of the conveyor belt transporting system used at 4 Belt Shaft at Lonmin's Marikana operations. The reason for the investigation was to prevent the occurrence of a 'bottleneck' at the main ore passes delivering ore to the conveyor belt system, thus creating more fluent operational conditions. The options assessed for increasing the efficiency of the conveyor belt transporting system were:

- Variation of the conveyor speed
- Concurrent tipping from two ore passes on the belt
- Increase the available drive unit power
- Increasing the feed rate from vibratory feeders
- Change in belt width/belt specifications

The report shows that the most preferable option to the current situation at 4 Belt, Lonmin, would be the option of concurrent tipping from two ore passes to the belt.

Introduction

During the period of December 2006 to January 2007, the author was allocated a project in partial fulfillment of the BSC. Eng (Mining Engineering) degree. The project was given to the author by Lonmin and was conducted at 4 Belt Shaft at Lonmin's Marikana operations.

Mine background

4 Belt is an underground platinum mine that is owned by Lonmin. The mine is situated in the North West Province of South Africa near Rustenburg. Access to the mine workings is by means of an incline shaft and a sub incline shaft. The inclination of both shafts is about twelve degrees measured from horizontal[1]. The mine was originally designed for the extraction of only Merensky Reef but over the years other reefs were identified such as the UG2 Reef. Therefore the mine produces two reefs at present, which is the Merensky Reef and the UG2 Reef.

Project background

The conveyor belt system used at 4 Belt, Lonmin, consists of four conveyor belts operating in an electrical interlocked system[1]. Currently reef and waste material are delivered to three of the conveyor belts from six different levels, one level at a time.

The system is used for the transportation of UG2 Reef, Merensky Reef and waste material. UG2 reef and waste material are delivered to the conveyor belt system through ore passes connecting the sub inclined shaft to all operating levels. Merensky Reef from all operating levels is delivered to the conveyor belt system through one ore pass connecting all Merensky Reef levels to the sub inclined shaft.

Objective

The objective of the project was to assess various options for increasing the efficiency of the existing conveyor belt transporting system. The efficiency of the system needs to be increased due to an expected increase in mining production targets and to create more fluent operation conditions.

At 4 Belt the shift time coincides for all levels of the mine, which leads to ore being trammed on all levels to the main ore passes at the same time. This results in a 'bottleneck', when main ore passes from all levels of the mine are filled up at the same time[2]. With the reef ore passes having a limited surge capacity of ±250 tons of reef each, most of the reef ore passes have to be tipped more than once per day[2]. It often happens that the main ore pass on a level is still filled up with rock by the time the tramming team arrives at the ore pass with the next load of ore to tip.

The aim of the project was to create more fluent operation conditions for all levels by either increasing the capacity of the belt conveyor system or allowing concurrent feeding from more than one ore pass to the belt.

* *University of the Witwatersrand, Johannesburg.*
 Paper received Feb. 2008; revised paper received Mar. 2008.

Increasing efficiency of conveyor belt transporting system 4 Belt Lonmin

Methodology

The necessary information about the conveyor belt system used at 4 Belt was collected in order to determine the design capacity of the conveyor belt system.

The information needed was collected by means of:

- ➤ Underground observation
- ➤ Engineering drawings
- ➤ Conveyor belt manuals
- ➤ Calculations.

In order to determine the amount of rock that needs to be transported by the conveyor belt system, the monthly production target for the mine had to be determined. The monthly production target was then divided into production target per day for the mine in order to determine the amount of rock that needs to be transported out of the mine on a daily basis.

The design capacity of the conveyor belt system was calculated from the information collected using different methods of calculation. Three different methods of calculation were used to determine the design capacity of the conveyor belt system. The three different methods each considered different aspects of the conveyor belt and were conducted in order to obtain the most accurate results.

In order to determine the daily time available for rock transport by the conveyor belt system, the hoisting times for the conveyor belt system over a period of six months were compiled. From the hoisting times compiled an average hoisting time per day could be calculated for the transportation of rock out of the mine.

After determining the design capacity of the conveyor belt system, the amount of rock needed to be transported per day by the conveyor belt system and the daily time available for the transportation of rock, various options for increased efficiency of the conveyor belt system can be assessed.

The options assessed for increasing the efficiency of the conveyor belt system were:

- ➤ Variation of the conveyor speed
- ➤ Concurrent tipping from two ore passes on the belt
- ➤ Increase the available drive unit power
- ➤ Increasing the feed rate from vibratory feeders
- ➤ Change in belt width/belt specifications.

Information collected

Information about the conveyor belt system currently in use at 4 Belt was collected to determine the design capacity of the system. The design capacity of the conveyor belt transporting system needed to be determined as part of the attempt to achieve the objective mentioned earlier.

Table A1 shown in Appendix A, presents information about the conveyor belt transporting system that was gathered by observation underground, observation from engineering drawings and performing the necessary calculations. Table I below presents a summary of the information about the conveyor belt system in Appendix A.

Information about the vibratory feeders used to feed reef and waste to the conveyor belt system was received from Joest, the original supplier of the vibratory feeders, and was compiled in Table A2, also shown in Appendix A[3].

Table A1 in Appendix A, shows the different characteristics of the current conveyor belt transporting system, which include information on the different conveyor belt drive systems used, the support structure implemented and the dimensions and type of conveyor belt used.

Table I shows the characteristics of the rock to be transported by the conveyor belt system. Added to the rock characteristics is the assumed moisture factor of the rock to be transported by the conveyor belt system. The moisture factor influences the capacity of the conveyor belt since the water present in the broken rock adds to the mass of material to be transported.

A demonstration of the conveyor belt system used at 4 Belt, Lonmin is shown in Figure 1. Figure 1 shows the individual conveyor belts (labeled R2, R1, R1A and R1B) that are part of the conveyor belt system used at 4 Belt and the main ore passes allocated to the different working levels on the mine.

Production target for 4 Belt

To establish the amount of ore that needs to be transported out of the mine, the monthly production target for a typical twenty-three-shift month was calculated. The monthly production target was then divided into a daily production

Table I

Conveyor belt system data (summary)

Conveyor system data	R1 Conveyor	R1A Conveyor	R1B Conveyor	R2 Conveyor
Belt width	1.2 m	1.2 m	1.2 m	1.2 m
Belt speed	1.5 m/s	1.5 m/s	1.5 m/s	1.5 m/s
Belt length	804 m (slope)	442m (slope)	500 m (slope)	582.2 m (slope)
Belt capacity	770 t/h	960 t/h	850 t/h	720 t/h
Inclination	12°	12°	12°	12°
Rock characteristics	**UG2**	**Merensky**	**Waste**	
In situ density	3.91 t/m^3	3.17 t/m^3	1.8 t/m^3	
Material size	300 * 350 mm	300 * 350 mm	300 * 350 mm	
Moisture factor	10%	10%	10%	

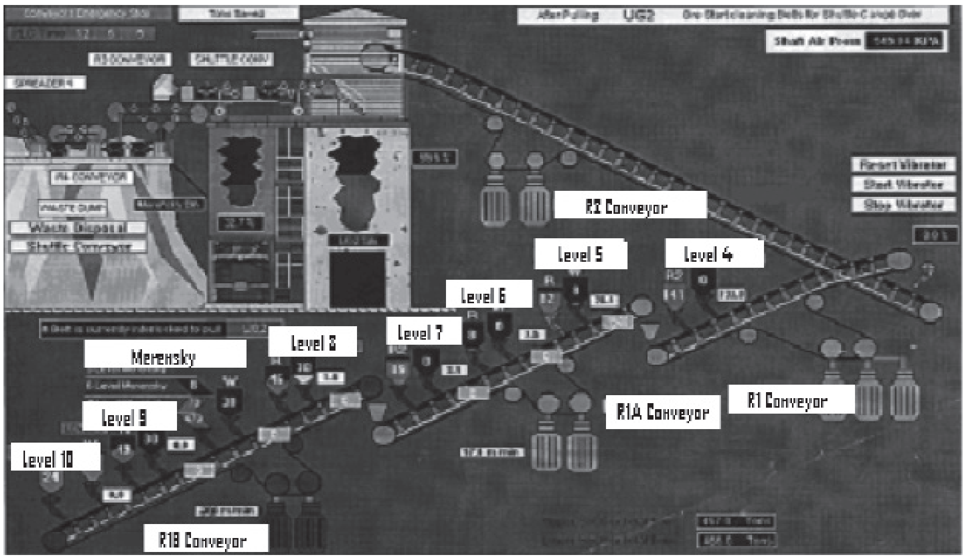

Figure 1—Graphic representation of the conveyor belt system[4]

target and later into production target per shift as the mine is operating in three shifts of eight hours each. The daily production targets from all operating levels were determined but cannot be displayed as it is a matter of confidentiality.

Since the reef and waste to be transported include a certain amount of water, a moisture factor needed to be taken into account. A percentage of 10% by weight was allowed for moisture included in the rock to be transported.

It was determined that the production target for UG2 Reef is far more than that of Merensky Reef with the UG2 production target from level nine being the highest of the individual levels on the mine. This implies that the biggest problem with the so-called 'bottleneck', described earlier in this report, will occur at level nine.

Capacity of the system of electrical interlocked conveyor belts

The capacity of each conveyor belt in the system was calculated using different methods. Different methods of calculation were used to obtain the best results as each method takes different aspects of the conveyor belt system into consideration. For example, the design capacity of the conveyor belt (without taking consideration of the drive units) was found to be 828 t/h but when the drive units of the belt were taken into account, the capacity of the conveyor belt system was found to be only 721 t/h.

Capacity of the conveyor belt system, without considering the drive units

In this section, the capacity of the conveyor belt system was determined for both reef types mined at 4 Belt. The calculations performed in this section do not consider the existing drive units. Different rock densities were used in the calculation of the capacity of the conveyor belt system since the conveyor belt system is used for all rock transport out of the mine.

Density (UG2) = 3.91 t/m³/density (Merensky) = 3.17 t/m³

The valuation department at Lonmin gave the *in situ* density for the UG2 Reef and Merensky Reef excavated at 4 Belt, as 3.91 t/m³ and 3.17 t/m³ respectively[6]. In the determination of the belt capacity the *in situ* density has to be converted to a loose density. The conversion has to be done by taking a swell factor into consideration. A swell factor of 0.6, obtained from the valuation department at Lonmin, was used in the determination of the loose density for both UG2 Reef and Merensky Reef transported[6].

Shown in Table II is the difference in capacity for the conveyor belt system when transporting the two different reef types (UG2 and Merensky) excavated at the mine. The results shown in Table II, however, do not take account of the drive units installed on the conveyor belt system and are purely done to illustrate how the capacity of the conveyor belt system changes with the difference in the rock density to be transported.

Parameters used in the determination of the belt capacity:

W = 1.2 m
SF = 0.6
V = 1.5 m/s
A = 0.0649 m²

Table II

Conveyor belt system capacity for different reef types

	UG2	Merensky
In situ density (t/m³)	3.91	3.17
Loose density (t/m³)	2.35	1.9
Load (t/m)	0.153	0.123
Capacity (t/h)	828	666

Capacity of the conveyor belt system, taking the existing drive units into consideration

In this section, the capacity of the four conveyor belts was calculated taking the power output from the existing drive units into consideration. The capacities of all four of the electrical interlocked conveyor belts in the system were calculated since the conveyor belt with the lowest capacity would act as a restraining factor to the amount of broken rock to be transported by the system of electrical interlocked conveyor belts.

Results of capacity calculations, taking the drive units into consideration

From Table III and Figure 2 it can be seen that when the drive unit power available is brought into account, the R2 conveyor belt has the smallest capacity of 721 t/h. Since all the conveyor belts operate in a closed system, the weakest of the conveyor belts needs to be considered when determining the capacity for the system.

The capacity for the belt conveyor system was calculated to be 828 t/h for the transportation of UG2 Reef and 666 t/h for the transportation of Merensky Reef. The calculations performed earlier do not take the drive unit power available into account; therefore the maximum capacity for the current system will be taken as 721 t/h for the transportation of UG2 Reef and 666 t/h for the transportation of Merensky Reef.

Belt tensions and power requirements

The belt tensions were determined for the three electrical interlocked conveyor belts. The different belt tensions for each of the electrical interlocked conveyor belts were determined using a constant feed rate of reef or waste to the belt of 600t/h. The calculated conveyor belt tensions were then used in the calculation of the different power requirements for each of the conveyor belts in the system of electrical interlocked conveyor belts.

Since the shaft power for each driving unit could be found in the original design of the system, a factor of safety could be calculated for a constant feed rate of 600 t/h to the system. A feed rate of 600 t/h to the conveyor belt system was chosen since it will be used later in this report. A feed rate of 600 t/h also allows a minimum factor of safety of 1.27.

The following section presents the tabulated results obtained from the tension/power calculations performed with a constant feed rate to the conveyor belt system of 600 t/h.

Results of tension/power calculations

In Table IV below, a summary of the tension/power calculations can be seen. Included in the summary is a calculated factor of safety for each conveyor belt when operating at a feed rate of 600 t/h.

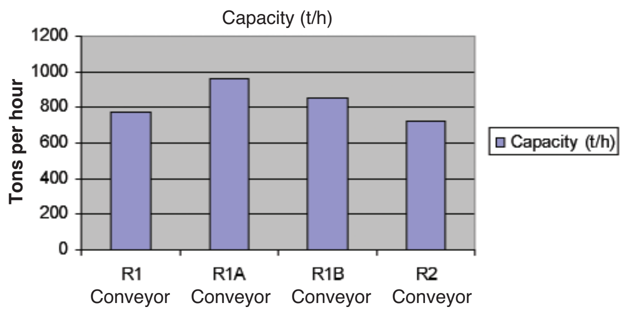

Figure 2—Conveyor belt system capacities (derived from motor power calculations)

Table III

Conveyor belt system capacities (derived from motor power calculations)

	R1 Conveyor	R1A Conveyor	R1B Conveyor	R2 Conveyor
Mass of belt (kg/m)	36.2	36.2	36.2	36.2
Length of conveyor (m)	804	442	500	582
Inclination (degrees)	12	12	12	12
Shaft power (kW)	436	296	296	296
Belt speed (m/s)	1.5	1.5	1.5	1.5
Friction	0.04	0.04	0.04	0.04
Height component (m)	167	92	104	121
Capacity (t/h)	771	960	844	721

Table IV

Power requirements (capacity—600 t/h)

	R1 Conveyor	R2 Conveyor	R1A Conveyor	R1B Conveyor
Load mass per metre	111.2 kg/m	111.2 kg/m	111.2 kg/m	111.2 kg/m
Mass of moving parts	71 kg/m	71 kg/m	71 kg/m	71 kg/m
Adjusted length	477.2 m	355.2 m	278.1 m	310 m
Tension required to move empty belt	11 621.25 N	8 650.19 N	6 772.57 N	7 549.43 N
Tension required to move load	20 801.34 N	15 483.31 N	12 122.49 N	13 513.02 N
Tension required to lift load	182 207.87 N	131 860.96 N	100 148.94 N	113 335.04 N
Total effective tension	214 630.46 N	155 994.46 N	119 044 N	134 397.49 N
Slack side tension	14 809.50 N	10 763.62 N	8 214.04 N	9 273.43 N
Sag tension	7 491.49 N	7 491.49 N	8 323.88 N	8 323.88 N
Maximum belt tension	229 439. 96 N	166 758.08 N	127 367.88 N	143 670.92 N
Power required	321.946 kW	233.992 kW	178.566 kW	201.596 kW
Power available	436 kW	296 kW	296 kW	296 kW
Factor of safety	1.35	1.27	1.66	1.47

In Table IV, it can be seen that all the conveyor belts will be able to transport ore at a feed rate of 600 t/h with a factor of safety of 1.27 or more.

Hoisting times

The hoisting times for six months that were collected from the planned maintenance department at Lonmin were compiled. This was done to determine the time that is available for hoisting reef and waste on a daily basis. In Table V below, the results for the months from May 2006 to October 2006 can be seen. From Table V, it can be seen that an estimated minimum of sixteen hours are available daily for hoisting both reef and waste material. This minimum time available for hoisting was used throughout the report in the calculation of the efficiency for the system of interlocked conveyor belts.

Available options to increase the efficiency of the conveyor belt transporting system

The following options were assessed in increasing the efficiency of the conveyor belt system:

- Variation of the conveyor speed
- Concurrent tipping from two ore passes on the belt
- Increasing the available drive unit power
- Increasing the feed rate from vibratory feeders
- Changing belt width/belt specifications

Variation of the conveyor speed

The efficiency of the conveyor belt system was calculated with an increase of 20% in the operating speed of the conveyors and then compared with the efficiency of the conveyor belt system when operating at the current speed of 1.5 m/s.

In an attempt to obtain the most accurate results, three different methods of calculation were performed. The results of the calculations performed at the increased speed were then compared with the results of the current speed of conveyors. The comparison between the capacity results obtained from the increased speed and those from the current speed can be observed in the next section. The capacity of the conveyor belt system was determined for the increased speed by taking the belt dimensions alone into consideration. The capacities of all four conveyor belts, acting in the system of electrical interlocked conveyor belts, were determined for the increased speed by taking the drive units into consideration. Tension calculations were used for the same purpose mentioned above.

Change in belt speed

Increase belt speed by 20%

Speed = (1.5 m/s * 20%) + 1.5 m/s
= 1.8 m/s

Capacity calculation for conveyor belts used at no. 4 inclined shaft (belt speed increased by 20%)

The capacity of the system of conveyor belts was calculated when operating at a speed of 1.8 m/s. A loose density of 2.35 t/m^3 and 1.90 t/m^3 for UG2 Reef and Merensky Reef respectively was used in the calculation. The calculations performed in this section considered only the conveyor belt alone and not the existing drive units. Table VI presents the results obtained from the increase in speed of the conveyor belt system.

Parameters used in the determination of the belt capacity:

W = 1.2 m
SF = 0.6
V = 1.8 m/s
A = 0.0649 m^2

Table VI

Capacity of conveyor belt system at increased speed (belt specifications)

	UG2	Merensky
In situ density (t/m^3)	3.91	3.17
Loose density (t/m^3)	2.35	1.9
Load (t/m)	0.153	0.123
Capacity (t/h)	990	796

Table V

Total hoisting times

	R 1			R1A			R1B			R 2		
Month	Total reef hoisting time	Total waste hoisting time	Budgeted total scheduled downtime	Total reef hoisting time	Total waste hoisting time	Budgeted total scheduled downtime	Total reef hoisting time	Total waste hoisting time	Budgeted total scheduled downtime	Total reef hoisting time	Total waste hoisting time	Budgeted total scheduled downtime
May	14561	5716	9360	22245	5472	9360	16770	5117	9360	25622	5841	9360
June	24048	4037	9360	22981	4590	9360	19747	3999	9360	25327	4726	9360
Jul	24259	5800	10800	23419	4774	10800	17688	4740	10800	26584	4615	10800
Aug	28717	5367	10800	25494	4953	10800	18937	5890	10800	30928	5192	10800
Sep	24162	6090	10800	22249	5967	10800	16624	5930	10800	25853	5986	10800
Oct	20280	4353	3720	18664	4666	10440	14371	4183	10560	21471	4318	10440
Total	136027	31363	54840	135052	30422	61560	104137	29859	61680	155785	30678	61560
Average	22671	5227.17	9140	22508.7	5070.3	10260	17356	4976.5	10280	25964	5113	10260
h/month	377.85	87.12	152.33	375.14	84.51	171.00	289.27	82.94	171.33	432.74	85.22	171.00
h/day	16.43	3.79	6.62	16.31	3.67	7.43	12.58	3.61	7.45	18.82	3.71	7.43
h/day		**20.22**			**19.98**			**16.19**			**22.53**	

Compiled from data received from the planned maintenance department at Lonmin 5

Conveyor belt capacity calculations taking account of limited power available

In the previous section, the motor power available was not taken into account. In this section, the capacity for each conveyor belt was calculated when operating at 1.8 m/s and account was taken of the limited motor power available. Table VII presents the results of the capacity calculations for the conveyor belt system at the increased speed when the limited power available was brought into consideration.

Calculating the capacity for the conveyor belts operating at 1.8 m/s, taking the belt tensions into consideration

The capacity for each conveyor belt was calculated again, now using the total effected tension on the belt when operating at a speed of 1.8 m/s. Table VIII presents the results obtained from the tension calculations performed for the conveyor belt system at the increased speed of 1.8 m/s.

Results of comparison between different belt speeds

In Table IX is the tabulated comparison of the effectiveness between the two belt speeds of 1.5 m/s and 1.8 m/s. Table X represents the results of the comparison between the two different belt speeds using three different scenarios.

From Figure 3, it can be seen that increasing the conveyor speed does not have a positive effect on the production ratio when the available motor power is taken into account. This outcome is the result of increasing power requirements by the conveyors for operation at a higher speed, which lead to the result that the conveyors can transport less ore when the speed of the conveyors is increased due to the limited power supply available.

Table VII

Capacity of conveyor belt system at increased speed (power)

	R1 Conveyor	R1A Conveyor	R1B Conveyor	R2 Conveyor
Mass of belt (kg/m)	36.2	36.2	36.2	36.2
Length of conveyor (m)	804	442	500	582
Inclination (degrees)	12	12	12	12
Shaft power (kW)	436	296	296	296
Belt speed (m/s)	1.8	1.8	1.8	1.8
Friction	0.04	0.04	0.04	0.04
Height component (m)	167	92	104	121
Capacity (t/h)	764	953	838	761

Table VIII

Capacity of conveyor belt system at increased speed (tension)

	R1 Conveyor	R1A Conveyor	R1B Conveyor	R2 Conveyor
Load mass per metre (kg/m)	126.31	156.17	137.54	117.58
Total power available (kW)	436	296	296	296
Belt speed (m/s)	1.8	1.8	1.8	1.8
Effective tension (kN)	242.22	164.44	164.44	164.44
Capacity (t/h)	817	1011	890	761

Table IX

Capacity at different speeds in tons/hour

	R1 Conveyor		R2 Conveyor		R1A Conveyor		R1B Conveyor	
	1.5 m/s	1.8 m/s	1.5 m/s	1.8 m/s	1.5 m/s	1.8 m/s	1.5 m/s	1.8 m/s
Taking account of belt alone	828	990	828	990	828	990	828	990
Taking account of motor power available	771	764	721	715	959	953	844	838
Taking account of tension on belt	908	817	768	761	1 018	1 011	897	890

Table X

Vibratory feeders operating at 400 t/h (one box at a time)

	UG2 time (min)	Waste time (min)	Merensky time (min)	Total time (min)	Total time (hour)
4 Level	84	2			
5 Level	107	9			
6 Level	90	7			
7 Level	114	9			
8 Level	66	8			
9 Level	211	6			
10 Level	16	28			
Merensky waste		39			
Merensky box			294		
Total	688	108	294	1090	18.17

Increasing efficiency of conveyor belt transporting system 4 Belt Lonmin

From Figure 3 it can be seen that the capacities for all the conveyor belts in the system are significantly increased at the increased speed when the available motor power is not taken into account. For the increase in speed of the conveyors to be utilized effectively, the installation of bigger drive units will be necessary.

Concurrent delivering from more than one ore pass to the conveyor belt system

The comparison was made between the times needed to transport ore when feeding from one ore pass and when feeding from two ore passes concurrently. The idea behind the concurrent feeding from more that one ore pass to the conveyor belt system can be executed by the installation of a simple automation program, allowing two chutes to be opened concurrently, that can be added to the system that is already installed on the conveyor belt system or be controlled from the control room.

Information compiled earlier in this report was used for the comparison compiled in Table X and Table XI. Taking into consideration that the moisture factor was already brought into account, it can be seen from Table X and Table XI that ore can be transported more time efficiently when delivered to the conveyor belt system from two ore passes concurrently. This statement holds only when the vibratory feeders are operating at 75% utilization, delivering ore to the conveyor belt system at a rate of 300 t/h each. Two ore passes delivering ore to the conveyor belt system at a rate of 300 t/h will require a belt capacity of at least 600 t/h. Since the weakest of the conveyor belts in the interlocked system hase a calculated capacity of 720 t/h, it will be able to handle a delivery rate of 600 t/h with a minimum factor of safety of 1.27.

Earlier in the report it was estimated that a minimum of sixteen hours is available for daily hoisting. From Table X it can be seen that when feeding ore to the belt from only one ore pass at a time at the maximum vibratory feeder feeding rate of 400 t/h, eighteen hours may be needed for the transportation of the ore available according to the calculated daily production target. This may pose a problem since there may be less time available for hoisting ore and then not all the ore available for hoisting will be hoisted for that day.

Referring to Table XI, two vibratory feeders are feeding rock to the conveyor belt system concurrently at a rate of 300 t/h each. The problem described in the previous paragraph is eliminated as less time than the minimum time available for hoisting is needed for the hoisting of the ore available on a daily basis.

In Table XI an example of a tipping schedule is given. The idea behind the tipping schedule is to limit the amount of time needed to empty out all the ore passes. In Table XI, when looking at the UG2 tipping schedule, it can be seen that the conveyor belt transporting system receives ore from levels 4, 5 and 10 in sequence while level 9 is also delivering ore to the belt at the same time. This implies that less time is used to empty out the ore passes. The concurrent delivering of ore

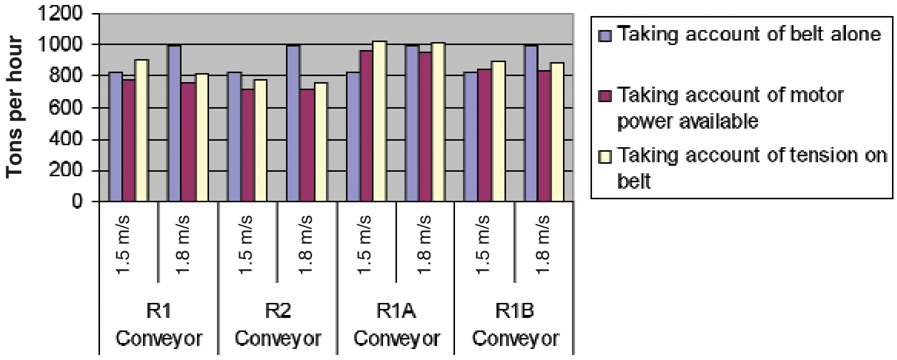

Figure 3—Capacity at different speeds

Table XI

Vibratory feeders operating at 300 t/h (two boxes at a time)

	UG2 time (min)	Tipping schedule					UG2 time (min)	Waste time (min)					Waste time (min)	Merensky time (min)		Total (min)	Total (hour)
4 Level	112	Tip						3			Tip						
5 Level	142		Tip					12	Tip								
6 Level	120				Tip			10		Tip							
7 Level	152				Tip			12	Tip								
8 Level	88					Tip		11		Tip							
9 Level	281	Tip	Tip	Tip				9			Tip						
10 Level	22			Tip				37				Tip					
Merensky waste								52				Tip					
Merensky box														294	Tip		
Total				300	160	90	550		13	11	9	52	85		300	935	15.58

to the conveyor belt transporting system allows ore to be drawn from more than one level at a time, resulting in the less time being wasted waiting for ore passes to be emptied out.

Increase the available drive unit power

Data were compiled of the belt power requirements needed for each of the conveyor belts in the range of capacities between 500 t/h and 1500 t/h. A summary of the results for the range of capacities mentioned in the previous example are shown in Table XII, showing the belt power requirements for each of the ranges of capacities mentioned earlier. Figure 4 shows the relationship between the belt power requirements for different capacities for each of the conveyor belts in the system.

Tabulated in Table XIII is the motor power requirements for operating the various conveyor belts in the system of conveyor belts for the range of capacities mention previously. The results obtained from Table XIII take account of a drive efficiency of 80%. Figure 5 represents a graph of the motor power requirements, using a drive efficiency of 80%. The graphs presented in Figure 4 and 5 were drawn for the observation of the increase in motor power required as the capacity increases.

From Figure 5, it can be seen that the R1 conveyor belt has the highest power requirements for all capacities. The higher power requirements of the R1 conveyor belt are due to the fact that the R1 conveyor belt covers the longest distance. Since the R1 conveyor belt has the highest power requirements, it will be one of the main deciding aspects when looking at the increasing of the drive unit power.

Table XII
Summary of belt power requirements (kW)

Capacity (t/h)	R1 Conveyor	R2 Conveyor	R1A Conveyor	R1B Conveyor
500	271	197	150	170
600	322	234	179	202
700	373	271	207	233
800	423	308	235	265
900	474	344	263	297
1000	525	381	291	328
1100	576	418	319	360
1200	626	455	347	392
1300	677	492	375	424
1400	728	529	403	455
1500	779	566	431	487

Table XIII
Summary of motor power requirements (kW)

Capacity (t/h)	R1 Conveyor	R2 Conveyor	R1A Conveyor	R1B Conveyor
500	339	246	188	212
600	402	292	223	252
700	466	339	258	292
800	529	385	293	331
900	593	431	328	371
1000	656	477	364	411
1100	720	523	399	450
1200	783	569	434	490
1300	847	615	469	529
1400	910	661	504	569
1500	973	707	539	609

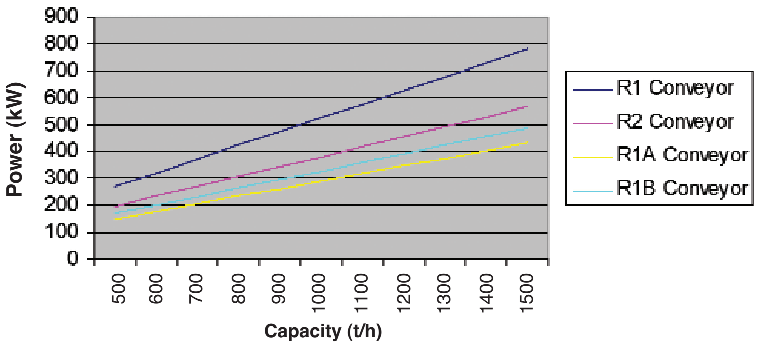

Figure 4—Belt power requirements

Increasing the feed rate from vibratory feeders

According to information received from Joest, the suppliers of the vibratory feeders used at 4 Belt, the feeding rate on the current vibratory feeders cannot be increased as the maximum capacity motors available for the existing feeders are already installed. In the opinion of Mr. Ben Wessels at Joest, the installation of bigger vibratory motors will require major adjustments to the existing feeders and may lead to premature destruction of the feeders[3].

Changes in belt width/belt specifications

The capacity for the conveyor belt system can also be increased by increasing the width of the conveyor belt. An increase in the width of the conveyor belts will allow an increase in the area available for loading rock, which in turn will result in a higher capacity.

With the increase in width of the conveyor belts, the structure will require major modifications since the idlers currently installed on the structure will have to be replaced and the driving power must also be increased[7]. This option seems to be the least favourite of the five options due to all the modifications that needs to be done. The modifications to the structure and drive units will have higher cost implications than any of the other options available, not to mention the downtime involved on the operating shaft.

Conclusions

The purpose of the project was to assess various options that could increase the efficiency of the conveyor belt transporting system that is used at 4 Belt. Five options were explored:

- Variation of the conveyor speed
- Concurrent tipping from two ore passes on the belt
- Increasing the available drive unit power
- Increasing the feed rate from vibratory feeders
- Changing belt width/belt specifications.

The preferred option was the concurrent tipping from two or more ore passes to the conveyor belt system. The reason for this statement is that if ore can be delivered from the ore passes to the belt system according to the schedule shown in Table XI, less time will be needed to empty out all the ore passes.

The method of concurrent tipping from two ore passes will also result in the added advantage that the amount of ore in ore passes from two levels will be reduced concurrently, thus creating space for ore to be delivered to these ore passes, resulting in more fluent operation conditions on the different levels themselves.

When comparing the option of concurrent tipping with the other options available, it can be clearly seen that all the other options available require more adjustments to the already existing system than the option of concurrent tipping. Therefore, the option of concurrent tipping is preferable to the other available options since all adjustments made to the system will cause more significant downtime for the installation of bigger drive units, wider belts, bigger size idlers, changes in structure, etc. than the installation of a simple automation program on the chutes from the ore passes that can be run from the control room. .

From the report it can be seen the option of concurrent tipping would decrease the time necessary to empty out all the ore passes and therefore increase the efficiency of the conveyor belt transporting system. A more efficient conveyor belt transporting system will ensure more fluent mining operations since the limited surge capacity will be utilized more effectively.

Recommendations

The initial design of a mine or shaft is important. The shaft must be designed for the maximum production rate that may be achieved through the life of the shaft. The particular scenario of 4 Belt shows that a shaft must consist of adequate surge capacity to prevent the occurrence of ‘bottlenecks’ in the ‘ore path’ out of the mine. If adequate surge capacity were not provided in the initial design of the shaft, the situation that is experienced at Karee Belt is likely to occur. Since the creation of additional surge capacity is nearly impossible on an operating shaft, the transportation system used needs to be altered. All alterations to the transportation system used in an operating shaft will cause significant downtime in the shaft and therefore loss of production, which should be avoided at all costs. If alterations to the transporting system are necessary, the option that would cause the least amount of downtime in the operating shaft should be chosen.

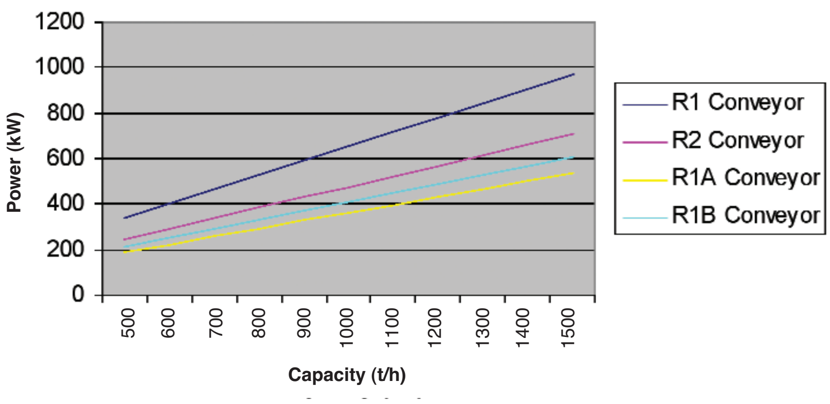

Figure 5—Motor power requirements

References

1. MITCHELL, J. Shaft Engineer, 4 Belt, Lonmin, conversation with the author, Dec 2006.
2. REILY, D. Section Engineer, Lonmin Platinum, conversation with the author, Dec 2006.
3. WESSELS, B. Service Technician, Joest, ben@joest.co.za, Dec 2006.
4. KLEYNHANS, A. Mechanical Foreman, Karee 4 Belt, Lonmin Platinum, conversation with the author, Dec 2006.
5. Planned Maintenance Department, Lonmin Platinum, Dec 2006.
6. Valuation Department, Lonmin Platinum, Dec 2006.
7. REZNICHENKO, G.G. MINN 308 Course Notes, University of the Witwatersrand, Johannesburg, 2006.
8. Dunlop Industrial Products, Conveyor Belt Manual, Dec 2006. ◆

Appendix A

Conveyor belt system information

Table A1

Conveyor belt system information

	Conveyor system data			
	R1 Conveyor	**R1A Conveyor**	**R1B Conveyor**	**R2 Conveyor**
Belt type	Steel core	Steel core	Steel core	Steel core
Belt tension	215 kN	120 kN	135 kN	156k N
Belt width	1.2 m	1.2 m	1.2 m	1.2 m
Belt speed	1.5 m/s	1.5 m/s	1.5 m/s	1.5 m/s
Belt length	804 m (slope)	442 m (slope)	500 m (slope)	582.2 m (slope)
Belt mass	36.2 kg/m	36.2 kg/m	36.2 kg/m	36.2 kg/m
Belt capacity	770 t/h	960 t/h	850 t/h	720 t/h
Operation time	16 h	16 h	16 h	16 h
Operating capacity	600 t/h	600 t/h	600 t/h	600 t/h
Deviation	1.28	1.6	1.42	1.2
Capacity per day	9600 t	9600 t	9600 t	9600 t
Inclination	12º	12º	12º	12º
	Belt drive system			
	R1 Conveyor	**R1A Conveyor**	**R1B Conveyor**	**R2 Conveyor**
Belt drive type	Triple	Double	Double	Double
Power	3 * 185 kW	2 * 185 kW	2 * 185 kW	2 * 185 kW
Shaft power	436 kW	296 kW	296 kW	296 kW
Speed (RPM)	1485	1485	1485	1485
Pulleys				
Drive pulleys				
Pulley diameter	900 mm	900 mm	900 mm	900 mm
Pulley face width	1350 mm	1350 mm	1350 mm	1350 mm
Head pulleys				
Pulley diameter	900 mm	900 mm	900 mm	900 mm
Pulley face width	1350 mm	1350 mm	1350 mm	1350 mm
Snub pulleys				
Pulley diameter	630 mm	630 mm	630 mm	630 mm
Pulley face width	1350 mm	1350 mm	1350 mm	1350 mm
Tail pulleys				
Pulley diameter	630 mm	630 mm	630 mm	630 mm
Pulley face width	1350 mm	1350 mm	1350 mm	1350 mm
Bend pulleys				
Pulley diameter	630 mm	630 mm	630 mm	630 mm
Pulley face width	1350 mm	1350 mm	1350 mm	1350 mm
Take-up pulleys				
Pulley diameter	630 mm	630 mm	630 mm	630 mm
Pulley face width	1350 mm	1350 mm	1350 mm	1350 mm
Number of pulleys	15	13	13	13
Pulley lagged	Yes	Yes	Yes	Yes
Snub pulleys	2	2	2	2
Belt rap angle	450	450	450	450

Appendix A (continued)

Conveyor belt system information

	Support system			
	R1 Conveyor	R1A Conveyor	R1B Conveyor	R2 Conveyor
Structure				
Idler diameter	127 mm	127 mm	127 mm	127 mm
Idler length	450 mm	450 mm	450 mm	450 mm
Idler spacing	0.9 m	1 m	1 m	0.9 m
Idler angle	35°	35°	35°	35°
Impact idlers	No	Yes	Yes	No
Return idlers	V - Return	V - Return	V - Return	V – Return
Diameter	12.7 cm	12.7 cm	12.7 cm	12.7 cm
Length	63.5 mm	63.5 mm	63.5 mm	63.5 mm
Spacing	3 m	3 m	3 m	3 m
Angle	10°	10°	10°	10°
	Rock characteristics			
	UG2	Merensky	Waste	
In situ density	3.91 t/m³	3.17 t/m³	1.8 t/m³	
Material size	300 * 350 mm	300 * 350 mm	300 * 350 mm	
Moisture factor	10%	10%	10%	

Table A2

Vibratory feeder characteristics

Material	Platinum ore
Max lump size	500 mm
Feed rate	400 tph
Bulk density	2.4 t/m 3
Moisture	10%
Abrasiveness	Medium high
Fed from	Ore pass chute
Feeding to	Belt conveyor
Liner material	10 mm Bennox

From ben@joest.co.za[3]

Dave Rankin retires as chairman of the Centennial Trust

At the end of 2007 Dave Rankin, a very well-known figure in the mining industry, retired as Chairman of the Board of Trustees of the Centennial Trust. The photograph shows Professor Huw Phillips presenting a gift to Dave Rankin in appreciation of his contribution to the Trust over a period of 10 years.

The Centennial Trust at the University of the Witwatersrand was established in 1996 from funds contributed by South African mining companies. The occasion for the raising of the funds was to celebrate the centenary of the establishment of the South African School of Mines in 1896, which subsequently became the University of the Witwatersrand. These funds were used to establish the Trust, which allowed the creation of the Centennial Chair of Rock Engineering in the School of Mining Engineering, University of the Witwatersrand, Johannesburg.

The first Centennial Professor appointed was Professor Ugur Ozbay, in 1999, and he was succeeded by Professor Dick Stacey in 2000. Professor Stacey will retire at the end of 2008, and it is expected that his replacement will be appointed during the course of this year.

The Centennial Trust has allowed a strong rock engineering teaching and research capability to be continued at Wits University, and the control exercised by Dave Rankin in managing the Trust is very sincerely appreciated. The importance of the funding provided by the mining industry to establish the Trust is also acknowledged with appreciation.

Dr John Cruise has been elected as the new Chairman of the Board of Trustees of the Centennial Trust.