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Impact of Loader Size on Dowtime Generation in Primary Crushing Plant

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Abstract: ***Feeding plant is the first parameter while you are studying plant performance. During feeding process in a crushing circuit, reduction of downtime is one of the most important key because it is optimising circuit and by the way increasing significantly feeding, production and profitability of the plant. In this article, we are going to compare three types of loader used to feed a crushing plant of 250tph capacity. 10tons loader was found the best based on the parameters monitored.***

Keywords: Downtime, running time, loaders, feed, primary crushing plant, etc

1. Abbreviations

- Ch10 : 10 tons capacity loader
- Ch13 : 13 tons capacity loader
- Ch16 : 16 tons capacity loader
- mm : millimeter
- t : ton
- tph : ton per hour
- kg : Kilogram
- m^3 : cubic meter
- Nber: number
- HMS: High Media Separation
- Min: minute
- DRC: Democratic Republic of Congo
- Stn: Stoppage number
- pBucket: probability per bucket
- hr: Hour

2. Introduction

Since the beginning of 2000's, the Republic Democratic of Congo is facing a mining boom period, what specialist used to call "boom minier", in this particular moment DRC is producing largely minerals and metals such as diamond 17,624,000carats, gold 2,860kg, cassiterit 7,567t, copper 919,588t and Cobalt 76,517t[1].

To maximize production and to increase profitability, key parameters such as running time, quality and target achievement at each stage are been monitored carefully in all plants.

Maximization of feeding include thosefactors:

- High running time,
- Good choice of equipment,
- Competent and competitive manpower,
- Short distance and high quality of material to be fed. Etc.

The Congolaise des Mines et de Development, Comide, where those studies were done, is one of factories of ERG group, is located in South of Democratic Republic of Congo, in the South of Lwalaba province, between Kolwezi and Likasi at 15 km from Kisanfu village. Comide is producing concentrate from Mashitu mine via two HMS and one spiral plant.

Our study cover the primary crushing circuit of HMS plant from period of November 2013 to March 2014, following are of HMS plant 1:

- A feed hopper of $22m^3$
- 250tph push feeder at fixe speed
- A grizzly of 100mm aperture;
- Jaw crusher
- 250tph sacrificial conveyor
- Second conveyor feeding scrubber
- A scrubber

3. Problematic

How to increase plant feeding? Is the main question of this study.To reply to it the point explored in this article is *by improving running time of the plant this means reducing downtimes*.

Table 1: Loaders planned performances for 250tph

	Bucket capacity	*Caterpillar[2]*	*Trips/hr*	*Time (min)*
Ch16	16t	992G	15.6	3.84
Ch13	13t	988H	19.23	3.12
Ch10	10t	950H	25.0	2.4

Some observations were made, size of loader were challengingplant stoppagesand total feed. Investigation were made to understand how each loader could impact on downtime.Therefore, what could be the probability increment while using each of them?

[1] Rapport ITIE RDC 2013, page 22, July 2015.

[2] Gamme de produits caterpillar, 2006, p3

Starting plant after stoppage is a random factor which can take from 25 min to 14 hours depending on the area and the cause of it.

Major's raisons of stoppage of the primary crushing circuit were listed:

- Chocking of push feeder bin and jaw crusher by big stones ;
- Chocking of inlet feed scrubber chute;
- Stoppage of sacrificial conveyor due to overload ;
- Stoppage of scrubber feed conveyor due to overload;

A special mention has to be made on the consequence of each stoppage of the circuit:

- Lost of time,
- Lost of material due to overload or chock;
- Increment of maintenance and risk of accident;
- Destruction of housekeeping

4. Materials and Methods

During 5 months, below factors have been monitored[3][4] :

- Type of loader used,
- Number of shifted of study, a day is having 2 shifts,
- Number of buckets fed by each loader,
- Raison of stoppage observed

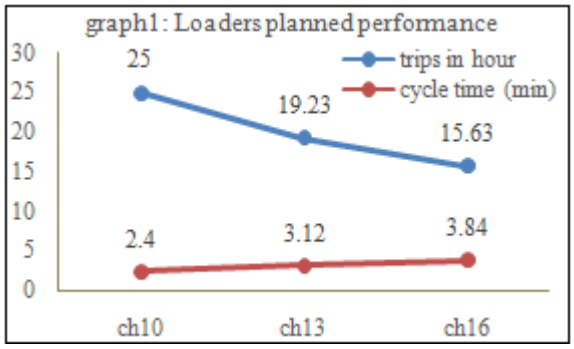
5. Results and Discussions

Loading cycle

The objective of the plant is to feed 250tph, table 1 below characterise number of trips theoretically made by each loader, and time by trip.

Feeding hopper operation have three stages:

- Going and coming back of the loader limited at 20km/h maximum by safety.
- Checking of mineral to avoid big rock inside of the bucket,
- Loading of the bucket,



From those three loaders,ch16 loader looked be the best to rich the target.The operator can achieved his target of 250tph with less trip, 15.68 compare to ch13 which is doing the same performance in 19.23trips; ch10 is the worse with 25trips an hour.

Ch16 ishaving the best timing, 3.84minutes to accomplish the cycle; checking, bucket loading and going and coming back. At this level, based on the calculation, big loaders, ch16,is the best.

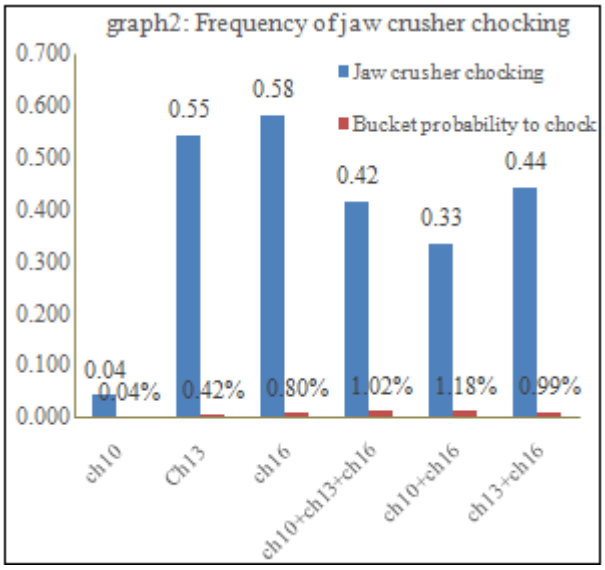
Chocking of jaw crusher

The table 2 is showing, the chockingfrequency of jaw crusher while using ch10, ch13, ch16 separately and associated.

From the table 2, it is observed the frequency of chocking of jaw crusher is increasing with the size of loader; loader ch10 is having only 0.04% probability of chocking per bucket, ch13 0.42% which is 10 time more than ch10 and ch16 is having 0.80% almost 20 time of ch10.

Table 2: Frequency of Jaw crusher chocking

	Data		Chocking of jaw crusher			
	Shift	bucket	*Stn*	pBucket	*Ton*	Shift
ch10	24	2788	*1*	0,04%	*27880*	*0,04*
ch13	11	1429	*6*	0,42%	*3096*	*0,55*
ch16	36	2617	*21*	0,80%	*1993,9*	*0,58*
ch10+ch13+ch16	12	488	*5*	1,02%		*0,42*
ch16+ch10	3	85	1	1,18%		*0,33*
ch16+ch12	9	403	4	0,99%		*0,44*



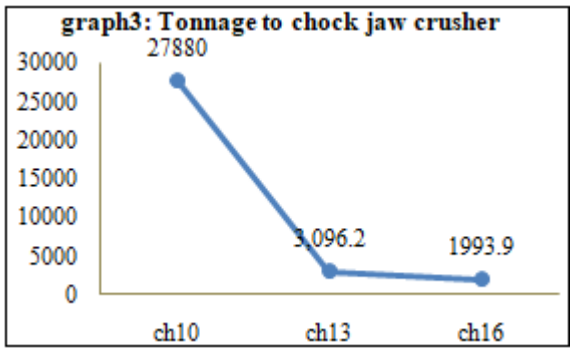
It is also remarked that the association of loaders are having probability superior at 0.95% all of them.

The number of stoppage of plant per shift is 0.04 with ch10, 0.55 with ch13 this represented 1.1 time per day and 0.58time with ch16. It is also interesting to see how ch10+ch16 is performing 0.33 time in a shift compare to ch10+ch13+ch16, 0.42 time.

ch16, at this stage become useless because, every time is been used, it is increasing stoppage frequency and downtime. Associated loaders are stop less compared to ch13 and ch16 taken alone.

[3] Tito GATTI, Total Productive Management AG4840 in technique de l'ingénieur, p2

[4] Jean-Marc Gallaire, les outils de la performance industrielle, édition d'organisation, Groupes Eyrolles, 2008, p37



Graph3 is demonstrating that 27,880t of material can be fed from ch10 to get the first stop but only 1,993.9t are enough for ch16.

Mineral heterogeneity is explaining that phenomena where big loaders, even having more time of checking material, are still charging big rock into bins. Checking by big loader, in practice is poor. The volume of the bucket doesn't allow operators to do correct rock removal compare to smallness loaders.

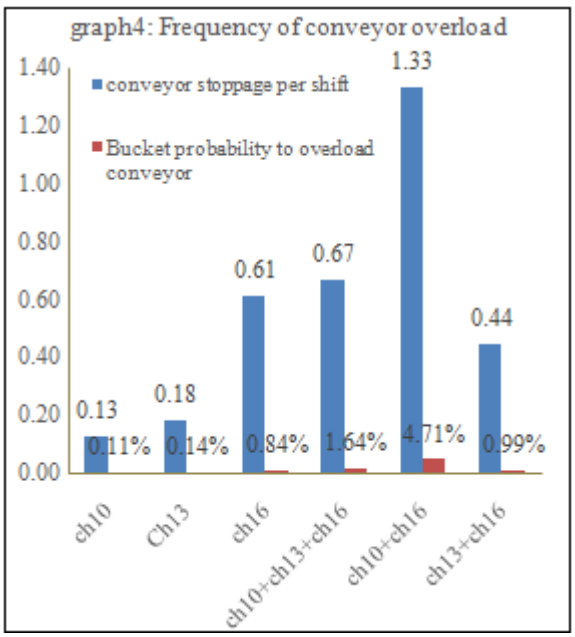
Note a random rock removal can take from 45 minutes to 12 hours specially when it request mechanical dismantling of equipment or using of heavy equipment.

Overload of conveyor

Table 3 showsthe link between conveyors overload and loaders. Instead of considering 2 conveyors as describe in introduction, we assumed that there is only one and data were summed.

Table 3: Frequency of conveyor overloading

	Data		Overload conveyor			
	Shift	bucket	Sstn	pBucket	Ton	Shift
ch10	24	2788	3	0,11%	9293	0,13
Ch13	11	1429	2	0,14%	9289	0,18
ch16	36	2617	22	0,84%	1903,3	0,61
All	12	488	8	1,64%		0,67
ch16+ch10	3	85	4	4,71%		1,33
ch16+ch12	9	403	4	0,99%		0,44



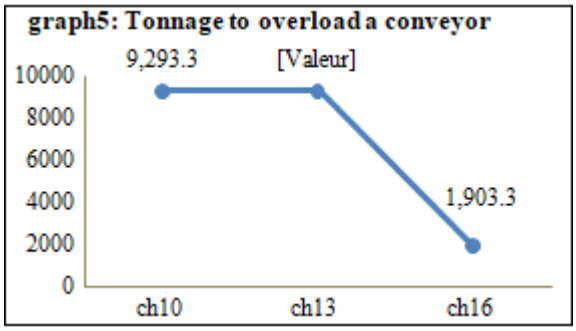
Conveyor trip due to overload probability per bucket is 0.11% for ch10, 0.14% for ch13, 0.61% for ch16 and the association of the loader are frequently superior to 0.44%. Stoppage of plant due to overload is also increasing with loader size, ch16 is stopping 4 time more than ch10.

Another phenomena is observed with associated loaders especially with ch10+ch16, less stoppage of jaw crusher explain this brutal increment of overloading of conveyors.

The rule should be "less jaw crusher is running, less conveyor overload should be observed" explain also the closest of valuesbetween ch10 and ch13. But this impact of ch10+ch16 long running of jaw crusher is be reflected in conveyor tripping.

As observed before, performance at this stage of ch10 and ch13 are very close 9293.3t and 9288.5t to stop the plant but only 1903.3t are enough for ch16.

Material carried on by ch13 and ch16 are huge and explain this overload of conveyor frequently.



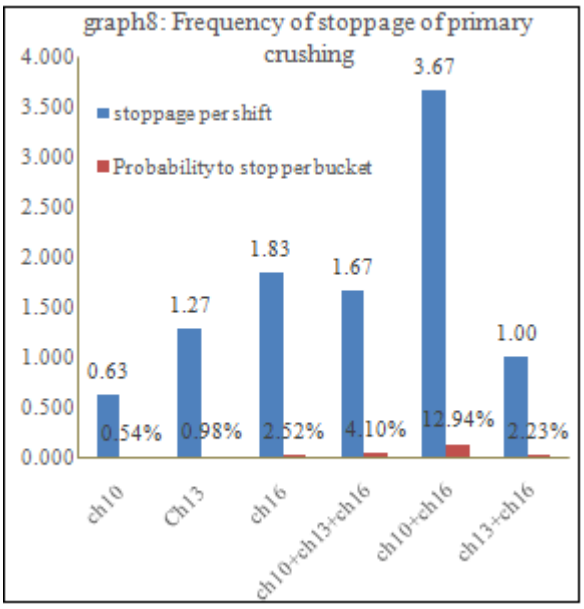
This type of stoppage generate unnecessaryloss of material and time due cleaning of belt and tail pulley.

Chocking of scrubber feed chute

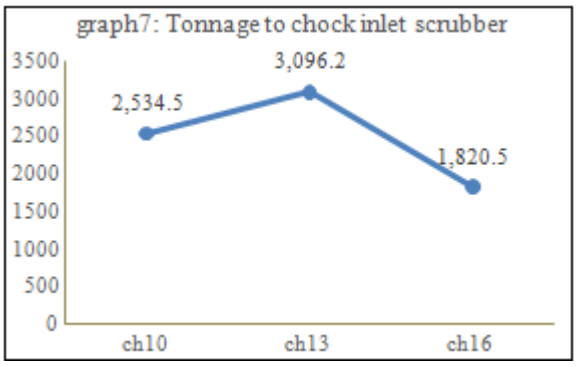
The risk of chocking scrubber feed chute will be affected by the performance of the conveyors and jaw crusher. Table 4 is giving result obtained.

Table 4: Chocking of scrubber inlet chute

	Data		Chocking scrubber feed chute			
	Shift	bucket	Stn	pBucket	Ton	Shift
ch10	24	2788	11	0,39%	2535	0,46
Ch13	11	1429	6	0,42%	3096	0,55
ch16	36	2617	23	0,88%	1820,5	0,64
All	12	488	7	1,43%		0,58
ch16+ch10	3	85	6	7,06%		2,00
ch16+ch12	9	403	1	0,25%		0,11



Except for ch10, using other loader it is sure to stop the plant at least one time a day due to chock of inlet scrubber. But it is observed a slight increment of stoppage due to loader size. Also ch10+ch16 looked to be the best stopper at this stage due to reasons mentioned in the point of conveyor overload; less stoppage on jaw crusher improved feeding capacity and risk of getting more rock in the chute of scrubber.



Graph7 shows that to get a chocking at this particular stage, ch13 as to fed 3096.2t, ch10 less than that 2534.5t and ch16 confirm his tendency of breaking running of plant by only 1820.5t.

Total downtimes

Table 5 is summarizing tables 2, 3 and 4.

Table 5: Summery of downtime

	Data		Total downtime			
	Shift	bucket	Nber	Bucket	Ton	Shift
ch10	24	2788	15	0,54%	1859	0,63
Ch13	11	1429	14	0,98%	1327	1,27
ch16	36	2617	66	2,52%	634,4	1,83
All	12	488	20	4,10%		1,67
ch16+ch10	3	85	11	12.94%		3,67
ch16+ch13	9	403	9	2,23%		1,00

Each bucket from ch10 is having 0.54% per bucket to stop primary crushing plant although ch13 is having 0.98% per bucket; ch16 is having a probability of 2.52% which is 4.7 times ch10.

ch10+ch16 impact negatively on the stoppage, it is having the worse probability.

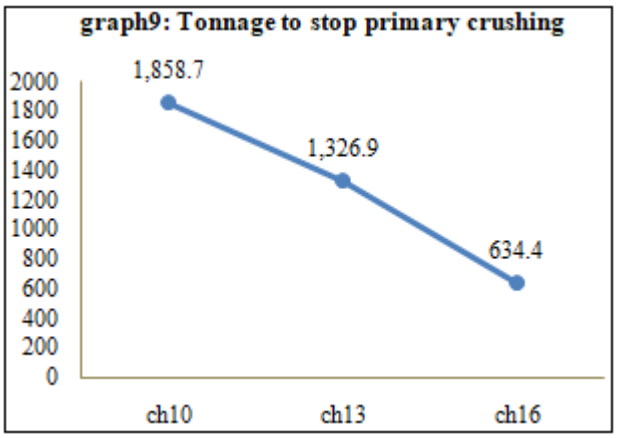
In general, the influence of ch16 is dramatic on plant running, it increasing probability to stop of about 5times paralleled to ch10.

Apart ch10, all loaders and association are stopping the plant at least 1 time per shift, 2 times a day. Ch16, ch10+ch13+ch16, ch10+ch16 are stopping minimum 3 times the plant per day.

Ch16 is stoppingplant 3.6times a day, ch13 2.5time a day and ch10 1.2 time. The association of loader also are poor as ch13 and ch16, 2 times a day.

In graph7, 634.4t are usefull to stop plant while using ch16, this amount is increasing at 1326.9t for ch13 and 1858.7t with ch10.

Clearly, ch10 is increasing the plant running time compare to others.



6. Conclusion

A suitable loader is needed to perform plant feeding specially crushing. Based on calculation, big loaderappeared to be the best because they can handle more material in a short period and insure feeding of the primary crushing but, others parameters such as chocking of jaw crusher by big rocks, overload of conveyors and chocking of inlet scrubber have to considered for plant optimization.

This article show how loader size is generating downtime and by the way sink production. Small loader are increasing running time while big one are reducing it. The 16t loader should be used to perform but it generating 4.5time more problem than ch10.

In definitive, ch10 allows a high running time, and help to achieve plant objective.

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