IMPROVEMENTS OF EFFICIENT CLASSIFICATION WITH HIGH FREQUENCY SCREENS ON CLOSED CIRCUIT GRINDING - CASE STUDIES

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ABSTRACT

There is always debate about the influence of the classifier efficiency in regards to grinding mill capacity and classification efficiency.
Hydrocyclones have been used for over five decades with the acceptance of fines bypassing back to the mill.
This paper presents case studies demonstrating the benefits of improved classification and mill throughput, when hydrocyclones are replaced by high frequency screens.

Key words: mill capacity, classification, grinding, mill, screen.

1. INTRODUCTION

Today mining operators are faced with high energy costs, low ore grades, the need to reduce carbon footprint and more restrictive environmental regulations. Technology is available to reduce the impact of all these factors, by increasing productivity with the same mill foot print when high frequency screens replace hydrocylones to close circuit grinding. Also, screens give sharp classification that allows mills to grind to proper liberated size the valuable mineral(s). It gives uniformity to the classification product with benefits to all downstream processes with more favorable metallurgical results which is the main concern of plant metallurgists.

It has been since the early 1900's when classifiers started to dominate the mine industry by closing circuit grinding (rake and spiral). Subsequently, the appearance of hydrocyclones in late 1940's which was due to the necessity of processing higher tonnage rates. Hydrocyclones became acceptable through time by reducing floor space, consuming less power with less maintenance than rake and spiral classifiers. This gave the path to cyclones to dominate closing circuit grinding. We should remembered that some decades ago energy costs were lower and ore grades were higher than today. Therefore it is time to review the classification box (hydrocylone versus high frequency screens).

Due to the fact that hydrocyclones classifies by size and specific gravity there is always that certain amount of bypassed fines or material already ground to the proper size returning to the mill with the circulating load. This fact has alerted some mine operators to take advantage of the new technology by avoiding over grinding. They have implemented the high frequency screen technology in closed circuit grinding by reducing over grinding, increasing new mill feed with an increasing in metallurgical recoveries and achieving better thickening, filtration and tailings deposition performances.

Avoiding over grinding with less circulating load gave space to additional new mill feed which propitiate an increase in plant revenue. This has promoted the success of these mine operators as they became able to produce more, better with an overall cost reduction.

2. FLOOR SPACE

Screens footprint should not be taken in consideration when one can reduce energy costs and increase mill throughput with better metallurgical results. This paper shows that it is possible to increase the capacity of the ball mills already installed when hydrocyclones are replaced by high frequency screens closing the circuit grinding. Even with the higher floor foot print the cost benefits are higher with a quick return of investment by mill operators.

3. CLASSIFICATION

Keeping proper classification as the target to maintain steady metallurgical results with the lowest cost possible is critical in today's competitive market when one operates with low ore grades and high energy costs. A uniform and constant product produce by the classification device to feed the next stage of concentration can save millions of dollars when high frequency screens are installed replacing cyclones. Why continue to produce variable products to feed the downstream circuits?

A homogeneous product is a key factor for a better flotation, thickening, filtration and tailings deposition. The sharpness of classification produce by high frequency screens with the reduction of slimes and coarse particles on the undersize product send to the downstream processes generates a reduction in reagents consumption with consequent reduction of coarser particles and entrapment of liberated particles by the ultra fines particles reducing the losses on the rougher flotation cells.

4. OVER GRINDING

Normally circulating loads produced in a grinding circuit with a ball mill closed by hydrocyclones contains somewhat bypassed fines. These bypassed fines consequently generate slimes that are prejudicial to the downstream processes.
Derrick high frequency screens fitted with long life polyurethane screen panels has proved in various installations around the world when closed circuits grinding that a substantial reduction in slimes (ultra fines) production is achieved by not allowing the return of the fine particles to the mill due to the fact that a screen can quickly remove the proper sized particles from the grinding circuit.

All plants that replaced cyclones by screens gain grinding mill capacity. These applications have contradicted studies in regards to the benefits of operating with higher circulating loads. The performance of the screens is influenced by the particle size distribution of the mill discharge, therefore as the circulating load decreases to lower levels the operator has to compensate increasing new feed to the mill. Sometimes it generates volume constrains as the mill sump pump does not have enough capacity to adsorb the pulp volume now generate to give proper feed density to the screen(s).

5. FIRST CASE - MINA COLQUIJIRCA – SOCIEDAD MINERA EL BROCAL S.A.A.

Grinding and classification circuit at Sociedad Minera El Brocal consists of two stages. The first stage is an open circuit with three rod mills (7’x 12’) and the second stage operated with four parallel ball mills (three 8’x 10’ and one 8’x 8’) operating in closed circuit by a nest of 10 hydrocyclones (D-10).

Operation analysis found an increment of slimes generated by galena that the circuit was over grinding mainly caused by the high circulating load (350%) as per circuit shown on figure 1. This high percentage of slimes produced by the circuit was prejudicial to the flotation of coarse particles as excess of reagents was required due to the higher relation of specific surface area to mass.

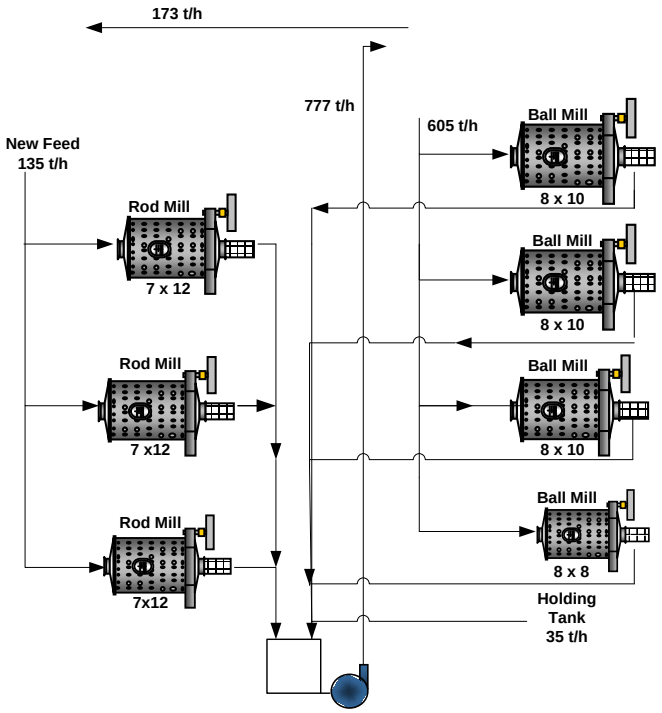

Figure 1

Brocal decided to operate the second stage of closed circuit grinding by high frequency screens. Operational results with Stack Sizer screens reported a circulating load of 61% as showing on figure 2 and consequently reduced the slime content (percentage of particles smaller than 10 microns decreased from 18% to 10% in the flotation circuit) of the grinding final product. Table 1 shows product size distribution with the circuit operated by hydrocylones.

Cyclone Size Distributions

Microns	Cyclone Feed	Cyclone Underflow	Cyclone Overflow
	% Pass	% Pass	% Pass
300	62.3	59.9	98.9
212	49.2	45.0	91.7
75	20.5	11.5	67.7

Table I

This system of classification facilitated the implementation of a coarser galena flotation in a bank of conventional flotation cells; however the most important benefit
was the reduction of the circulating load to 61%. This allowed the secondary grinding stage to operate with only two ball mills; converting the third 8'x 10' mill in a third
stage of grinding that implemented the regrinding of the tailings from the galena flotation bank**.**

Stack Sizer Size Distributions

Microns	Stack Sizer Feed	Stack Sizer Oversize	Stack Sizer Undersize
	% Pass	% Pass	% Pass
300	69.5	11.5	85.2
212	52.8	10.5	78.0
75	38.1	8.2	56.3

Table II

Mill throughput had an increase of 110 tons/h, after closing the secondary grinding stage with Derrick Stack Sizer screens fitted with 500 microns polyurethane panels.

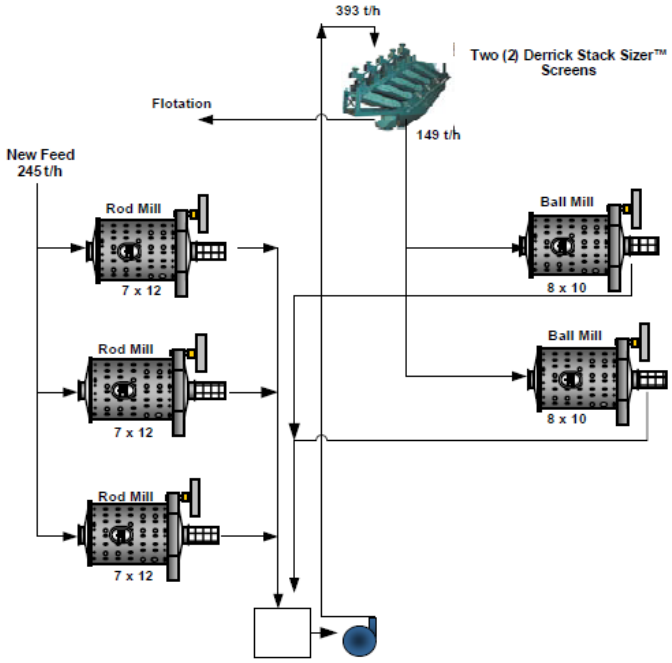

Figure 2

6. SECOND CASE - COMPANIA MINERA CERRO LINDO

Cerro Lindo is located southwest of Lima, Peru producing copper, lead and zinc concentrates. The grinding circuit consisted of 14.5'x 23.5', Marcy ball mill operating in closed circuit with GMax D-26 hydrocyclone nest with a circulating load of 260% as per figure 3. Table 3 shows product size distribution with the circuit operated by hydrocylones.

Cyclone Size Distributions

Microns	Cyclone Feed	Cyclone Underflow	Cyclone Overflow
	% Pass	% Pass	% Pass
300	100.0	100.0	100.0
212	63.9	52.1	94.4
75	22.5	8.4	58.9

Table III

Compania Minera Cerro Lindo replaced the hydrocyclone nest by four Derrick Stack Sizer units; three operating with 0.23 mm polyurethane Derrick screen panels and one operating with 0.18 mm as per figure 4. Table 4 shows product size distribution with the circuit operated by Stack Sizer screens.

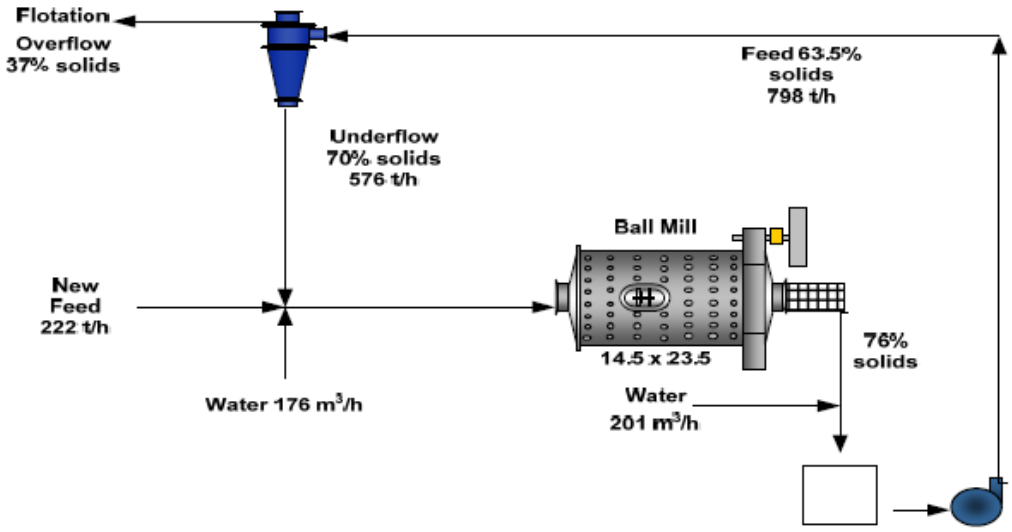

Figure 3

Stack Sizer – Size Distributions

Microns	Stack Sizer Feed	Stack Sizer Oversize	Stack Sizer Undersize
	% Pass	% Pass	% Pass
300	75.3	54.9	99.3
212	59.4	31.1	90.6
75	30.4	9.9	47.0

Table IV

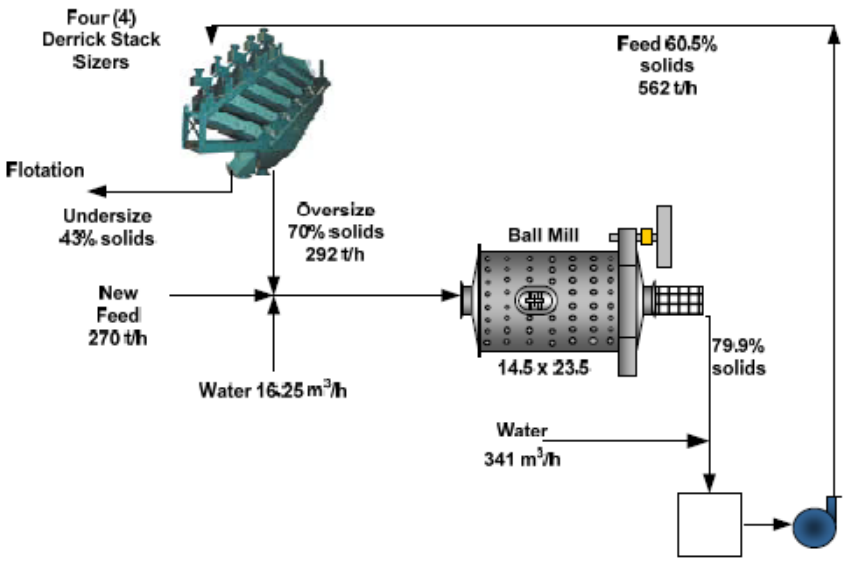

Figure 4

The improved classification system with screens was able to reduce the mineral overground on the mill; propitiating a throughput increase of 800 tons per day.

Basically increase of throughput is explained by the reduction of the circulating load; while operating with hydrocyclones it was around 244 % and after changing to Derrick Stack Sizer high frequency screens it was 108 %.

Cerro Lindo hydrocyclones D-26 compared with Stack Sizer

Control Parameters	**Hydrocyclone D-26**	**Stack Sizer**
Tonnage t/hr	242	275
Ball charge %	37	37
RPM	15.5	15.5
Critical Speed	76.8	76.8
Mill Motor	**Hydrocyclone D-26**	**Stack Sizer**
Voltage	3960.68	4139.21
Kw	2183.03	2199.58
Energy Consumption (Kwh/Ton)	6.79	6.55
grams of steel/Kw-h	777.69	696.06
Classification	**Hydrocyclone D-26**	**Stack Sizer**
Circulating Load	244	108
Classification Efficiency	58	79
Mill Discharge	**Hydrocyclone D-26**	**Stack Sizer**
% - 200 mesh	23.58	47.01
% solids	82.5	78.7
Flotation Feed	**Hydrocyclone D-26**	**Stack Sizer**
% - 200 mesh	55	47
P80 microns	140.5	160

Table V

Percentage of particles passing 200 mesh at the mill discharge increased; becoming a beneficial factor to the undersize product of the screens; classification efficiency increased by 23% and other gains were achieved as per table 5 comparing hydrocyclone operational data with Stack Sizer operational data.

7. CONCLUSIONS

Today one can not say that screens are not an economical equipment to close circuit grinding as more than thirty circuits around the world are taking advantage of the technology, so your company can might well achieve the same or better results.

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