NEWMONT USA AND DERRICK CORPORATION COLLABORATE ON TECHNOLOGICAL ADVANCEMENTS OF SCREEN SURFACE TECHNOLOGY IN GOLD PROCESSING PLANTS

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Abstract

As mine operators continuously look for ways to improve functionality and increase capacity of their facilities, existing process equipment is often pushed to and past its designed limitations. As a result, equipment manufacturers are asked for economical solutions to meet redefined processing needs. Newmont USA (Newmont) in Nevada was faced with such a need in their Carbon-in-Leach (CIL) train. In a collaborative effort between Newmont and Derrick Corporation, tests were conceived to assess the viability of drop in replacement screen using a three dimensional screen panel. The urethane pyramid screen panel was designed to increase flux while maintaining the existing equipment footprint. The test is the end result of an ongoing research and development project that Derrick undertook in an effort to refine and upgrade their urethane screening media. The application of this new screening media is presented for this CIL application along with future plans to implement the technology in trash, safety, carbon dewatering, carbon sizing, and other scalping applications.

Introduction

In Spring of 2014, Process Machinery Associates (PMA), Derrick Corporation's (Derrick) local area representative, met with Newmont USA (Newmont) to discuss the operation of the in tank screens in the carbon in leach (CIL) train at Twin Creeks, near Golconda, Nevada. The process was originally designed for 13,000 +tons per day (tpd) but has been steadily rising since the plant was commissioned and now Newmont requires 16,000 tpd to be processed. The original screens were running at their maximum capacity and Newmont required additional screening capacity to continue the upward trend in production.

Physical separation by use of screening is one of mineral processing oldest methods. Screening media can be prone to blinding and pegging and the necessary support structures required for finer apertures result in smaller open areas. Therefore, more screening area generally requires larger panels and therefore larger machines, screening media that doesn't blind, or a combination of both.

In an effort to avoid larger machines, Derrick Corporation had been working on a revolutionary three dimensional panel which would add non blinding screen area in the same footprint of an existing machine. Alpha testing of the new screen panels began at Newmont Mill 2/5 (Carlin, Nevada) in July of 2013 and was still occurring when PMA approached Twin Creeks about beta testing a refined machine and pyramid panel. After presenting the initial results, Twin Creeks determined that an upgraded machine and pyramid panels would be a possible solution to meet production needs. The testing of a machine eliminated the risk of capital costs to Newmont and provided Derrick the opportunity to obtain additional data.

This article intends to provide a brief review of scalping screen basics, a review of Derrick's screen panel development, and a case study of the machine at Twin Creeks CIL with some background from the alpha testing at Newmont Mill 2/5. The direction of the technology and future tests in other applications are also briefly discussed.

Scalping Screen Basics

Screens are used for scalping, media recovery, dewatering, trash removal, and safety screens applications. In its simplest form, the screen is a surface having many apertures usually with uniform dimensions. Particles presented to that surface will either pass through or be retained, according to whether the particle is larger or smaller than the dimensions of the aperture (Wills 186). Performance is often measured in terms of efficiency based on the recovery of the material at a given size or on the mass of misplaced material in the over or unders product (Wills 186). Fine screening is often accomplished with high frequency, low amplitude, vibrating screens. Screens are vibrated in order to throw particles off the surface so they can be presented to the screen again, as well as to convey oversized particles along and off the screen (Wills 189).

In gold processing plants, scalping screens are designed to remove oversized material from the flow before, during, or after different processes. For example, trash screens are used to remove unwanted material before float cells, loaded carbon screens are used to separate the carbon from slurry as it is recovered from the top end of CIL trains, and in tank or inter-stage screens are used to keep carbon in the correct location. These screens are generally designed to be in an uphill position, in order to form a pool near the feed end. These applications are generally tasked with removing a relatively low percentage of oversized material. In the test at Newmont's Twin Creeks Operation the scalping screens being examined are in tank or inter-stage screens.

Advancements in Screening Technology from Derrick Corporation

Since the early 1950's, Derrick Corporation has been at the forefront of screening technology. In the early 1980's Derrick developed and patented a unique process which allows for the manufacture of high open area urethane screen surfaces. Using urethane as a screening media proved to be an extremely novel approach as it was found to be extremely durable and maintained a high throughput capacity. The original design of the panels utilized a tensioning system which allowed the media to maintain its shape and keep openings sized properly. This helped eliminate blinding and allowed screening efficiency to remain high. Derrick continued to develop the manufacturing process and now the technology is established to manufacture panels with open areas as high as 45% and mesh sizes down to 45 microns.

In an effort to obtain greater flux, Derrick started working on a three dimensional pyramid style panel which would allow greater screen area while maintaining the same equipment footprint. Initially, pyramid panels were made of wire mesh which proved to be extremely successful in increasing flux and subsequently became widely used in the oil and gas industry. Unfortunately, wire mesh panels were found to have durability issues in the mining industry and did not last long enough in typical gold slurries to be a feasible option. To obtain greater durability, Derrick looked at using urethane as a material of construction and initial attempts using a urethane pyramid panel showed promise in terms of flux. However, the tensioning mechanism currently in use for Derrick's machines did not work well. The tension force to keep the shape was not conducive with a three dimensional panel, the panels ripped quickly, and wear rates could never be established.

Derrick was encouraged enough by the increased flow to explore new panel construction methods and also new ideas for holding the panel in place on the machine. Over a five (5) year period Derrick developed a pyramid panel that was believed to be both durable and substantially increase flux. A compression system used to hold the wire pyramid panels in place, (previously developed for the oil industry) became the backbone of the new Hyperpool Mining Machine. The oil field machine, however, had not run in a mining application and its performance was unknown.

In the following figure, the new pyramid panel is shown in comparison to the standard Derrick urethane panel. In addition to the shape of the panel, the major difference shown is how the panel is supported. The flat urethane panel (orange) is tensioned across stringers which are part of the machine. Rubber protectors are used to protect the metal stringers from wear. The pyramid panel has its support mechanism built into the panel. The black proprietary materials seen under and on the edges of the pyramid panel are used to support the fine material (gray).

Figure 1. New Pyramid Panel vs Standard Urethane Panels

In additional to the pyramid panel, the Hyperpool machine also offers additional upgrades from the previous Derrick model. The compression system that was designed to hold the pyramid panels in place and maintain slot size and open areas, is also very operator friendly. This system allows panel changes to be completed very quickly (less than 5 minutes for a 4 panel machine) utilizing a simple lever system with spring actuated pins which eliminate the previous bolting system. The old system was extremely effective for keeping panel life long and maintaining slot size, but panel changes were more time consuming than the new Hyperpool Machine.

Figure 2. Compression System

The Hyperpool screen frame was also designed to withstand larger forces. The Derrick linear motion screen is equipped with two vibrating motors that rotate in opposite directions. Maximum fluid capacity is achieved with an angle set on the screen causing the formation of a pool at the feed end and the head from the pool increases throughput. This creates an issue with conveying oversize material up a hill. The Derrick dual motor design vibrates the screen in a linear motion perpendicular to the motor mounts. This configuration allows the forward conveyance of oversized particles off the screen frame. The older style machines contained 20 in-lb eccentric weights, whereas the Hyperpool frame was designed to allow for 42 in-lb weights while weighing approximately the same. This resulted in an increase from approximately 3.5 G's of force being exerted on the frame to approximately 8 G's. This increase in G force greatly enhanced the machines ability to convey oversized particles.

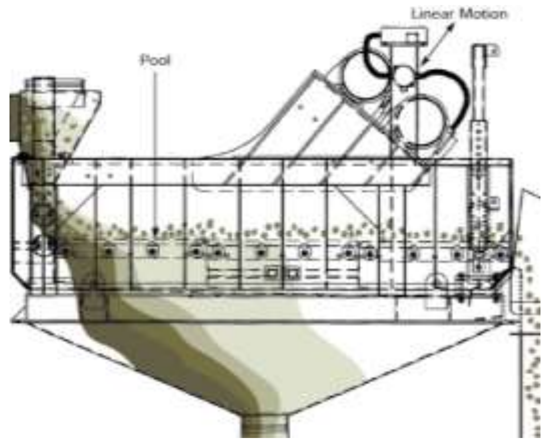

Figure 3. Linear Motion Machine
Source: Adapted from "Linear Motion Machine Brochure" Derrick Corporation © 2002

Newmont Mill 2/5 CIL Test

As Derrick continued to advance the pyramid panel technology and knowing several customers in Nevada would greatly benefit from a drop in replacement machine which offered additional capacity, PMA began to look for potential test locations. During discussions it was quickly learned that the drop in replacement was a key component for customers. Capital expenditures for structural steel and other modifications to install larger machines would likely not be approved with the decline in gold prices during spring of 2013.

Newmont Mill 2/5 was one such customer known to need additional capacity in their CIL and was approached to be the initial test location. The CIL, as opposed to trash or safety, was chosen as an ideal test location since it is likely the hardest scalping application in the gold industry. Slurry characteristics would be the same in other applications but the CIL contained far more oversized material in the form of carbon. The goal of the test was twofold, learn whether the machine would work in this application, and to experiment with different materials for panel construction. This test offered a possible solution to Newmont and also provided an opportunity for Derrick to test new technology.

The initial test machine was installed in July 2013 and was recently removed from service (Nov 2014). The test showed that the new Hyperpool machine outperformed the older style Derrick machine in terms of slurry throughput and carbon conveyance. Variances were found in the durability of different panel materials, but all panels tested showed promise for long life spans. With lessons learned, minor modifications were made to the machine and the construction of the panel was changed slightly. Derrick also decided on which panel showed the most promise and elected to move forward with that material. Although early in the process, Newmont decided to order several machines and start exchanging old style machines for Hyperpools. This was done with an agreement from Derrick that they would continue to push the technology forward. Alpha testing data is not presented in this paper for two reasons. Primarily, existing plumbing constraints didn't allow the Hyperpool to be pushed to a maximum capacity. Secondary, Derrick would like to protect proprietary secrets involving panel materials, panel construction and life span. Based on the success of alpha testing, Derrick and PMA decided to look for a new site for a beta test of the Hyperpool machine using the chosen panel.

Newmont Twin Creeks CIL Test

PMA has been involved in the Twin Creeks CIL project since construction and has witnessed the escalation of production. Knowing that the CIL could use additional capacity and that the plumbing was advantageous to push the machine to its limits, PMA suggest the Twin Creeks CIL as a potential beta testing site. The Twin Creeks CIL also offered conditions that would be harder on the machine. The CIL processes autoclave ore which is more viscous and it also utilizes higher in tank carbon concentrations than Mill 2/5.

As with Mill 2/5, Newmont and Derrick agreed to test the machine for a one (1) year period. This test was designed to be slightly different than the Mill 2/5 test. With the refinements made to the panel and the machine, Derrick knew the Hyperpool would work and the beta test was intended to push the machine as hard as possible to determine maximum capacity and evaluate panel wear rates. As Mill 2/5 was starting to install Hyperpools, both parties were extremely interested in evaluating the technology. Derrick was also interested in producing a business plan to turn the Hyperpool machine into a viable commercial product for the mining industry.

Newmont's process goal for the CIL is 16,000 tons per day in a single train. The slurry is 40-45% solids, which translates to a flow rate of approximately 5,000 gallons per minute (gpm). Carbon varies some, but generally a concentration of between 30 and 80 grams per liter of carbon is kept in the top tank. The top tank of the CIL is configured with five (5) older style Derrick screens each being fed approximately 1000 gpm. The older style screens were originally designed to accommodate 850 to 950 gpm and the increased feed rate removed all safety factors from the design.

All screens are submerged into the tank and there is no plumbing, valves, flow meters, or other controls to direct, change or measure flow to an individual machine. Flow is however, regulated to the tank and each machine takes as much flow as possible before overflowing. The flow rate of the older style machines was previously verified by PMA in several other installations in Nevada and by Newmont at Twin Creeks CIL (The rule of thumb for the old machine is approximately 950 gpm of slurry which is approximately 3000 tons/day with 20 grams/liter carbon oversize). The test would simply measure the flow rate to the tank and the flow rate for the new machine would be determined by turning off one or more of the older style machines while maintaining the fluid level in the tank. If the tank level started to rise, one of the older machines would be started back up.

The CIL Circuit at Twin Creeks is fed by the combined stream of a Sulfide Mill and an Oxide Mill with a combined feed rate of about 760 TPH at about 38% solids. The Sulfide Mill has two Autoclaves each fed up to 300 TPH of Sulfide ore at about 50% solids having a grind of about 80% passing 625 mesh. The Oxide Mill has a throughput of up to 250 TPH, with a grind of about 90% passing 200 mesh as measured at the cyclone overflow. The sulfide and oxide circuits are combined prior to the CIL circuit to form a single feed to CIL. Every year the Autoclaves are taken down for maintenance one at a time. This maintenance down period happened for one of the Autoclaves at the beginning of this test. During an Autoclave shut down it is sometimes possible to process short periods of oxide ore through the Sulfide Mill producing a product similar to the Oxide Mill above, this will result in a lot higher flow rate to CIL for this period. With these different combinations of feed to the CIL the pH varies and as the pH varies so does the slurry viscosity. There was also a lot of other process upsets early in the test period, creating feed variability.

Table 1. CIL Operating Conditions

Operating Conditions	7/7/14 – 9/28/14			8/25/14 – 9/25/14		
	Avg	Max	Min	Avg	Max	Min
Feed (TPH)	549	709	70	629	709	439
Slurry Flow Rate (GPM)	4554	1000	6426	4886	6235	1979
Solids CIL Feed (%)	39	54	25	39	46	25
pH	10.16	11.87	9.17	10.3	11.67	9.84
Carbon Concentration	62	88	30	67	88	45
New Carbon Size	(-)8 Mesh + 12 Mesh			(-)8 Mesh + 12 Mesh		
Slurry Size	90% Passing 200 Mesh			90% Passing 200 Mesh		

Test Results

The following figure shows a side by side photo of the older style machine (left) and the Hyperpool (right). In this snapshot, the flow rate was approximately 4000 gpm and the Hyperpool was running along with two (2) of the older style machines, thereby doing approximately 2000 gpm. The noticeable items in the picture are the dewatering point on the machines. The older style machine is still dewatering near the lifting hooks not far from the discharge end. The Hyperpool is dewatering near the beginning of the motor mounts while doing twice the flow rate.

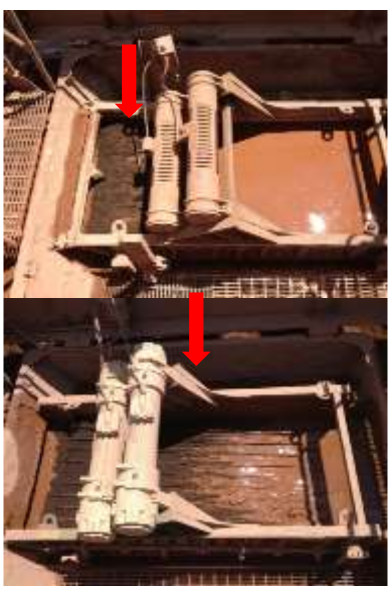

Figure 4. Side by Side Dewatering Points

Partial results are shown in the following figure. The beginning of the chart has been removed for clarity as the start of the test occurred during the autoclave maintenance period as mentioned above. The initial data shows quite a bit of variation in feed conditions and more consistent conditions were observed in later time periods. Because of the variability, older style machines were turned on and off more often and capacity of the Hyperpool was difficult to pinpoint. Therefore data from the test start on 07/07/14 through 07/28/14 is not included. Flow rate in gallons per minute is shown on the left side Y axis and time is shown on the X axis. Time is given in half hour increments and starts on 07/28/14. The right side axis shows the number of older style machines required processing the flow rate and the Hyperpool machine was running during the entire period. The scaled tons showed on the graph make the calculation from flow rate in gpm and using the density calculate tons. They are scaled by a factor of five (5) to fit on the same scale as the flow rate.

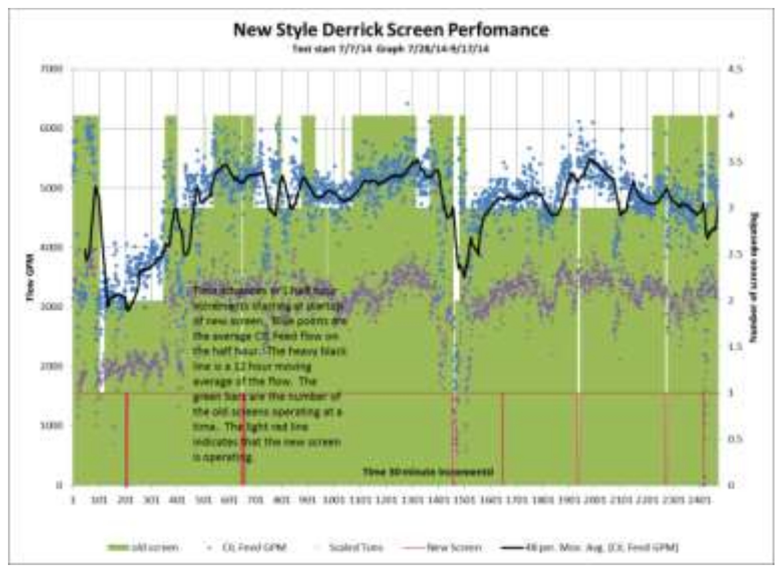

Figure 5. CIL Flow Rates and Interstage Machine Useage

General trends observed show that as flow approaches 5000 gpm, the Hyperpool and three (3) older style machines must be used to handle the flow rate and occasionally a forth screen must be used. In areas where flow is a bit lighter at the beginning of the test, it was observed that the Hyperpool and two (2) older style machines were able to handle approximately 4000 gpm. As flow increases past 4000 gpm and during the oxide ore run between time periods 800 and 1050, the third (3rd) machine was also required. This would indicate that the Hyperpool machine is capable of handling approximately twice or perhaps slightly more than twice the flow of the older style machines.

As the test progressed, the flow through the CIL has been averaging approximately 5,500 gpm. Continued observations showed that during a twenty four hour period at that flow rate the tank level will cycle such that three (3) machines can be run for approximately 75% of time but the forth screen must be utilized for 25% of the day to lower the tank level before overflowing occurs. If one (1) of the older style machines are not running due to maintenance, the tank will rise to the point of flooding all the other machines or overflowing the tank. The rising tank level is stopped as soon as the machine is returned to service. Running with a reduced number of the older style machines does result in the dewatering point moving to the very end of the machines. The Hyperpool dewatering point also moves up but never reaches the very end of the machine. Because of the cycling levels of the tank and a need to run the facility, Twin Creeks has opted to run all screens all the time currently. However, the operations pattern required to run the CIL and observations of the tank levels show the capacity for the Hyperpool to be slightly more than 2X the original machines.

The wear patterns of the pyramid panel as shown in the following figure. The failure mechanism on the panel appears to be simple wear. Small holes developed and once it is deemed that carbon could make it through the panel, it was replaced. The structure and overall construction of the panel is such that no catastrophic failures have occurred. Preliminary data on life span is also encouraging and appears to be as good as the flat urethane panels which Derrick has previously demonstrated to have long life spans. However, due to the limited number of panels used, additional study is needed to accurately assess pyramid panel life span.

Figure 6. Typical Wear Pattern

Conclusions

Based on the testing seen to this point, the Hyperpool machine with pyramid panels has proven to be a viable machine for use in the mining industry. The Hyperpool can accommodate between 2 and 2.5 times the flow rate of the older style machine depending on feed conditions in a CIL application. The Hyperpool was designed to fit existing Derrick screen installations with only minor structure modifications required. New uprights are required to accommodate the new compression system which saves substantial capital costs from those that installation of a larger machine would require. The machine can be installed quickly and easily and has been shown to meet Newmont's need for additional capacity.

Panel life span and other consumable items associated with the machine are still under study. The overall operations and maintenance costs are currently unknown. Consumable items such as float mounts, bulkhead protectors, and seals are still being studied. The new motors are expected to last longer but will need additional running time before conclusions can be reached. As mentioned, the authors are not yet ready to publish screen panel life span due to the small volume of panels consumed. More data is required before accurately predicting panel life and additional time running the machine will be required to assess overall operations and maintenance costs.

Future Applications

Based on the results at Mill 2/5 and Twin Creeks CIL, the Derrick Hyperpool is situated to become the screen of choice for trash screens, carbon dewatering, carbon handling, carbon column safety and interstage or in-tank screens for CIL applications. This scalping screen is currently being tested in a trash application at another gold producer in Nevada and an additional trash application machine is scheduled to be tested at another Newmont property in the spring of 2015.

1. Wills, B.A., "Wills Mineral Processing Technology" Seventh Edition. San Francisco, 2008 pp. 186-192. Editor T.J. Napier-Munn