Advancements in Interstage Screening Using Synthetic Media to Improve Performance at Nevada Gold Mines Resin In Leach Facility.

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Abstract

As part of normal operations, Nevada Gold Mine's (NGM) Goldstrike Operation continuously evaluates equipment for efficiency and reliability. Recently noticed were shorter than expected lifespans, loss of throughput, and excessive cleanings for the stainless steel Wedge Wire baskets.

In a collaboration with Derrick®, tests were conceived to assess the feasibility of using urethane screen surfaces to extend life and reduce blinding. Tests began in January 2018 and continue through today. At of the start of 2020, there are several interstage screens (baskets) with at least one year run time and all have shown very positive results. The New Urethane Interstage baskets require virtually no cleaning thereby reducing maintenance costs. The new media has met the required throughput, removed blinding issues, and have had zero (0) high levels reported during operations. In addition, the baskets have been shown to be more durable as documented with decreased resin breakthroughs compared to the stainless steel. The use of these screens has shown enough economic and process benefits that NGM has started systematically replacing the existing stainless steel wedge wire baskets with Derrick Style G-Vault™ Screens throughout.

Introduction

In Fall of 2017 Nevada Gold Mines (NGM) Goldstrike Operations (Operated by Barrick®) approached Process Machinery Associates (PMA), the Nevada area Derrick Corporation Representative (Derrick), with regards to throughput issues with the interstage screens in the Resin in Leach (RIL) train. The plant was having trouble obtaining their desired throughput and had previously engaged PMA and Derrick to help with similar throughput issues on the trash and safety screens for the same circuit.

Using a new screen surface technology that was developed for a different machine (Mortensen et al 2015), and a previously completed proof of concept test, PMA and Derrick worked to develop a prototype screen that would fit into the existing infrastructure.

This case study intends to provide a brief review of screening in the Carbon In Leach process, a review of new technology for these screens, and a case study of the test at the NGM Goldstrike Resin in Leach Facility. Some background information from a proof of concept test is also discussed.

Interstage Screening Basics

Physical separation by use of screening is one of mineral processing's oldest methods. 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 oversize or undersize product (Wills 186).

Carbon in Leach (CIL) is a technique that is commonly used for concentrating gold around the world. The ore is comminuted and in its simplest iteration, a cyanide solution is added to the slurry. The goal is to form a gold cyanide complex which is then extracted from the slurry via adsorption to activated carbon.

The in-tank or interstage screens operate within the tanks in the gold adsorption process. The purpose of the screens is to facilitate the counter current transfer of carbon and slurry. The slurry flows, often by gravity, down the circuit while carbon is pumped up the circuit. The interstage screens are designed to prevent the carbon from flowing back down stream. Virgin carbon is added at the bottom tank and new slurry is introduced at the top and results in gold laden carbon collected from the top tank.

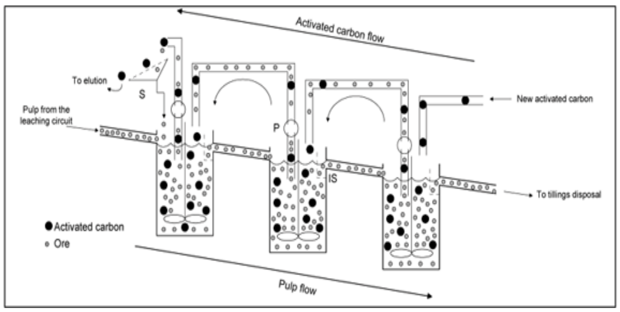

Figure 1. Carbon In Leach Flow Diagram
(https://www.911metallurgist.com/blog/gold-cil-process-explained)

Thiosulphate leaching of gold (and silver) ores has been studied by many over the years and there is plenty of literature on the subject including papers by Tozawa et al., 1981, Langhans et al., 1992 and Li et al., 1995.

NGM, in cooperation with SGS Lakefield, developed an effective, efficient, Resin In Pulp process, using commercial strong-base resins (Thomas et al., 1998) which mimicked the traditional CIP process in terms of a counter current flow of resin and pulp. This process has been developed to treat the carbonaceous, preg-robbing ores of NGM's Goldstrike orebody in the Carlin Trend of Nevada, USA. The ore has been proven to be amenable to thiosulphate leaching, under mild conditions; gold leaches rapidly as the gold thiosulphate complex, which, because of its low affinity for graphitic carbon, does not suffer the preg-robbing phenomenon that is a feature of these orebodies in cyanide leach circuits (Thomas et al., 1998). This case study is to evaluate the effectiveness of different screening media to keep the resin beads from moving downstream.

Advancements in Screening Technology

Historically, Derrick has always been a vibrating screen and surface technology company. Each product is specifically designed to complement the other and increase the overall screen efficiency for a customer's specific application. With the development of the Hyperpool™ machine (Mortensen et al. 2015) and the research and development of a new synthetic media, it became apparent that although they work best together, the screening media could offer improvements in other, non vibrating applications.

During the original testing of the Hyperpool™ and urethane synthetic pyramid panel, a business case was developed to make the machine and screening media a viable commercial product. As a typical gold process flow sheet was reviewed and customers questioned, it was clear that vibrating surfaces were commonly used in trash and safety applications, but the in-tank application was increasingly seen with a stainless steel basket style interstage screen.

The wedge wire baskets typically used are constructed of a continuous integrally welded stainless steel assembly, whereby the openings are created by welding wedge wire bars to cross supports on a specially constructed welding lathe. The slot length is determined by the spacing of the weld in the cross bars. Materials of construction range from Austenitic to Nitronic to Hastalloy grades. The open area of the basket is dependent on the aperture size. Typical open areas for sizes seen in in-tank applications are approximately 24% for 1 mm openings, 21% for 700 micron openings, and 18% for 500 micron openings. The NGM resin plant utilizes a 500 micron opening for its operations due to the size of the resin used. Overall screening areas are usually reported in square meters and range from 3 meters squared to 27 meters squared. The stainless baskets utilized at NGM are approximately 7.5 meters squared.

The Derrick solution consists of a stainless steel welded cage as the structural support of the system with multiple individual replaceable urethane screen cartridges. The cartridges populate the cage to make a completed screen surface. Because the cartridges are individually replaceable, any worn or damaged sections can be replaced, eliminating the need for the customer to replace the entire basket (Figures 2 and 3).

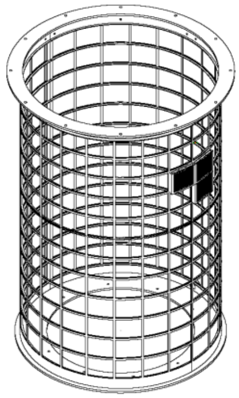

Figure 2. Derrick Stainless Steel Cage (J. Colgrove)

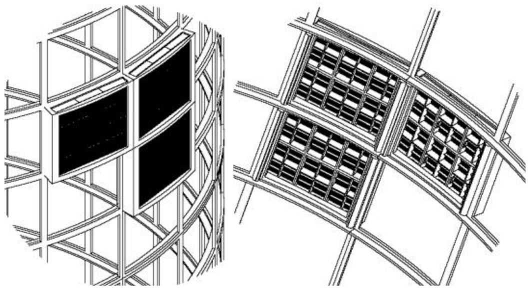

Figure 4. Individual Sections (J. Colgrove)

In addition to having the ability to repair sections individually, the move to a urethane surface offered a higher percentage of open area compared to the same size aperture in wedge wire. Open areas for the Derrick screens are approximately 44% for 1 mm openings, 37% for 700 micron openings, and 32% for 500 micron openings. The Derrick basket loses some of the area increase because of the way the replaceable windows work, but it's an overall net gain. The wedge wire basket being used at NGM has approximately 7.5 meters of screen area. At 18% open area, the total open area is approximately 1.35 meters squared. The Derrick basket offers 32% open area of 5.5 meters squared for a total open area of 1.76 meters squared, an 30% increase.

The Derrick screening media is constructed of a proprietary thermoplastic polyurethane blend. The material has good wear properties against abrasion as well as cut and tear resistance. It also has excellent hydrolysis resistance, good flexibility over a wide temperature range, excellent impact strength and resistance to oils and solvents.

The screen media is supported with a nylon derivative frame that is structurally robust. The screen sections in concert with a nylon derivative support frame allow for a very durable and yet, non-blinding surface that is excellent for a variety of applications.

With the improvement in a non-blinding screen panel that would work without a tensioning device, the decision was made to run a proof of concept test.

Proof of Concept Test

A major gold producer in Nevada was approached by PMA about retrofitting a basket style screen with the Derrick standard urethane panels. The Kambalda style screen works as the pulp flows up through the bottom of the basket and carbon is retained in the tank. Since the basket only allows flow from the bottom, screen area is limited to one surface and panels are easily and relatively cheaply produced. Figure 5 shows the Derrick urethane Kambalda panels prior to installation.

Figure 5. Kambalda Panels (J. Colgrove)

The panels were installed in November of 2015 and ran for approximately twelve (12) months without cleaning. The machine never needed to be pulled from the tank for maintenance, cleaning, or carbon breakthrough. At approximately the one-year mark, operators on site found carbon in their regularly scheduled dip test indicating panel failure. After pulling the screen, failure was attributed to a wiper blade that failed and hit the screen, damaging 6 of the 8 panels. The remaining two (2) panels were inspected and were considered worn, but still usable. This proof of concept test showed that the urethane material would be robust enough to last and would also be non-blinding. With positive results from this proof of concept, a business case was developed to see if the Kambalda panel was worth pursuing. Unfortunately, there are a limited number of facilities utilizing the Kambalda style screen, but there are quite a few gold producers that utilize a basket style (often NKM or Kemix® style) screen.

NGM Resin Test

NGM Goldstrike is the first producer to commercialize the recovery of gold using thiosulphate. The project known as the TCM or Total Carbonaceous Matter, included major upgrades to the leaching circuits, construction of a chemical plant to manufacture thiosulphate, construction of a water treatment plant, and other items.

The ore is crushed, ground and autoclaved as before, but the traditional cyanide leach circuit was replaced. The gold in the leached slurry is liberated in a series of tanks containing thiosulphate and resin as previously described and included new stainless steel wedge wire interstage screens.

In the RIL circuit the slurry percent solid target is 37% solids in the head tanks and the resin concentration target is at 40 ml per liter in the head tanks and 15 ml per liter in subsequent tanks. There are two trains with 7 tanks in each train and 3 interstage screens in each tank. To keep the circuit operational, weekly cleaning and maintenance of the screens was necessary.

Once full production was achieved, it was realized that the RIL stainless steel wedge wire screens were an operational and maintenance problem. The screens blinded quickly, required constant cleaning, and were experiencing premature failures. The original design of the plant called for 600 TPH (47% solids which is approximately 4000 gpm).

To maintain throughput a crew of four (4) contractors worked Monday to Thursday (10 hour shifts) every week. Each screen was cleaned once per shift and occasionally some were done twice depending on conditions. A crane was required to pull screens from the tanks and a 5,000 psi pressure washer was used to clean the blinded surface. To further reduce blinding, the pulse blades on the outside of the basket were adjusted as close as possible to the screen and acted as physical wipers to clean instead of pulsing material away. This caused unnecessary wear on the outside of the basket resulting in premature failures due to vertical cracks, flange separation or the slinky effect. On average two baskets were replaced each week. The cost for this work was approximately $40,000 (per week) including the crane rental, 3rd party labor crew, and materials.

In 2017, in an effort to increase production and reduce costs, NGM teamed up with PMA and Derrick to develop and test the new G-Vault™ screens. Two test units fitted with 500 micron screens were installed in different RIL tanks. During testing, the screens were never pulled for cleaning and dipped every shift to check for panel failure. After 6 months and no issues or cleanings required, the test was deemed a success and the decision was made to systematically replace all the wedge wire baskets with the G-Vault™ screens.

Figure 6. Derrick G-Vault™ Pulled from NGM Resin Circuit for Inspection (E. Mortensen)

Conclusions

As a result of changing the wedge wire screens to the new G-Vault™ screens, the RIL circuit is no longer the bottleneck. The plant can now handle everything that the upstream systems can produce and downstream systems can handle. On average the RIL is fed 3,000 GPM per train and 900 TPH but NGM has spiked the system for short periods of time and fed 3,200 GPM per train and 1,100 TPH.

In 2017, Goldstike deferred 22,000 tons from the budget due to plugged wedge wire screens. In 2018, the number of deferred tons was reduced to zero (0) and the budgeted tons for the system per day has been steadily increasing (600 in 2017 to 650 in 2018 to 682 in 2019 and 730 in 2020). A full cost analysis has yet to be completed because a full G-Vault™ rebuild has not yet been needed. However, with the elimination of maintenance costs and the proven increase in production the cost of switching was justified.

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10. Barrick is a registered trademark of Barrick Gold Corporation Canada 161 Bay Street, Suite 3700 Toronto, Ontario Canada M5J2S1