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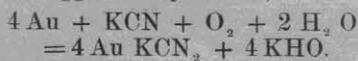
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DESCRIPTION OF THE CYANIDE PROCESS AT THE NEW GOLDEN GATE GOLD MINING COMPANY, MATHINNA.

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CHEMISTRY OF THE PROCESS.

THE fact that gold is soluble in a solution of an alkaline cyanide has been known to chemists for a considerable period, but it is only of late years that this knowledge has been brought into daily use for the saving of gold on a commercial scale. The actual chemical reaction that occurs is not exactly known. The reaction accepted by chemists is one suggested by Elsner, viz.—



The principal methods of precipitating gold from a solution of cyanide are by the use of (1) zinc shavings; (2) charcoal; (3) the Siemens-Halske process, in which sheets of lead and iron are alternately placed in the extractor boxes, and the whole connected with a dynamo. The action of the electric current from the dynamo precipitates the gold on to the lead, the iron going into solution.

The method principally used is that of precipitation with zinc shavings. Cyanide having more affinity for zinc than gold, the zinc replaces the gold in solution, the latter forming a black slimy material. This reaction is represented by the equation—



Charcoal, as a precipitant, is also largely used in these Colonies.

When the plant working at this mine was first erected, a charcoal-precipitating plant was also placed in; but it was found that the charcoal in this district was not suitable, a great percentage being of very little use on account of its hardness. This plant was then replaced by the zinc-extractors, which are still in use.

To precipitate the gold from solution, the solution must contain free cyanide. In this plant I find the best precipitating solution is one whose strength varies from .15 to .18 per cent. If the strength fall much below this, the zinc shavings get covered with a white substance, which, I believe, is a form of cyanide of zinc. This substance can be removed by slightly strengthening the solution before it enters the zinc-extractors.

GENERAL DESCRIPTION OF PLANTS AT THE NEW GOLDEN GATE.

There are, or will be, shortly, three plants at work on this company's property viz., the No. 1 or battery-plant; the No. 2 plant, treating a heap of accumulated tailings; the No. 3, or slime-plant, to treat the slimes coming from the battery, and also an accumulated heap.

The No. 1 Plant.

This plant was erected in 1897, commencing work in August of that year, but for some months without success. It has a treating capacity of 400 tons per week, and consists of twelve Oregon pine vats of different sizes, arranged as follows:—Top row, or distributing vats, consisting of four vats, each 26 feet in diameter and six feet deep. Staves and bottoms of vats are 12 inches wide by three inches thick. Each vat is strengthened with five hoops of one-

inch round iron, made in four pieces, and joined with cast-iron strainers. Each vat is fitted with a filter-bottom, made as follows:—Lengths of hardwood, 4 by 2, are laid parallel on the two-inch edge on the bottom of the vat, about 12 inches apart. The underside of each of these pieces has circular cuts taken out at regular intervals to allow free circulation on the bottom. Across these pieces are placed 8 by 1 boards almost side by side, the faces being bored with one-inch holes at regular intervals. Over these boards coir matting is stretched, and, on the matting, 3 by 1 battens are laid three inches apart. These battens are to keep the matting in its place, and also to protect it when the vat is being emptied. The vats are emptied through cast-iron side-doors, large enough to allow the passage of a half-ton truck. These doors are bolted to cast-iron frames, which are bolted through the sides of the vats, a strip of packing between the door and the frame making this water-tight. The tailings flow into the vat through a Butter's distributor fixed over the centre of the vat. The overflow of water and slimes is taken off from three sides of the vat, the latter being finally drained dry through a pipe under the false bottom.

Each vat is erected on nine brick piers, four feet square. These carry six 12 by 9 Oregon pine bearers 14 feet long. On the bearers are 9 by 3 joists, on their edge, carrying the vat. Immediately in front, parallel to and lower than these distributing vats, are four leaching vats. These are exactly similar to the distributing vats, with the exception, of course, of the overflow and distributors.

In front of the leaching vats, and below them, is a small vat, eight feet in diameter and four feet deep. This is the intermediate vat: into it are led the drain-pipes from the leaching vats. It is used as a settler for any slime, &c., that may come through with the solutions. The outlet pipe from the intermediate is carried up inside from the bottom of the vat to nine inches of the top. By this means the vat is always full, and a regular pressure maintained through the extractors.

Next in order to the intermediate vat the extractor-boxes are placed. There are four boxes for each of the two sand plants and one for the slime plant. These are pine boxes, each 11 feet long, two feet wide, and two feet deep. Each box is divided into five compartments, by double partitions, in such a manner that the solution is forced to flow down between the partitions and up through each compartment. The zinc shavings are placed on iron mesh-trays, about seven inches from the bottom of the boxes. The solution flowing up through each compartment has to pass through the shavings, making the contact as perfect as possible.

Next to the extractors are the solution sumps. These are three in number, three-inch Oregon pine, 20 feet diameter, and five feet deep, and are placed below the extractors to allow the solutions, after passing the extractors, to gravitate into them. These sumps contain different strength solutions, No. 1 the first or strongest, No. 2 a weaker solution, and No. 3 the water-wash. These solutions are pumped from the sumps to the leaching-vats, through a three-inch cast-iron pipe, by a double-cylinder Worthington cyanide pump.

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Method of Working No. 1 Plant.

The tailings crushed in the battery, through a 200-hole grating, are passed over frue vanners: then flow to an 16-inch plunger-pole, which forces them to the distributing vats. When about 90 tons have settled in one vat the flow is turned into the next in order. The vat filled is allowed to drain dry through the filter-bottom, and is then emptied into the leaching vat immediately in front. Tailings settling in water are too compact to allow good percolation: the breaking up caused by tipping into another vat allows the solutions to percolate freely, the expense of removing the tailings being more than covered by the higher extraction gained. The leaching vat being filled and levelled, the first solution is pumped on. This solution has a strength of .28 per cent. cyanide. This is allowed to stand on for 24 hours, then the drain-pipes are opened and the solution drawn off through the zinc shavings, then flowing back into No. 1 sump. Quantity of first solution is 33 short tons, and the time taken to run completely off averages 13 hours. When run dry a second solution from No. 2 sump is pumped on. Strength of this solution varies from .15 to .17 per cent. This solution is kept percolating fairly fast for 12 hours; weight of solution used 34 tons. After the second solution has all passed through the zinc, a water-wash is pumped on to wash out final traces of cyanide. When the tailings have drained the doors are taken off, and the leached tailings trucked out over the tip. Average assay of tailings before leaching is 2 dwts. 4 grs. per ton, and, after leaching, 12 grs. per ton, or almost 77 per cent. extraction. When the first solution is drawn off it has lost a trifle of its volume and 38 per cent. of its strength. The loss in volume is made up with the first part of the second solution, it being, in turn, made up with the first part of the water-wash, which always carries a little cyanide: the quantity of solution in use by these means always remaining the same. The loss in strength is made up by adding potassium cyanide, the quantity of this salt so used being a little under one pound weight for every ton treated. The strength of the second solution remains constant, gaining sufficient cyanide from the remains of the first solution left in the tailings to keep it so.

The No. 2 Plant.

This plant was erected at the beginning of the present year to treat a large quantity of tailings which accumulated previous to the No. 1 plant starting to work. This plant consists of four leaching-vats, Oregon pine, three inches thick, 27 feet 6 inches in diameter, and six feet deep, fitted with filter-bottoms, drain-pipes, strengthening hoops, and side discharge-doors, similar to the No. 1 plant. Each of these vats hold 100 tons of tailings, and the 40 tons of solution required to cover them. The vats are each erected on seven stone piers, carrying 12 by 12 Oregon pine bearers, 9 by 3 joists taking up the bottom of the vat. The drain-pipes lead to an intermediate vat, similar in size, &c., to that used in the No. 1 plant; then follow the zinc-extractors, similar also in size and number to the No. 1 plant. Last of all, the three solution sumps, 20 feet diameter and six feet deep.

The tailings are drawn up to the leaching vats in trucks, holding slightly under one half-ton, over an incline tramway, by means of a double six-inch cylinder-winch, driven with compressed air. These tailings having been exposed to the weather for some time, a small amount of free sulphuric acid, ferrous sulphate, and ferric sulphate has been formed from the sulphides escaping the concentrators. It is found necessary to give these tailings a preliminary treatment before the leaching proper. This is done by adding lime to the tailings, or, sometimes, a caustic soda-wash; after this the treatment takes the same form as in

No. 1 plant, with the exception that as we use a greater quantity of solution we can use a correspondingly weaker solution, quantity of cyanide used being a little over one pound weight per ton of tailings treated. The average assay value of the whole of the heap is 2 dwts. 12 grs. per ton; but there is a large quantity of slimes, assaying over 4 dwts. per ton, which cannot be treated by ordinary percolation. This reduces the value of the tailings suitable for treatment to 2 dwts. 4 grs. per ton, out of which we get an extraction of 70 per cent.

The No. 3 or Slime Plant.

In the overflow from the No. 1 plant distributing vats there are carried away about 27 tons of slimes per week, and during the time the mine has been working several thousand tons of these slimes have accumulated. This material cannot be treated by ordinary percolation, the slimes being impervious to the solution. To effect contact of the gold and solution, the slimes and solution have to be agitated for some hours; the slimes are then allowed to settle, and the solution is decanted off from the slimes.

The slime plant is now in course of erection, so no working results can yet be given. The slimes average assay value is $4\frac{1}{2}$ dwts. per ton, and, by experiment, an extraction of 3 dwts. per ton has been obtained. Slime gold is very fine, and, therefore, easily dissolved by a solution of cyanide; and I have no doubt that, with better means of agitation than already tried, a larger extraction can be obtained. I hope to be able to prove this within the next few months.

The Clean-up.

The zinc-extractors are cleaned up every fourth week. The zinc shavings which are discoloured with gold slime are taken out and rubbed to wash off any loose-adhering slime: the solution is then syphoned out of the extractors to within a few inches from the bottom. The gold-slimes, which have fallen through the mesh-tray are then washed through an inch-pipe, let into the bottom of the box, into a launder, and thence into a tub. The slimes are allowed to settle in this tub, the solution decanted off, and the slimes taken out and dried in camp-ovens. These dry slimes are placed in a large iron tray, about six inches deep, a little nitre added, and are roasted for about two hours over a wood fire to oxidise the zinc. The oxidised slimes are then fluxed with borax, soda, and sand, and fused in salamander crucibles. The resulting bullion is worth from £2 17s. to £3 3s. per ounce.

Since the cyanide process was started at this mine bullion, valued at over £15,000, has been won by its use, being equal to 6s. 11 $\frac{1}{2}$ d. per ton of tailings treated, at a cost of a fraction over 3s. per ton of tailings. The quantity of zinc used varies a good deal from month to month. Average cost of zinc per ton of tailings treated being 1-38d.

Experiments on Cyaniding Pyrites.

The tailings at this mine pass over concentrators after leaving the battery. Samples of the pyrites obtained were taken and treated with solutions of cyanide for a period extending over five days. The average assay value of the samples was a little over five ounces per ton, and, after treatment, the residues contained nearly two ounces per ton. This experiment was tried to prove whether concentration before cyanide was profitable. Taking into consideration the extra time and cyanide required to treat these sulphides, and the value of the residues, I believe that it is more profitable to concentrate before cyaniding.

Mathinna, 15th November, 1899.