1903

Cyanide practice

John A. Rogers

"C Y A N I D E P R A C T I C E."

SONORA CYANIDE WORKS,

SONORA, MEXICO.

MARCH 3rd., 1903.

The ENCINO CYANIDE PLANT was erected for the treatment of old accumulated tailings, which were worked by the "Patio" and "Cazo" processes.

As with most accumulated tailings, which have been exposed to the action of the air for a considerable period, they have undergone changes, whereby, forming compounds which are highly detrimental to a solution of Potassium Cyanide and the direct cause of the present high consumption of Cyanide.

The tailing contain the decomposition products of iron pyrites, which consist of free Sulphuric Acid and insoluble basic iron salts.

There is also a considerable quantity of Organic matter; this, however is contained in earthy matter diseminated through the tailing.

This earthy matter contains about 14% of Organic matter, the most of which finds its way into the leaching tanks, as it is impossible to separate it from the tailings, and is another factor in Cyanide consumption.

Sufficient lime in the form of powder is mixed through the charge to neutralize these products and to keep the solution alkaline to protect it from the Carbonic Acid Gas of the air; but a considerable saving in Cyanide would be effected if it were possible to use an alkaline wash, instead of mixing the lime through the charge; but owing to the scarcity of water, it is impossible to apply an alkaline wash.

-- THE PLANT.--

This consists of (6) six leaching tanks; each(15) fifteen meters long, (10) ten meters wide, and one meter deep, (inside measure), having a capacity of (150) one hundred and fifty tons each.

The filter-bed is (3)" three inches deep, covered with cocoa-nut matting and ixtle, upon which are layed wooden strips (1") one inch square, (8") eight inches apart to protect the filter from the shovels in discharging.

Two solution tanks where the potassium Cyanide is disolved. Each (10) ten meters long (4-1/2) four and a-half meters wide, and two meters dep. - Capacity, (90) ninety tons of solution.

Two intermediate tanks, where the solution from the leaching

anks is allowed to settle before entering the precipitating boxes.

These tanks have a capacity of (50) fifty tons each. and are (10) ten meters long, (5) five meters wide, and one meter deep .

Two precipitating boxes,(4-1/2) four and one-half meters long, (1/2) one-half meters wide and (70) seventy centimeters deep.

Each box is divided into (5) five compartments (75) seventy five centimeters long, (50) fifty centimeters wide, and (70) seventy centimeters deep, holding (100 lbs.) one hundred pounds of Zinc shavings each.

One Sump to store the solution after passing through the precipitating boxes. - It is (10) ten meters long, (1-1/2) one and one-half meters deep and (5) five meters wide. - Capacity(75) seventy-five tons of solution.

Two pumps for handling the solutions

Engine and Boiler.

Lathe for turning the Zinc shavings.

Rails for train and cars; 410 meters of pipe and connections.

Assay Office,

Laboratory and

Melting Room.

- CONSTRUCTION OF TANKS.-

The leaching tanks are built in excavations, their tops being about a foot above the surface of the ground.

The foundation extends down to the solid rock, which is only about (6) six feet below the surface.

The foundation is of stone and mortar, with a coating of cement and painted with asphaltum.

The side are (2) two feet thick, of stone and mortar, a coating of cement and painted.

The solution tanks, the bottom of which is (1) one foot above the top of the leaching tanks, are built of solid masonry, up to that point. The sides are two(2) feet thick; the whole tank being coated with cement and painted with asphaltum.

Intermediate tanks.. The tops are (6) six inches below the bottom of leaching tanks. Are built of Stone, mortar, cement, and painted.

The precipitating boxes: - Are constructed of wood (3") three inches thick, and held together by iron rods. Each box is divided into (5) five compartments, by means of partitions and baffele boards; the baffle board racks to within (2)" two inches of the bottom of the box. This causes the solution, on entering the precipitating boxes, to pass upward through the Zinc, depositing the Gold and Silver upon the under side of the Zinc shavings.

The Zinc shavings are held on a tray (4)" four inches above the bottom of the box. - These tray being inside of a 24 mesh screen.

The Sump tanks is contained in an excavation in the rock, but owing to the porous nature of the rock, it was necessary to build the tank of stone and mortar, cement, and paint it.

---METHOD OF TREATMENT.----

Before entering the leaching tanks, the tailings are sorted, making two products:-

Sands and Slimes.

The object being to obtain a product that will permit of perculation.

If the Slimes were charged into tanks by themselves, it would be impossible to treat them by this method, but the sorting out the sands, and mixing them in the proportion of (3) three parts Sand and (2) two parts Slimes, we obtain a product that will leach about its weight in solution and wash water in eight days.

These (3 lbs.) three pounds of lime, per ton of tailings, is thoroughly mixed through the charge.

The tank is fitted to the top, leveled off, and a strong solution of Potassium Cyanide run xxxx in from below the filter. (upward perculation)

This first solution centains 0.30% (three-tenths of one per-cent) of Cyanide, and is allowed to remain in contacts with the charge for a period of (24) twenty four hours, when it is drained off. As the solution sinks into the charge, the surface is allowed to remain clear of any solution for about (3) three hours.

During this period, air is drawn down into the charge , and provides the necessary oxygen for the solution of the Gold..

More solution is now run at the top of the charge and the air which has been drown down into the charge escapes through the drainage pipe or bubbles up to the surface.

This is continued untill about (85) eighty five per cent of the weight of charge in solution has been applied, wash wetter, equal to about (15) fifteen perfent of the weight of the charge is put on.

The charge is now allowed to drain, and the tank discharged.

The total time required for charging, treating and discharging, is (10) days.

This long time of treatment is necessitated by the poor leaching quality of the material treated.

USE OF SLACKED LIME Ca. $(OH)_2$.

Lime is mixed with the tailings to protect the Cyanide solution from atmospheric Carbon Dioxide, free sulphuric acid, and Organic Matter.

The Carbonic Acid Gas of the air, decomposes Cyanide of Potassium, forming Potassium Carbonate, and liberating Hydro-Cyanic Acid. This Hydro-Cyanic acid would be lost if it were not for the lime in solution it combines with it, forming Cyanide of Calcium, which is as good a solution for Gold and Silver, as Cyanide of Potassium.

Cyanide of Patassium is decomposed by Sulphuric Acid, forming Potassium Sulphite, With the liberating of Hydro-Cyanic Acid.

The object of the Lime is to neutralize the free Sulphuric Acid.

- SAMPLING THE CHARGE.-

Accurate sampling is very essential in order to make the actual and theratical extraction come very near each other.

In charging the tank, a shovel-full is taken from each carload.

In discharging, cars are taken from top to bottom of charge in several places.

Four (4) to (8) eight assay tons are taken for the assay.

It is possible some times to obtain a sample of the discharge residues that will show higher values than the charge, before treatment.

This, however, is not due to any faulty manipulations of the solution or imperfect washing, but is due to an uneven distribution of lime through the charge and the solution upon entering such spots looses its alkalinity, and if tested will show an acid reaction.

As the plant solution is a cupriferous, on becoming acid, the Gold and Silver is precipitated, which accounts for the rich samples sometimes obtained from the discharge residue.

The precipitated Gold and Silver, is slightly soluble in potassium cyanide; but once precipitated in the charge, is very difficulty to recover consequently it is of the utmost importance to have the lime thoroughly mixed through the charge where you have a cupriferous solution.

- The COPPER SOLUTION. -

It is possible, but hot profitable, to remove the Copper from the solution.

This can be accomplished by coating the Zink shaving with lead from a solutio of Lead-Acetate, and adding Amonia Hydrate to the plant solution; but as the solution is already alkaline from use of lime, which cannot be discarded, the addition of a small percent of Amonia Hydrate, would add a great surplus of Alkali to the solution, which will cause an immense consumption of Zinc, and the danger of forming Sulphides with the

with the sulphurs of the Ore, which would decrease the percentage of extraction of the Silver and increase the Cyanide consumption.

---- RECOVERY OF THE GOLD AND SILVER. --

The solution from the leaching tanks containing the Gold and Silver after settling in the intermediate tanks, pass through the precipitating boxes, depositing the Gold and Silver upon the Zinc shavings.

The method of knowing if proper precipitation is taking place, is to assay the sump solution regularly.

Method of assaying the solution is: - Measure out 300 C.C. into a beaker and add about 50 C.C. (5 C.C.) of Sulphuric or hydrochloric acid and stir well; allow the precipitate to settle; decant the solution and collect the residue on a filter paper, wash with warm water to remove acid, bur the filter paper and scorify. - It is not necessary to add any copper sulphate, as the solution already contains sufficient copper.

The total amount of solution passing through the precipitating is seventy five (75) tons per twenty four (24) hours.

The total amount of Zinc in the boxes is about one thousand pounds.

The precipitation of the Gold and Silver takes place principally in the first two compartments, which is demonstrated by the following sample experiment:-

	GOLD.	SILVER.	TOTAL.
Value of one ton of Solution	$5.00	$4.80	$10.00
" after passing 70 C.M. of Zinc	1.80	1.20	3.00
" " " 140 " " "	0.60	0.40	1.00
" " " 210 " " "	0.24	0.10	0.34
" " " 280 " " "	0.18	trace	0.18
" " " 350 " " "	0.12	"	0.12

From the above table we have an extraction of 99% of the Gold and Silver. One percent (1%) passing off into the sump. - This, however is not all lost, as the solution is never allowed run to wash; but is used over and over.

THE CLEAN UP. ----

This takes place twice per month.

The flow of solution into the precipitating boxes is stopped, the Zinc removed from the first box, which is filled with water and a sieve of 30 mesh placed in the box.

The Zinc is now placed on the sieve in small bunches, and thoroughly washed to remove as much of the adhering Gold and Silver as possible. What remains on the sieve, is placed into boards to prevent axidozation. After all the Zinc has been washed in this way, the stop-cocks in the bottom of the boxes are opened and the Slimes washed out into a wooden launder, which carry them into a small tank, when they are allowed to settle. - The clear liquid is then removed into wooden tubes, where they are treated with crude Sulphuric Acid, - To remove the Zinc.

They are then washed with water to remove the acid ~~charged~~ dryed at a red heat, pulverized and smelted.

----- SMELTING THE PRODUCT.----

This is done in a wind or crucible furnace, built of adobe and lined with fire brick. Coke being used for fuel.

The charge, which consists of:-

Slimes	50 parts.	
Borax	20 "	
Soda	12 "	(B.Carhonate of)
Saud.	12 "	

is charged into No. 45 Plumbago crucibles.

When liquid, the contents of the crucible, is poured into conical-shaped Moulds which have been heated. The small pieces of bullion obtained are afterwards melted together.

The bullion obtained this way, averages 965 fine, and is sold to the Mexico Mint at San Luis Potosi, Mexico.

The slags from this operation contain considerable Gold in the form of beads, are crushed and panned to recover the gold, which is again smelted with a small addition of fluve.

---- COST OF PLANT.----

Eleven (11) Tank ----------	$44.00
Precipitating	1.60
Pumps, 2	10.00
Engine and Boiler	10.00
Cars - 6	6.00
Rails	2.00
Pipe & fittings	5.00
Filters for tanks	3.00
Total-------	$81.60

Cost of tanks include material and labor; the stone costing only the hauling about a quarter-of-a-mile. - Lime at $7.00 (seven dollars) per ton. - Asphaltum at $100.00 per ton . A crude product mined near Tampico, Mexico.

Mexican labor at 31¢, and stone masons at 50¢.

The above prices are in Mexican Silver.

--- COST OF TREATMENT, PER TON OF TAILINGS.---

For Cyanide, four (4) punds per ton-----	$2.50
" For charging ----------	0.06
" discharging ----------	0.08
To prepare the material----------	0.10
Zinc ----------	0.22
	.75
	$20.76

--- LABORATORY EXPERIMENTS.---

Table No. 1.-

TO DETERMINE THE MOST ECONOMIC STRENGHT OF SOLUTION.

No.	percent Key.	No. of C.C.Solution.	Grammes Ore	Assay Value of tailing. AN.	Ag.	total	Assay of Residue An.	Ag.	total	Extraction An.	Ag.
L	.05%	100	100	$5.-	$4.-	$9.00	$4.-	$4.-	$8.-	20	00
2	.10%	"	"	"	"	"	1.50	3.12	"	70	24
3	/15%	"	"	"	"	"	"	2.63	"	70	36
4	.20%	"	"	"	"	"	"	2.30	"	"	44
5	.25%	"	"	"	"	"	"	2.05	"	"	50
6	.30%	"	"	"	"	"	"	1.64	"	"	60
7	.35%	"	"	"	"	"	"	1.64	"	"	60
8	.40%	"	"	"	"	"	"	1.64	"	"	60
9	.45%	"	"	"	"	"	"	1.64	"	"	60
10	.50	"	"	"	"	"	"	1.64	"	"	60

From Table No. 1, a solution of 0.30% Potasium Cyanide, appears the most economic, although of 0.4%,0.5% and 0.15% were tried on a large scale, abounded in favor of the 0.3%/ the .0.4% and the 0.5% because of an increase in Cyanide consumption and no increase in estraction.

The 0.15% because it required too long a time to get the same extraction as obtained in (10) ten days, using A. 0.3-9/0 Solution.

TABLE NO. 2.-

---- TIME REQUIRED TO DISOLVE THE GOLD AND SILVER.---

No.	Agitated. No. of hours.	Extraction. An.	Ag.
1	1	60%	30%
2	2	78%	64%
3	3	78%	72%
4	4	78%	72%
5	6	78%	72%
6	10	78%	72%
7	14	78%	72%
8	20	78%	72%
9	30	78%	72%
10	60	78%	72%

%

TABLE NO. 3.-

SIZE OF MATERIAL BEST ADAPTED.-

No.	Mesh	Extraction. An.	Ag.
1	100	93%	86%
2	90	93%	84%
3	80	93%	84%
4	60	89%	83%
5	50	80%	76%
6	40	68%	52%
7	30	51%	40%
8	24	42%	32%
9	20	28%	16%
10	16	24%	14%

From table no. 3 it is evident that with all the material crushed to 90 mesh, which would necessitate agitation, an increase in extraction could be obtained.

And from table No. 2, we see that it only requires about (2) two hours to effect a solution of the Gold and Silver. This would mean a big Saving in the time required to treat a charge, which would mean an increased Capacity of the plant, and no doubt a big saving in Cyanide, as the same amount of solution woul not be exposed to the action of the Carbonic Acid gas of the air for such a long time, and would not pass through the Zinc boxes so often.

Thesis for the Degree of
Mining Engineer.
J. Rogers Beede 1897