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(No 63.)

DESCRIPTION OF THE TREATMENT OF TAILINGS BY THE NEW PINAFORE GOLD MINING COMPANY, LEFROY.

By J. T. Stubs, *General Mine Manager.*

The heap of tailings and slimes undergoing treatment by the cyanide method at the above company's battery is the result of some 22 years' crushing at the 40-head battery originally built by the New Native Youth Gold Mining Company, and now the property of the above company.

Had the whole of the tailings been saved, it would have meant something more than 120,000 tons, but in the early days, and up to a very few years ago, tailings were looked upon as an encumbrance, and it was only with a view to conserving the water for the use of battery in dry weather that the tailings were pumped up into a large dam, and the water used over again. When water was plentiful, everything was washed into the creek, which meant a saving of pumping tailings, and of a labourer to look after the sand dam. The result is a heap of about 30,000 tons, 20,000 tons of which may be termed suitable for the percolation system of treatment. The company has now been successfully treating these since 3rd March, 1897, and, thanks to the cyanide method, has been enabled to do a considerable amount of prospecting at the mine from the profits derived therefrom. Every mine in the district which has produced quartz has contributed its quota of tailings, so that it may be termed a fair average sample of the tailings from the field. It was by no means an ideal heap for the process, but, on the contrary, was considered by many experts as quite unsuitable. However, after meeting with numerous obstacles in the preliminary tests, the results were sufficiently good to warrant the erection of a small plant, which has turned out quite as well as it was anticipated it would do.

The plant at present consists of 3 steel vats, 16′ diameter x 4′ deep, 1 wooden vat, 20′ x 5′, and 2 wooden vats, 18′ x 4′ and 15′ x 5′ respectively. These two latter were erected in the first place as an agitating plant for the treatment of slimes, but, not proving successful, were turned into leaching vats for tailings. There are also 3 sumps and 2 solution vats, the whole of which were constructed out of old condemned boilers from the mine and battery. The method of making was by separating the flue from shell and closing each of the ends with bricks and cement. The interior and exterior were then given a good coating of lime (applied hot), the result being an everlasting tank, free from leaks and loss of gold-bearing solution, which cannot always be said of wooden vats. A 12 h.p. portable engine is used for hauling the sand up to vats, and for working a centrifugal pump for pumping solutions to storage tank; and two small steam-ejectors are used to supply solution for filters. A large trommel, worked by a donkey engine, is used for screening sand and mixing lime therewith before treatment in the vats. The precipitation plant consists of 33 charcoal filters, of about 4 cubic ft. capacity each. The charcoal is prepared by passing it through a charcoal crusher at the mine, and a reverberatory furnace 12′ x 4′ is used for reducing it to an ash. Two smelting furnaces, and a well-equipped assay office complete the plant.

The treatment consists of *1st, Preliminary*, or *making the tailings suitable for subsequent cyaniding*. This is effected as follows :—The tailings are trucked up together, with a certain proportion of slimes, according to fineness, and deposited on the feeding-floor of a large trommel fitted with grating, ½-inch mesh. A certain quantity of slacked lime is then added to each truck-load, (the amount of lime necessary is determined previously by a laboratory test.) The mixture is then fed into trommel by a boy, and the sand and slimes passing through the screen being very intimately mixed with the lime, are trucked up an incline tramway and dumped into the percolating vats. Different systems have been tried for this preliminary treatment, with more or less success. 1st. The tailings were, after screening through standing screens, trucked direct from heap into the leaching vats, and subjected to a water-wash to eliminate the acid and soluble iron salts, after which a very strong solution of caustic soda was passed through to neutralise any acid that may be left. Results not at all satisfactory, owing to great length of time and excess of caustic soda required. 2nd. The tailings were screened as before, and on each truck being tipped into the vats, the necessary amount of lime was added, and mixed as well as possible, by boys, in the vats. This method was an improvement on the caustic soda, but results were not always satisfactory, as occasionally the K.Cy. solutions would come off blue, caused through imperfect mixing with the lime, and portions of the solution coming in contact with the acid tailings. This, of course, meant total loss of cyanide, and, consequently, poor extraction. 3rd. Wash-pits, or boxes, capable of holding about 30 tons of sand were constructed. These were fitted with a hopper at the head, and the sand fed into it with a plentiful supply of water. Stops were put in at the tail of the box, similar to a Cornish tye, until it was full. The acid-water and slimes in suspension were passed over canvas tables, and there concentrated for treatment by chlorine. When thoroughly drained down, the sand was trucked up to the vats, as before, when the lime, which was now reduced by more than one-half, was added, as before. This method eliminated 60 per cent. of the acid and soluble iron salts, and was used for a considerable time with great success until scarcity of water compelled the management to adopt other methods. Against its adoption may be quoted the fact that only 80 per cent. of the tailings and slimes fed into the hopper was trucked into leaching vats, the remaining 20 per cent. going away as slimes in suspension. The assay value, after washing, was not increased in proportion, and although some of the gold was caught on the canvas trays in the form of concentrates, the final residues were too high in gold to be termed a complete success. In conjunction with this method an agitation plant was erected with a view of dealing with the slimes, but after many trials, without success, it was abandoned. It, however, may eventually be resorted to.

After being dumped into the leaching vats the sand goes through the usual process of cyaniding, the solutions in use varying from ·2 per cent. K.Cy. to a mere trace of K.Cy., followed with a final water-wash to keep the quantity in use constant. The consumption of cyanide is heavier than is usually the case, owing to the fact of the tailings containing antimony (in the form of stibnite) and copper. Practice and repeated experiments have proved that the stronger the working solutions are made, the

greater the consumption of cyanide, without being attended with a better extraction. It has also been found that the fine slime is much heavier in the consumption of K.Cy. than the coarse tailings. This, I think, is due to the fact that a much greater percentage of fine mineral, especially stibnite, is present in the slimes, and as a proof that copper is present it is only necessary to plunge a pocket-knife into some of the lower seams of tailings, when it immediately becomes coated with metallic copper. The presence of this latter objectionable metal rendered the precipitation of the gold by means of zinc very unsatisfactory in the small tests made in the experimental plant. The precipitation was all that could be desired for a time, but the exceedingly weak solutions passing through the zinc-box caused the copper to be precipitated, after which the solutions were found to contain as much gold after passing through as before going on. Charcoal was then tried, and found to give excellent results, and, in consequence, it was decided to use that agent as a precipitant. With reference to the respective claims of the two precipitants, I would here like to state that there can be no doubt whatever that zinc is admirably suited for clean and sweet tailings free from copper, and has then certain advantages over charcoal. The smaller plant required in the first place, and the smaller amount of trouble in collecting the gold, are arguments that are certainly in its favour. On the other hand, charcoal is suitable for all sorts and conditions of solutions, whether acid or alkaline, with or without copper, and it always leaves the solution in a sweet condition, provided always that the filters are properly attended to, and not allowed to run too long. Experiments have been made with the solutions zinc *v.* charcoal, with the result that the charcoal has been equally successful with strong and weak, clear, and blue solutions, while the zinc has always done good work with strong solutions; but with weak solutions containing copper, or at all acid, it has been a failure, and what has proved a success may easily have been a failure if zinc had been used instead of charcoal in this case. When working full time 40 filters are burnt down per month, resulting in about 80 lbs. ash, which is mixed with suitable fluxes, and smelted in No. 16 Salamander crucibles, the resulting gold being about 900 fine.

When the tailings were comparatively free from slimes the total time of treatment was four days, from time of filling each vat until it was sluiced out into the creek. Now that the percentage of slime is large, one vat is filled and one emptied every day, Sundays excepted. This gives seven days' treatment, with comparatively weak solutions. Actual results in the shape of gold recovered do not always tally with the theoretical extraction, for which many reasons can be adduced—1st. Having no system of weighing each truck the weight is only approximate, added to which the moisture in the tailings varies according to the weather (wet or dry). 2nd. Loss of solution by leakages and insufficient water-wash. 3rd. Losses in burning charcoal in the furnace. This is proved by assaying the soot from smoke issuing from the port-holes, which is always rich in gold, carrying as much as 90 ozs. per ton. 4th. Losses in smelting the ash, in the form of fine dust carried off by the draught into the flues, assays from the sides of which have shown over 20 ozs. gold per ton, and losses in the slag treated after melting down. At the above works the slags and worn out crucibles are ground up with mercury in a berdan, and the residues saved for further treatment, the amalgam obtained being retorted and smelted as usual. Experiments have been made with the charcoal ash with a view to treating it more expeditiously and cheaply than by smelting. It was found that 66 per cent. of the gold was very easily recovered by amalgamation, but the remaining 34 per cent. was obstinately retained by the ash in spite of the amalgamating process being continued for a great length of time.

By agitating with a strong solution of K.Cy., the gold is easily redissolved, but it takes considerable time to wash all the gold from the ash, and similar treatment by chlorine is attended with like results. To test the efficiency of charcoal for precipitating, a small filter, containing 2 cubic feet of charcoal, was slowly fed with rich solution of K.Cy., and samples assayed from time to time, until it ceased to precipitate any more gold. The charcoal was then burnt down, and the ash smelted for 14 ozs. gold, over 900 fine.

Agitation Plant.—The small plant erected for the treatment of slimes beforementioned, consisted of a vat 18′ × 4′, fitted with stirrers, which were set in motion by an overhead pulley, driven by means of an endless wire rope connected with a small donkey engine. The slimes direct from sand heap were fed into this, and enough water added to make it of the consistency of gruel. Lime was then added, until a strong alkaline reaction was observed on testing with litmus paper. The stirrers were then lifted out of slimes, and the whole allowed to settle, when the excess of water was drawn off the top by means of a hose attached to a float. A weak solution of cyanide was then added, and the stirrers again set in motion, and the agitation continued until the gold was dissolved, after which the stirrers were again lifted out, and solution, when clear, decanted from the top, as before. Water was then added and the same process repeated, after which the whole of the contents of the vat were sluiced into the creek. The solutions were passed over charcoal filters in the usual way. This method was fairly successful with slimes of fair quality, say 6 dwts., but when tried with slimes assaying 3 dwts. 6 grs. was found too slow and costly. The acid nature of the slimes may be imagined when as much as 45 lbs. of lime per ton were required to give a faint alkaline reaction.

The quantity of tailings and slimes treated to date is 14,478 tons, for a yield of 2302 ozs. 7 dwts. gold, value approximately, £8748. The assay value, before treatment, has averaged 4 dwts. 21 grs. per ton, and the residues 1 dwt. 12 grs. per ton, the actual extraction being 3 dwts. 4.3 grs. per ton, the difference between actual and theoretical extraction being accounted for as above. The cost of treatment, when in full work, is 4*s.* 9*d.* per ton, and the capacity of the plant, when treating clean tailings, is 900 tons per month. The amount being treated at present, however, is about 600 tons per month. This is due to the fact that a greater percentage of slimes is now being worked up with the free leaching tailings. The erection of the plant, preliminary experiments, and subsequent working of the process have been under the immediate supervision of General Mine Manager (Mr. J. T. Stubs), who was very ably assisted by the Battery Manager (the late Mr. W. H. Stubs), who had full charge of the plant until the time of his regretted death, since which the work has devolved on the General Mine Manager.

Lefroy, December 16th, 1899.

Photo-Algraphy Process.

NEW PINAFORE GOLD MINE, LEFROY