10th May, 1894.

SOME IMPROVEMENTS IN TREATING MINERALS FOR THE WET EXTRACTION OF GOLD AND SILVER.

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The question of the most profitable means of winning Gold and Silver from the various ores in which they are found is one possessing an extensive literature of its own. The author's intention in this Paper is to draw attention to some details in one department or branch of the subject—a branch that has been growing steadily in importance of late years, and one which is destined in his opinion to be largely employed, viz., the wet extraction of Gold and Silver. Here in Australia comparatively little has been done (with the exception of Mount Morgan Gold Mines, where chlorination was exclusively used to dissolve out the Gold from the ore) towards extending the use of wet methods of Gold and Silver extraction. These methods departing entirely from the use of Quicksilver Amalgamation for the recovery of Gold and Silver, were based upon the action of one or more chemical re-agents dissolving the wished-for Gold or Silver. The watery solution thus obtained was filtered off from the ore originally containing these metals. When that point was successfully attained, the ultimate recovery of the Gold or Silver, as the case might be, was a very easy task. One of the main reasons why more attention to the wet extraction of these metals had not been given, was due to the long time that had hitherto been required to complete the circle of operations—a time sufficiently long to necessitate the employment of much plant, besides other inconveniences.

Chief amongst these difficulties had been the slow speed at which filtration of the solutions from the ore took place, after the Gold and Silver had been dissolved. This drawback was common to all methods of dissolving, whether Chlorine or Cyanide of Potassium were used for the extraction of Gold, or Hyposulphite of Soda for the dissolving of Silver. Taking Gold as the most important metal, we as chemists, were familiar with existing and satisfactory working methods of dissolving it out from its matrix—methods yielding up to 98 per cent. of the total Gold contained in the ore operated on. Chlorination, and even the, in some cases, despised wet method known as the "Cyanide Process" (a method, by the way, first described in 1844 by Prince Peter Bagration) attained these results on a working scale.

As a commercial question, it was not the dissolving of the Gold or Silver that gave trouble, but it was the filtering the solution off from the ores and the subsequent washing out of the last traces of dissolved metal from the ore under treatment that were the drawbacks. In some instances that difficulty was so pronounced as to entirely prevent profitable work being done; in short, the mechanical part of the process stood most in need of improvement, and not the chemistry of the operations. From time to time various endeavours had been made to hasten the filtration by adopting artificial pressure. Filter presses had been used, hydraulic pumps employed, compressed air had been applied, and also suction to the bottom of the filter beds, but only with qualified benefit. In all these endeavours so far (and due largely to the more or less corrosive nature of the chemicals that had to be employed) any form of apparatus having *moveable* working parts had too short a life, in addition to the great cost, to be a continuous working success. Practically, filtration under natural atmospheric prssure had to be reverted to, with all its great drawbacks of slowness and uncertainty.

Working in conjunction with Mr. B. T. Lacy (of the Parke and Lacy Co.), they had devised what was considered to be an

important simplification of the mechanical process of pressure filtration. The apparatus was simple in the extreme; it had no moveable working parts, required neither engine or pumping gear, and when working in quantity attained a speed of filtration greatly surpassing anything hitherto employed. The filtration method he employed possessed sufficient novelty to warrant him in bringing the matter before the Association.

A working plant had been built, and was now in successful operation in Sydney. It treated two tons ore charges at a time. The guiding idea in the apparatus was the direct use of steam as the source of the power or pressure. By means of specially designed parts, the result of many interesting experiments, the steam direct from the boiler was admitted upon the body of solution requiring to be filtered, without breaking the surface of the latter A pressure equal to the steam pressure in the boiler employed was thus obtained. As a consequence of the quick and uniform action of the steam upon the surface of the solutions,—or water, when that was used for washing purposes, only the expenditure of steam on the surface was required to produce the pressure.

The working details of the plant as arranged were divided into two sections, Plate I., viz.:—

1st. The pressure tank.

2nd. The filtering or leaching vat, into which the material to be operated on was charged.

The pressure tank was of the following dimensions:—

Length of cylindrical body, 6ft. 6in.

Diameter of ditto, 3ft. 6in.

Length of conical top, 3ft.

Total length, 10ft.

It had separate inlets for steam and solution and an outlet pipe connecting it with the filtering or leaching vat. There was also a separate cock fixed to the outlet pipe, by which (when desired) the filtered solution, after refilling into the pressure tank, could be forced whenever required. The upper

part of the pressure tank was fitted with a conical top preferably, tapered to an angle of 75° from the horizontal. Fitted to the top of this tapered part of the tank was an inverted cone, having also a taper of 75°. This inverted cone had three equidistant openings near its base, and was directly attached to the steam source. The practical result of this arrangement was, that the steam, when admitted, pressed evenly, and without any breaking of the surface, upon the liquid, and forced the liquid through a connecting pipe into the leaching or filtering vat. The filtering or leaching vat had a total length of 6ft. 6in., with a diameter of 4ft., and was fitted with a conical bottom, hinged and bolted, to enable the charge (after being exhausted) being emptied at once for a fresh charge, both of which operations could be completed in less than half-an-hour.

The moveable bottom had fitted to its upper surface a strong wooden grating, covered with sacking, asbestos cloth, or other suitable material, depending on the nature of the solutions employed. We thus had the filter permanently in place and always ready. For charging the vat the upper part of the cone opened on a hinge, and fixed to the inner side of the top was a distributing plate upon which, when in action, the solution from the pressure tank first impinged, and was thus uniformly distributed over the surface of the mass to be filtered.

In cases such as where chlorine was used, the pressure tank and filtration vats might be lead lined with advantage. If desired, the conical top of the pressure tank could be adapted to the filter vats, and thus dispense with a separate pressure tank.

Having thus briefly, and, he trusted, with sufficient clearness, described the plant, it only remained now to detail the working results which had so far obtained. Experience has shown that different types of ore could be filtered at varying degrees of speed. This was only what might be expected,

when we considered the almost endless varieties of ores which were found containing gold and silver.

That you may apprecite fully the difference in speed of filtration as compared with existing experience, he wished to state that the average quantity of solution required per ton of ore when using either chlorine or cyanide of potassium as a solvent was 120 gallons, and for the washing a quantity of water equal to about 50 gallons. We thus had a total quantity of 170 gallons of liquid to force through every ton of ore under treatment. The pressure tank had a capacity of 12·56 cubic feet for every foot in depth, or equal to 59·9 gallons, with a total working capacity of 389·3 gallons. The filtering vat had a capacity of 12·56 cubic feet for every foot in depth, or equal to 78·2 gallons, with a total working capacity of 275·7 gallons.

A special trial was made with quartz tailings, which had been passed through a 30-mesh screen, equal to 900 holes per square inch. A 3ft. 6in. depth of these tailings (in weight nearly 2 tons to the charge) was tested. Working with a steam boiler pressure of 55lb. to the square inch, 600 gallons were forced through in 50 minutes, whilst under atmospheric pressure upon the same quantity of ore the speed of filtration was 15 gallons in the same time (*i.e.*, 50 minutes). This was equal to a speed of forty times quicker filtration by means of pressure system. These were the comparative results of filtering a crushed ore of a nature presenting no pronounced difficulties. They afterwards tested the working speed of filtration upon an ore which had hitherto presented peculiar and great difficulties in treatment and filtration; he referred to the gold ore as found in the Pambula district in our Colony. The result of our operations on this ore were as follows:—Working with charges of over a ton in the filtering vat, they found they could force through a depth of 2ft. of ore at a speed of 154·6 gallons in 33 minutes. Natural filtration gave a speed, or rather a slowness, of 1 gallon in 10 minutes.

Brought to a common standard, they had attained a speed of filtration in which the comparative speed of the one method as against the other is 46·8 times greater; or, to put it broadly, with a working filtering plant of equal size they could filter in a week what would take a working year to do by the prevailing method.

The ultimate point requiring consideration was, at what cost are these results obtained? Speaking of the working plant from which they had obtained the results given, their experience had been that, as regards the expenditure of steam, the amount consumed in each case was nearly equal to what would be required to drive a steam-engine of one-half horse-power.

That this question of speedy and effective filtration was one of importance was evident from the following extracts American advices upon the subject:—

"So much is leaching of ore delayed by fineness, that at Silver City, where the tailings from the Bremen Mill were leached, the rate of leaching all through, aided by the use of pumps to exhaust the air from the bottom of the tank, fell as low as one-sixteenth of an inch per hour."

And again, in mentioning the necessity of having a large filtering capacity, it was said that for fine ores the rate of filtration was at the rate of one inch per hour. In other cases it was stated that the only way of getting over the difficulty of filtration was by coarse grinding, which naturally resulted in a diminution in the yield of gold.