

charge, as will be seen later on. In applying the extra solution to roasted or raw ore after treatment with ordinary solution, and in the minimum quantity, namely, just sufficient to saturate the charge, the same *modus operandi* as previously described is adopted, in order to replace the ordinary solution. As soon as this is accomplished, the discharge of the solution from the lixiviation-vat is stopped, and, as will be afterwards explained, circulation of the extra solution is commenced. But outside of these measurements, which are absolutely necessary, it is recommended to measure all the wash-water and lixiviation solution consumed, so that only a fixed quantity, established by experience, is passed through the charge. This can be accomplished by applying the solution in charges measured in the lixiviation-vat itself. The space above the ore—say, 12in. deep—is filled with solution. The discharge at the bottom of the vat having been stopped, leaching is now resumed, and continued until the solution has sunk to the surface of the ore. At this moment the discharge is stopped again, and a fresh quantity of solution put on, and so on. This method is somewhat tedious on account of the frequent interruptions of the process; but it is the only one to be recommended.

“The facility with which a solution filters through the charge depends upon various conditions. With raw ore, a large percentage of slimes acts injuriously, especially if they consist of clay and talc. The roasting of such material has a beneficial effect. Well roasted ores generally leach freely, even if in a fine condition. This difficulty may become serious in case of raw tailings, which are mostly treated in the form of slime.

“By the Korting injector attached to the discharge-pipe of the lixiviation-vats, a vacuum below the filter can be produced, and the solution forced through with considerable speed. This method is the most simple and effective of all for that purpose, and the only one to be recommended. The introduction of the Korting injector is one of the greatest improvements that has been made in lixiviation from a mechanical standpoint. Through the same injector the circulation of the extra solution becomes possible. By circulation is meant the drawing of the solution from the bottom of the lixiviation-vat, and retaining it in the same vat, so that it filters through the ore continuously.

“The rate of leaching or the volume of solution that filters through the charge in a given time is very valuable. Mr. Russell states that the most advantageous rate of leaching is as fast as possible; but if it is from 6in. to 8in. per hour he rather prefers to have it at that rate, instead of accelerating it to 12in. or 14in. by using the Korting injector. Roasted ores containing caustic lime should be leached rapidly.

“Another precaution in lixiviation should not be neglected. In introducing water or solution into the vat the force of the current should be broken by directing it against a piece of matting, or by running it through the copper-sulphate box, in case the extra solution is made in the lixiviation-vat, so that the even surface of the ore is not disturbed.

“*Charging Lixiviation-vat with Ore.*—After the vat is charged the surface of the ore should be levelled. Upon application of the first wash-water to roasted ore or lixiviation solution to raw ore the charge sinks more or less. This shrinkage is from 10 to 18 per cent. for raw ore, and from 12 to 24 per cent. for roasted ore. For this reason the vats should be filled to such a height that after the settlings of the charge has taken place a space of about 12in., rather more than less, is left free above the ore. This is easily accomplished after a few trials. A vat 14ft. by 6ft. 6in., as formerly described, will hold from 38 to 48 tons of raw ore, or from 27 to 38 tons of roasted ore.

“*Treatment of Roasted Ores.*—The first wash-water: The quantity of this varies between 20 and 80 cubic feet per ton of ore; the time of leaching from one hour and a half to four hours. It is generally used cold, but with warm water the operation is accomplished sooner. The soluble salts removed by the first wash-water are principally sodium-sulphate and chloride; besides these there may be the soluble sulphate and chlorides of copper, zinc, manganese, alumina, iron, and calcium, also antimonial and arsenical salts, and caustic lime. Should lead-chloride be present in the roasted ore, it will be changed to sulphate in contact with sulphate solution. Lead-sulphate, however, is somewhat soluble in a concentrated sodium-sulphate and chloride. So are cupreous-chloride and silver-chloride. The leaching with water is suspended, and the liquor ceases to give a perceptible reaction with sodium-sulphide. The first portion of more concentrated wash-water may hold sufficient copper and silver to be worth saving, and in this case is collected in a separate tank. Cement silver can be precipitated from it by copper, and the copper subsequently by iron. Warming and the addition of sulphuric acid hasten the reaction.

“Silver-chloride, cupreous-chloride, lead-sulphate, and antimonial salts are in part precipitated from the concentrated wash-water by diluting it. Should the ore contain caustic lime the wash-water, provided the solution shows a caustic reaction, will be free from copper, but may hold considerable silver. In this case the silver is best precipitated with scrap-iron after the caustic lime has been neutralised with sulphuric acid, and a surplus of acid has been added besides. The reaction is hastened by treating the solution with steam. At Lake Valley, New Mexico, a precipitation of the cement silver was accomplished in twelve hours, and 1½ to 4oz. of silver per ton of ore was saved, with an expenditure of 2lb. of sulphuric acid. Complete statistics regarding this question are not yet at hand.

“It has been recommended in certain cases to introduce the wash-water below the filter, and force it up through the ore until it reaches several inches above the charge; then fill up the vat from above and reverse the current. Precipitation of silver-chloride, &c., takes place as already explained, and these salts are caught in the charge. It is also claimed that the subsequent filtering of the solution is more rapid. This may be due to the removal of fine ore particles from the filter through the upper current of the water.

“*The Lixiviation.*—Under this head we have to consider the following cases:—

“(a.) The roasted ore does not contain caustic lime. The order in which the solutions are applied in this case is one-half of the ordinary solution; then the extra solution, followed by the other half of the ordinary solution. The volume of the ordinary solution varies 20 to 120 cubic feet per ton of ore; the time of leaching with it from twelve to thirty hours. The extra solution is