

circulated from four to six hours. Both solutions are generally used warm. After the treatment with water has been finished, and the wash-water has nearly been replaced by a measured quantity of ordinary solution, the liquid running from the lixiviation-vats should be closely watched for the appearance of the ordinary solution by testing it with sodium-sulphide. As soon as a perceptible reaction takes place the solution is turned into the precipitating-tank. Leaching is now continued until the first half of the ordinary solution has passed through the charge. Then the extra solution is applied in the manner previously described, only with the following modification: The quantity of the extra solution prepared should be from 5 to 8 or even 10 per cent. less than is required to saturate the charge. The object of this precaution is to avoid waste in any extra solution by running it into the precipitating tanks before the cupreous-hyposulphite has done its work on the ore, which would easily occur if the volume of the extra solution were either the exact amount needed to saturate the charge or in excess of it. After the extra solution has circulated a sufficient time it is replaced with ordinary solution, and leaching with the latter is recommended, and continued in the usual way.

“(b.) The roasted ore contains an appreciable percentage of caustic lime. In this case the treatment is modified as follows: A large volume of extra solution precedes the ordinary, and the former is not circulated, but applied like the latter. The volume of the extra solution varies between 18 and 40 cubic feet per ton of ore, and that of the ordinary solution between 30 and 90 cubic feet. Both solutions are used cold. Practical experience has demonstrated that if roasted ore containing an appreciable percentage of caustic lime are treated with ordinary solutions after the first wash-water the result is very disastrous, and that the damage done is only partially made good by subsequently leaching with extra solution. But if the extra solution is applied at once the cupreous-hyposulphite neutralises and counteracts the deleterious effects of the caustic lime, and leaves the silver in a soluble form. The extra solution is put on in several charges, commencing with one of $\frac{4}{10}$ per cent. concentration in copper-sulphate, and followed by others of less concentration, the last one only containing $\frac{1}{10}$ per cent. of copper-sulphate. Before the extra solution follows the first wash-water it has been found beneficial to impregnate the ore with a small quantity of strong copper-sulphate solution. It can easily be seen that the first portion of the extra solution replacing the wash-water now becomes more or less diluted in contact with water. This dilution may be so considerable that an insufficient quantity of copper is present to protect the silver from the deleterious influence of the caustic lime. The *modus operandi* is as follows: About 11b. of copper-sulphate per ton of ore is dissolved in such a volume of water that it will fill the lixiviation-vats to a depth of not less than 1in. and not more than 2in.

“As soon as the first wash-water has sunk to the surface of the ore, leaching is suspended and the copper solution is put in. The latter is made to sink a little below the surface of the ore before the extra solution is run on the charge, and leaching is started again. When the extra solution has replaced the wash-water the discharged liquor is turned into the precipitating-tank, and leaching with extra solution is continued. How the ordinary solution is to be applied after leaching with extra solution has been completed needs no further explanation. The second wash-water, as soon as the extraction of the silver is completed, is in order. Its quantity is from 7 to 10 cubic feet per ton of ore. The time of this operation varies between an hour and a half and two hours and a half. After the ordinary solution has been replaced by the wash-water the latter is allowed to run to waste if the tailings are to be shovelled out; but remains in the charge if the tailings are to be removed by sluicing.

“*Discharging the Tailings.*—The tailings are now sampled with a long butter-tester if they are removed by sluicing, or a sample is taken from each car if the tailings have to be shovelled out. The quantity of water required for sluicing is about 12 cubic feet per ton of ore. Hence it will be possible in most cases to resort to sluicing if ores are treated raw. Should water be scarce in working roasted ores, the first wash-water after silver and copper have been precipitated from it may be pumped to a tank and used for sluicing. This method of removing tailings will, under all circumstances, be cheaper and more convenient than shovelling.

“*Treatment of Raw Ores.*—Raw ores require no first wash-water. The order in which the solutions are applied is, in most instances, extra solution followed by ordinary. In some instances, but not frequently, the extra solution is both preceded and followed by ordinary. In the latter case the operation is the same as already described for roasted ore without caustic lime. The extra solution is always circulated. If leaching is commenced with extra solution its volume should be sufficient to cover the charge after circulation has been started. Should the extra solution made in the extra tank fall short of its required volume, enough of ordinary solution is added. The time of circulating the extra solution is from four to six hours. The volume of ordinary solution varies between 20 and 90 cubic feet, and the time of leaching between twelve and thirty hours. Both solutions are generally used warm. What has been said in the former paragraph about the second water and the discharging of the tailings holds good here also.

“Mr. Russell conducted several interesting experiments in reference to the treatment of raw ores and ores subjected to an oxidizing roasting. The samples experimented on were obtained from the Sombeerete District and vicinity, Zacatecas, Mexico. These experiments showed the remarkable effect produced by treating the ore with an aqueous solution of copper-sulphate prior to the application of the lixiviation solution,—

“(1.) Experiments with ores that had been roasted without salt in a reverberatory furnace for two hours at a low heat:—

“Value of ore, 24·9oz. silver per ton.

“Value of tailings, 14·58oz., after lixiviation with ordinary solution.

“Value of tailings, 7·5oz., after lixiviation with ordinary and extra solution.

“Value of tailings, 2·6oz., after first using copper solutions and then adding sodium-hyposulphite.