

The Chemicals and Solutions.—The chemicals used are sodium-hyposulphite or the commercial hyposulphite of soda, copper-sulphate or bluestone, caustic soda, sulphur, sulphuric acid, and sodium-carbonate or soda-ash.

Sodium-hyposulphite.—This is packed in barrels, and does not decompose in contact with the atmosphere. If imported in large lots from England it costs in New York $\frac{3}{4}$ d. a pound. If bought from dealers the price asked is $1\frac{1}{4}$ d. per pound in New York, $1\frac{1}{4}$ d. in St. Louis, and $1\frac{1}{2}$ d. in San Francisco.

Caustic Soda.—Only a high-grade article should be ordered of 70 to 76 per cent. It is principally imported from England, put up in sheet-iron drums, holding 600lb. to 700lb. It should not be left exposed to the air after the drum has been opened as it absorbs carbonic acid. The price in New York is $1\frac{1}{4}$ d. per pound for 60 per cent. Hence 74 per cent. caustic soda would cost $1\frac{1}{4}$ d. per pound.

Sodium-carbonate.—It is most economical to buy the pure alkali of 58 per cent., made by the Solway or ammonia process. This alkali is in the form of white powder, and is so pure that it contains 98.7 per cent. of sodium-carbonate, the remainder being principally sodium-chloride and sulphate and 0.25 per cent. moisture. On account of the entire absence of sodium-sulphide and caustic soda (which are always found in the ordinary soda-ash) the solution for the precipitation of lead does not require purification.

Copper-sulphate.—Price is $2\frac{1}{2}$ d. per pound in New York, 2d. in Omaha, $2\frac{1}{2}$ d. in St. Louis and San Francisco.

Sulphur.—It is immaterial whether the sulphur is crude or refined or flowers of sulphur. Lump sulphur should be pulverized so as to pass through a No. 10 screen before using it in the preparation of sodium-sulphide. It is more convenient to buy the sulphur already pulverized. Price in New York of refined sulphur in rolls is $1\frac{1}{4}$ d. per pound.

Sulphuric Acid.—Off 66° Beaume is best transported in sheet-iron tanks, which hold about 1,700lb. If shipped in this way it is much less than in glass carboys, the cost of such tanks being 26s. each; price in New York, $\frac{3}{4}$ d. per pound.

Solutions: The ordinary Stock Solution.—This is made by dissolving a proper quantity of sodium-hyposulphite in a measured quantity of water in the storage-tanks. To hasten the solution steam may be passed through the lead pipe-coil. As the weight of a cubic foot of water is 62 $\frac{1}{2}$ lb., this number of pounds of sodium-hyposulphite added to 100 cubic feet of water will produce a solution of 1 per cent. concentration, and so on. Practical experience has demonstrated that it is not economical to work with a solution of higher concentration than 2 per cent., even if high-grade ores have to be treated. In that case increased volume of solution is made to do the work. With low-grade ores a solution of 1 per cent., and even less, concentration may be most profitable. In starting new works it is best to begin with 2 per cent. solution, and then diminish its concentration according to circumstances. The strength of the solution after continued use changes, and in most cases it becomes weaker. The weakening is caused as follows:—

- “(1.) By admixture of some wash-water which may precede and always follows the solution.
- “(2.) By a condensation of steam from the Korting injectors.
- “(3.) By a decomposition of hyposulphite through atmospheric influences.
- “(4.) By a decomposition of sodium-hyposulphite with copper sulphate in making the extra solution. For each 1lb. of copper sulphate thus consumed 1lb. of sodium-hyposulphite is destroyed.

On the other hand the solution gains strength by evaporation, but principally in precipitating the sulphides of silver, copper, and lead (provided the lead has not been previously eliminated by sodium-carbonate) with sodium-sulphide, which always contains a large amount of hyposulphite. The more silver, lead, and especially copper precipitated, the larger will be the quantity of hyposulphite added to the solution, so that cases may exist where all the loss in hyposulphite is not only compensated, but the solution may even increase in strength.

After the most advantageous concentration of the solution has been determined by experience, it should be maintained by constant addition of sodium-hyposulphite. This is best done by making the extra solution, as will be shown later on. The concentration of a solution of hyposulphite after it has been in use cannot be estimated, even approximately, by its specific gravity, for reason that will soon become apparent. Hence a chemical test is the only one on which reliance can be placed. One method is to ascertain how much silver-chloride will be dissolved by a certain number of cubic centimeters of the solution, and to compare the result with a scale that has been prepared for this purpose. Preference, however, should be given to the volumetric assay, which is based on the fact that a solution of iodine in potassium iodide in contact with sodium-hyposulphite changes the latter to sodium-titrathionate, while the iodine combines with sodium to sodium-iodide. The end of the reaction is indicated by the blue colour of starch which has been added to the hyposulphite solution. The details of this can be found in any book on analytical chemistry. The original stock solution is subjected to other changes outside those mentioned above in consequence of a gradual accumulation of sodium-chloride, sulphate, and titrathionate. It can easily be seen whence these salts are derived. Sodium-chloride and titrathionate do absolutely no harm. Sodium-sulphate diminishes the solvent energy of the solution only slightly. Calcium-salts are introduced if gypsum is present in raw ore, or if calcium-sulphate or caustic lime exist in roasted ore. In case the lead is precipitated by soda, the calcium is also precipitated, and no calcium-salts can exist in the solution. The concentration of the solution in these salts, however, does not go on indefinitely, but reaches a maximum and then remains stationary. It can easily be seen that this effect is produced by the wash-water, which either precedes or follows the lixiviation solution. In this operation both a loss and a dilution of the lixiviation solution takes place.

There is, however, another change in the condition of the stock solution that is of great importance—namely, its assuming a caustic solution. Silver-ores only that carry a comparatively large percentage of antimonial and arsenical compounds may be benefited by treatment with a