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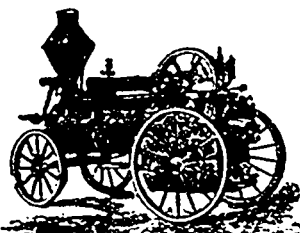
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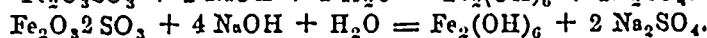
MINING.

THE CHEMISTRY OF THE CYANIDE PROCESS.

Written for the Engineering and Mining Journal by Chas. Butters, Ph. B., and John Edward Clennell, B. Sc.

(Continued.)

Preparatory Treatment of Pyritic Material.—Before attempting to treat such ores or products with cyanide, it is therefore necessary to get rid of the free sulphuric acid and soluble iron-compounds. This is generally done by giving a leaching with water until the liquid running off the tanks no longer shows a coloration with ammonium sulphide. After the treatment, however, there still remain the insoluble basic sulphates, which are gradually decomposed by water, and would act upon the cyanide solution. A washing is accordingly given with caustic soda or limewater, which converts the basic salts into ferric hydrate, and sodium or calcium sulphates:



But the preliminary water-wash may be omitted with advantage in cases where the quantity of free acid and salts is comparatively small. Lime in the dry state is sometimes mixed with the tailings before the cyanide treatment commences. When this method is adopted the iron is precipitated as a mixture of ferrous and ferric hydrates.

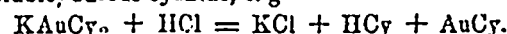
After the washing with alkali is complete, the tanks are allowed to drain, and "strong cyanide solution" (about 6%) is pumped on. Even after this treatment the consumption of cyanide, with moderately pyritic tailings which have been partially decomposed by exposure, is found to be four times that which occurs with free-milling material. The presence of a large excess of alkali in the solution brings about various secondary reactions which lead to a loss of cyanide, such as the hydrolysis, before alluded to, and a peculiar action in the zinc box, which will be discussed later.

Lime, although slower in its action, is preferable to caustic soda as a neutralizing agent, as it is equally effective in decomposing the iron salts, less active in bringing about secondary reactions on the cyanide, and also less energetic in attacking the zinc in the precipitating boxes.

Ferric hydrate does not appear to be acted upon by potassium cyanide, but ferrous hydrate, which is formed in the neutralization of the iron salts by alkalis, reacts on the excess of cyanide, with formation of ferricyanide of potassium:



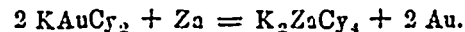
Deposition of Gold from Cyanide Solutions.—Under certain conditions, such as the absence of sufficient oxygen in the solution, a partial precipitation of the previously dissolved gold appears to occur. If by any chance the solution should become acid, there is a decomposition of the double cyanide of gold and potassium, in which the gold is generally supposed to be thrown down as (insoluble) aurous cyanide, e. g.



In working on the circulation and transfer system, we find that where pyritic material is under treatment it is not safe to transfer a solution already rich in gold to a fresh lot of tailings, as the extensive decomposition of the solution which takes place may lead to a final loss of gold.

Selective Action of Cyanide.—It is claimed by the promoters of the McArthur-Forrest process that in a mixture containing metallic gold, silver, copper and base metals, cyanide of potassium exerts a selective action, dissolving first the gold, then the silver, and afterward attacking the copper and base metals. The process, however, does not appear to have been successfully applied to ores, such as these met with in California and Australia, which contain considerable quantities of foreign metals. Ores containing sulphide of silver and sulphide of copper produce considerable decomposition of cyanide, the copper being partially dissolved as sub-sulphocyanide, the silver, however, remaining unattacked. In two experiments, carried out by Mr. William Bittel, Chief Chemist of the Robinson Gold Mining Company, who has kindly given us valuable assistance in the compilation of this paper, on ore from the Albert Silver Mine containing 30 cz. of silver and 10% of copper, it was found that no extraction of silver occurred, this metal being present as sulphide.

Action of the Zinc Shavings on the Solution.—We must now pass on to consider the action of the zinc on the gold-cyanide solution. Theoretically a simple substitution of zinc for gold occurs in accordance with the following equation:



Taking Zn = 65.1, Au = 196.8, it follows that 65.1 parts by weight of zinc should be sufficient to precipitate 393.6 parts of gold, or 1 lb. of zinc should precipitate about 6 lbs. of gold. The actual consumption is about 1 lb. of zinc per ounce (Troy) of gold recovered. It is evident then that zinc is consumed in some other way than in mere substitution for gold.

During the passage of the solution through the zinc boxes we notice a constant and vigorous evolution of small bubbles, which prove to consist principally of hydrogen gas. The outflowing liquid is found to possess a greater degree of alkalinity than it had on entering at the top of the box, and a smell of hydrocyanic acid, and sometimes of ammonia, is constantly observed in the neighborhood of the zinc boxes. It is clear then that a decomposition of the potassium cyanide solution itself by the zinc is in progress, and this is not to be wondered at when we consider the powerful electro-chemical effect which must be produced by the contact of such a highly positive metal as zinc with a strongly negative metal such as gold. Ordinary commercial zinc loses weight when immersed for some time in cyanide solution, but the action is slow. It is doubtful whether pure potassium cyanide would have any action at all on chemically pure zinc.