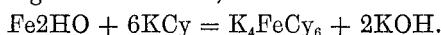


cement silver could readily be seen. Which of the two is the actual reaction plays but little part in the working of the process, however. There will be a few complaints of insufficiency of oxygen, as, according to the reaction, but 15.96 parts of oxygen by weight are required to dissolve 396.6 parts of gold. The probabilities are, however, if oxygen is required at all, that it must be present in larger quantities, as no hydro-metallurgical process works in practice in exact accordance with the simple chemical formula. If the cyanide process in particular did so, only 130.04 parts of cyanide of potassium would be lost in dissolving 106.8 parts of gold—or, more correctly, two parts of cyanide to three parts of gold; but in reality the quantity consumed amounts, on the freest ore, to 3lb. to the ounce of gold recovered, or 43.7 parts of cyanide to 1 of gold. On more refractory ores, containing soluble base metals, and particularly acid salts, the consumption is greatly in excess of this.

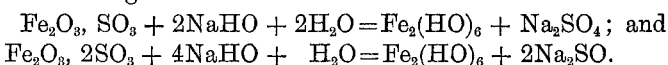
*Solubility of other Metals and Minerals.*—According to Guélin, zinc, iron, nickel, and copper are dissolved by potassium-cyanide, with evolution of hydrogen; cadmium and silver in the presence of oxygen; and tin, mercury, and platinum not at all. Sulphide of silver is dissolved by strong solutions and a sufficient quantity of weak solution. Silver-arsenate ( $\text{Ag}_3\text{AsO}_4$ ) and silver-antimonate ( $\text{Ag}_3\text{Sb}_2\text{O}_6$ ) are readily dissolved by potassium-cyanide, as are many of the argentiferous arsenical and antimonial minerals found in nature. Chloride of silver dissolves readily, forming chloride of the alkali and a double cyanide of silver and potassium. While metallic silver, when sufficiently fine, dissolves readily in the solution, that found native in ores is not attacked unless existing in their laminae. The oxides and sulphides of copper are attacked by the solution, and dissolved, as is metallic copper. It is claimed that the presence of copper-sulphide in a silver- or gold-ore prevents the precious metals from going into solution. Although experiments have shown that little or no silver or gold is dissolved in certain ores containing sulphide of copper, this question is by no means settled, as artificially-prepared sulphide of silver is dissolved in actual contact with the copper compounds. Metallic iron is attacked, but very slowly. Ferric hydrate is not attacked by the solution, but ferrous hydrate formed in the neutralisation of the iron salts by alkali is attacked by cyanide, according to the reaction,—



Thus ferrocyanide of potassium and caustic potash are formed.

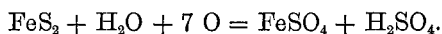
*Treatment of Pyritic Ore previous to Lixiviation with Cyanide.*—Pyritous ore, if but slightly exposed to atmospheric action, always contains free sulphuric acid and soluble salts of iron. To prevent reactions on the solutions, it is necessary to leach these ores with water previous to lixiviation with cyanide of potassium, and before washing with an alkali. If the alkali solution was added directly to the ore, the consumption of alkali would be extremely large, and the amount of solution necessary, if lime was used, would prove inconvenient to handle.

The alkali solution, assuming that caustic soda is used, reacts on basic iron salts, insoluble in water, according to the following reactions:—

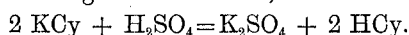


Thus ferric hydrate and sodium-sulphate (or calcium-sulphate if lime is used) are formed. Sodium-sulphate is soluble, and passes off with the wash-water, but calcium-sulphate remains. The hydrate of the sesquioxide of iron is insoluble in water, and, to all appearances, is unattacked by the cyanide solution; but, as has been mentioned before, the hydrate of the protoxide is dissolved with formations of ferrocyanide of potassium. Mr. C. W. Merrell precipitated ferrous hydrate by caustic potash from a cyanide solution. The solution contained but a small percentage of free cyanide, as it had already acted on the ore and zinc in the precipitation of dissolved gold, and it is unlikely that this reaction, regenerating the cyanide of potassium, which had been rendered inert by the solution of the iron, would occur in a comparatively strong solution.

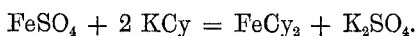
*Direct Treatment of Pyritic Ores by Cyanide of Potassium.*—As has been explained, the direct treatment of these ores is unadvisable and extremely expensive. Pyrite ( $\text{FeS}_2$ ) is decomposed by the oxygen of the air and moisture into soluble ferrous sulphate and free monohydrated sulphuric acid; according to the reaction—



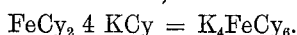
The ferrous sulphate is decomposed by the action of the air to insoluble basic sulphates. In addition, normal ferric sulphate ( $\text{Fe}_2(\text{SO}_4)_3$ ) is produced, which gradually loses acid and becomes a soluble basic sulphate,  $\text{Fe}_2\text{O}_3 \cdot 2\text{SO}_3$ . There are many basic salts of somewhat complex and doubtful composition formed likewise. Thus, in an oxidized ore which has contained pyrite are found sulphuric acid, ferrous sulphate, basic ferric sulphates, ferric sulphates, and basic ferrous sulphates, all of which react upon potassium-cyanide. Sulphuric acid reacts upon potassium-cyanide with evolution of hydrocyanic acid, according to the reaction,—



Ferrous sulphates react upon cyanide with the formation of ferrous cyanide, a yellowish-red flocculent precipitate:—



This ferrous cyanide is attacked by the excess of the cyanide in the solution, and ferrocyanide of potassium is formed, according to the reaction,—



That is to say, one molecule of ferrous sulphate decomposes or renders inert six molecules of cyanide of potassium. Other things being equal, if 1 per cent. or 20lb. of ferrous cyanide existed in the ore, some 51lb. of cyanide would be rendered inert for the solution of gold, and, in fact, would be lost. This, at the average price of chemically-pure cyanide, would cost over £6 per ton.