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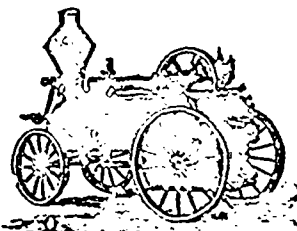
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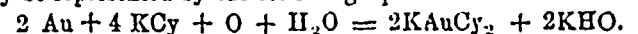
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## MINING.

### THE CHEMISTRY OF THE CYANIDE PROCESS.

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

*Solubility of Gold in Potassium Cyanide.*—That metallic gold is soluble in cyanide of potassium has long been known as a scientific fact. Faraday pointed out that gold-leaf immersed in the solution became so thin that it transmitted green light. Prince Bagnation observed (J. pr. Chem. xxxi, 367) that the very finely divided gold obtained by precipitating a solution of the chloride with ferrous sulphate may be dissolved by this reagent. Erlenmeyer showed, however, (J. pr. Chem. xxxvii, 333,) that the presence of oxygen is required for the solution of the gold. A solution is obtained which, on evaporation, yields colorless octahedral crystals of the composition  $\text{KAuCy}_2$  (auro-potassic cyanide) which may be looked upon as a double cyanide of gold and potassium ( $\text{KCy} \cdot \text{AuCy}$ ). The reaction which occurs may, therefore, probably be represented by the following equation:

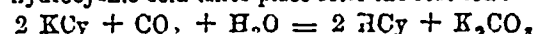


There are two interesting points indicated by the above equation which it is well to bear in mind in conjunction with the application of potassium cyanide as a solvent for gold on a commercial scale.

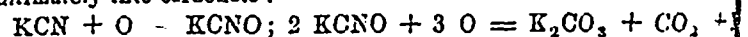
1. That the quantity of cyanide theoretically necessary to dissolve a given weight of gold is infinitesimal in comparison with the weight actually required in practice. Taking  $\text{Au} = 196.8$ ,  $\text{K} = 39.04$ , and  $\text{Cy} = 25.01$ , we see that 130.04 parts by weight of potassium cyanide should be capable of dissolving 196.8 parts of gold, or, approximately, two parts of cyanide should dissolve three parts of gold. The minimum actual consumption in treating free milling ore, assaying, let us say, 10 dwts per ton is about 3 lbs. per oz. of gold recovered—roughly, 40 parts by weight of cyanide for 1 part of gold. In the leaching tanks alone a pound of cyanide is generally consumed per ton of material treated.

2. That an extremely small quantity of oxygen is sufficient to bring about the solution of the gold, 15.96 parts being required for 396.6 parts of gold or ore part for nearly 25 parts of gold. The quantity present in a pound mass of tailings, to say nothing of that dissolved in the water used in making up the solution, would be considerably in excess of that actually required for the reaction.\*

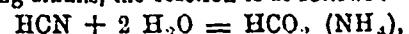
*Decomposition of the Cyanide.*—How, then, does it happen that such enormous consumption of cyanide occurs? In the first place we must bear in mind the great instability of the simple cyanides. Hydrocyanic acid, when liberated from a chemical point of view, perhaps the weakest acid known, is liberated from its salts by all mineral acids, by carbonic acid, and by organic acids of common occurrence. Then atmospheric carbonic acid is accountable for a certain amount of decomposition, in which a certain evolution of hydrocyanic acid takes place after the reaction:



Then, again, we must consider the proneness to oxidation which cyanides exhibit, and which, in fact, lies at the base of most of their technical applications. Potassium cyanide readily changes into cyanate, ultimately into carbonate:

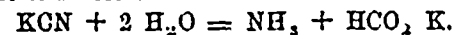


The presence of alkalis, which always occur in commercial cyanide solutions, to induce that peculiar and little understood decomposition known as "hydrolysis."† In this reaction the alkali appears to determine a change in which water plays a part, while the alkali itself is not in the least affected. When hydrocyanic acid is treated with concentrated mineral acids or with boiling alkalis, the reaction is as follows:



ammonium formate being produced.

The hydrolysis of potassium cyanide, which undoubtedly occurs to a considerable extent when excess of alkali is present in the solution, has been added to the tailings before treatment with cyanide, gives rise to ammonia and potassium formate.



The smell of hydrocyanic acid, generally noticeable in the neighborhood of the cyanide tanks, is partly accounted for by the decomposition of atmospheric carbonic acid, alluded to above. But there are good reasons for supposing that in dilute solutions a dissociation of the cyanide takes place so that what we term a weak solution of potassium cyanide is in reality a mixed solution of potassium hydrate and hydrocyanic acid:



The truth of this theory is supported by the extraordinary facility with which distillation of hydrocyanic acid takes place when a current of a neutral gas (e. g., nitrogen) is passed through a cold dilute solution of cyanide. In the case, it is evident that hydrocyanic acid, which is an extremely volatile body, must be constantly disengaged from all vessels in which cyanide solutions are freely exposed to the air.

\* The solubility of atmospheric oxygen amounts to about .066 litre in each litre of water at the ordinary temperature and pressure. Assuming that a quantity of, say, .0025 litre is dissolved in each litre of 25 tons (50,000 lbs.) of solution, a quantity of oxygen, amounting to .175 lb., will be available for the reaction on the gold. This amount is of course considerably more than that required for the solution of the 49 oz. of gold which might be contained in a ton of tailings.

† The decomposition of the solution by "hydrolysis" occurs mainly in the tailings and seems to be induced by the presence of the metal.

(To be continued.)