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EXTRACTION OF GOLD AND SILVER BY SOLVENTS.

IMPROVEMENTS IN, OR RELATING TO, THE EXTRACTION OF PRECIOUS METALS FROM THEIR ORES.

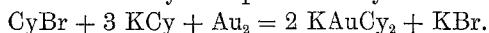
We, Henry Livingstone Sulman and Frank Litherland Teed, D.Sc., analytical chemists, both of London, in England, do hereby declare the nature of our invention for "Improvements in, or relating to, the Extraction of Precious Metals from their Ores," and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to the solution of precious metals generally, but particularly to that of gold and silver from their ores.

By present known methods or processes where cyanide of potassium is used the time required for perfect extraction by solution is lengthy, and such processes can only be successfully applied in particular cases, such, for example, as the following: The gold must be in a state of very fine division amongst the other compounds or substances present in the ore, and the substances in the ore (other than precious metals or their compounds) must not be capable of rapidly destroying or deteriorating the solution of cyanide used; further, the precious-metal contents of the ore must not be relatively great; thus, ores containing coarse gold or a high value of gold per ton (whether coarse or fine), copper compounds, and certain other metalliferous substances cannot be successfully treated by cyanide, and pyritic ores give rise to many difficulties and cyanide losses. Even under the most favourable conditions a great loss of cyanide occurs, owing, among other causes, to the action of the carbonic acid in the air, residual alkali in the prepared ore, the formation of Prussian blue and other compound cyanides, &c. These losses are caused or accentuated by the fact that potassium-cyanide alone is incapable of dissolving gold, and requires oxidation, atmospheric or otherwise, to effect the production of the soluble double cyanide of potassium and gold, and that even with the aid of air the solvent-power of cyanide on gold is comparatively feeble, and requires a lengthened period to effect complete solution.

Now, we have found that halogen compounds of cyanogen—to wit, the chlorides, bromides, or iodides of cyanogen—when added in certain proportions to cyanide of potassium in water form a series of solvents for precious metals, particularly gold, of great power and efficiency. The solution of the precious metal in such solvents is rapid and complete, and, whilst the solution is kept alkaline, the secondary reactions of the solvent on the other compounds of the ore, such as copper- or iron-pyrites, are very limited in extent, the shortness of the time required to dissolve the gold out of the ore reducing them to a minimum.

The solvent reaction which occurs may be represented by the following chemical equation:—



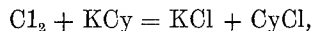
It is to be noticed here that no oxygen nor oxygenation process is required, but that it is a chemical reaction independent of the oxygen of the air or of the oxygen of the water, no hydrolysis taking place.

It is also to be noticed in this connection that these haloid compounds of cyanogen are of considerable stability, and do not act by the liberation of the haloid element, but the whole reaction is complete as between the chemicals employed and the gold—that is, without the further intervention of any extraneous agent.

We may proceed in carrying out our invention in any of the following ways:—

(1.) We may form separately a chloride-bromide or iodide of cyanogen by any known and suitable method, and add a requisite proportion of any one or a mixture of such products to the requisite proportion of cyanide of potassium in water; this solution suitably diluted is then applied to the crushed ore or ore-products, which may be contained in any suitable tank or vessel, open or closed, constructed of any suitable material, such as wood. The solution of the gold or precious metal is effected in a very short time—in the case of some of our experiments an hour has been sufficient to extract the gold from a copper- and iron-pyrites and quartz matrix—and the gold-bearing solution is then drawn off, and the precious metal recovered therefrom by any known means; but we prefer to use the process of precipitation and recovery hereinafter described. The cyanogen haloid may, if desired, be applied after the cyanide of potassium has been mixed with the ore.

(2.) We may proceed also by acting upon the solution of potassium-cyanide, or the solution of any suitable cyanide of the alkalies or alkaline earths, by chlorine, bromine, or iodine in quantity sufficient to produce the requisite amount of the desired cyanogen haloid, according to the chemical equation,—



and keeping undecomposed a sufficient excess of cyanide of potassium for the required combined solvent action on the precious metal. The solution thus prepared is then applied in the same manner as specified in the preceding paragraph.

(3.) A further alternative is to act by the addition of the haloid elements, or of mixtures capable of yielding the same, to compounds containing or yielding cyanogen (other than the cyanides before specified), such as the double cyanides, sulpho-cyanides, &c., which shall thus, by their mutual reaction, yield products which contain the desired corresponding haloid-cyanogen compound.

A further application of our invention relates to the treatment of the waste liquors, which are obtained from the process of the extraction of the gold or precious metals from the solvent solution, by the action of zinc on these latter. The addition of a halogen element, or of mixtures capable of yielding the same, decomposes the double cyanide of zinc and potassium which is found therein with the formation of insoluble cyanide of zinc—which may be separated from the liquors by filtration or other means—and effects the regeneration of the haloid-cyanogen compounds, which can thus be used again for fresh solvent purposes when mixed with a suitable proportion of potassium-cyanide. This may be represented by the following chemical equation:—

