

UNITED STATES PATENT OFFICE

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CYANIDATION METHOD

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7 Claims. (Cl. 75-105)

This invention is concerned with the cyanidation of ores carrying precious metals, i. e., gold, silver, and metals of the platinum group, and is concerned particularly with the cyanidation of ores which are not highly amenable to treatment by the conventional cyanide process.

One of the particular objects of the invention is to provide a cyanidation procedure for difficultly processed ores, whereby a higher total recovery of precious metals is secured. A further object of the invention is to provide a cyanidation process for difficultly processed ores carrying precious metals, in which a high regeneration of cyanide is obtained, reducing to an unusually low level the cyanide consumption per ton of ore treated.

A further object of the invention, in its preferred embodiment, is to provide a cyanidation process for difficultly processed ores carrying precious metals, in which the extraction procedure is carried out in the presence of a caustic alkali reagent at a greater alkalinity than has heretofore been found useful in the art.

During the many years of development of the use of the cyanide process in the recovery of precious metals, numerous ores have been found which show a comparatively low recovery from the cyanide treatment; it is my present conclusion that these difficultly processed ores may be contaminated by the presence of compounds normally insoluble in conventional cyaniding solutions and which tend to coat or otherwise prevent contact of the precious metals by the solution used in the extraction process. According to the present process I carry out the cyanidation procedure in a caustic solution containing a relatively high concentration of an alkali metal hydroxide, and thereby secure the cyanide extraction of a much higher proportion of the precious metals from the ore, possibly as a result of the solution or other removal of such interfering coatings.

According to a preferred practice of the invention, I carry out the cyanidation of a gold or other precious metal-bearing ore in the presence of a solution containing a caustic compound of an alkali metal in a concentration much greater than that usually employed where such a compound is used to provide "protective alkalinity," and preferably corresponding to between five and forty pounds of sodium hydroxide per ton of solution. I further preferably carry out the cyanidation process at a temperature materially above ordinary natural water temperature and preferably in the neighborhood of

90° F. or above. The accompanying flow sheet illustrates a preferred practice of the invention and the various related steps therein, and referring thereto:

An ore supply is indicated at 1, feeding to a pair of ball mills 2, the discharge from which enters classifiers 3, and the discharge from the classifiers enters the No. 1 thickener T₁. The overflow from the No. 1 thickener is carried to a gold tank 4 and the underflow from the No. 1 thickener is carried to the agitator series shown as comprising three agitators A₁, A₂, and A₃. The discharge from the third agitator A₃ is fed to the No. 2 thickener T₂, the underflow from No. 2 thickener is carried to the No. 3 thickener T₃, and the underflow from No. 3 thickener is carried to a filter, which discharges the ore tailings. The overflow from the No. 3 thickener is returned to the No. 2 thickener.

The overflow from the No. 2 thickener is carried to a tank 5 which is designated "mill solution," from which portions may be withdrawn from time to time through a line 6 to the gold tank 4. The mill solution from tank 5 is carried through a line 7 to a storage tank 8 and thence through a conduit 8a to the ball mills 2. The solution from the gold tank 4 is carried to precipitation at 9, and the effluent from the precipitation step, hereinafter called barren solution, is carried through conduit 11 to a junction box 12.

Caustic (i. e., an alkali-metal hydroxide) may be added to the circuit at the discharge of the classifiers 3 in any suitable manner, as through a conduit 13 communicating with tanks 14a and 14b wherein caustic may be formed, for example, by a hydrothermal reaction with sodium carbonate and lime, water being conveniently supplied to said tanks in the form of barren solution from line 11, and heat being supplied through the agency of steam or in any other suitable manner.

It will be appreciated that there will be some tendency for conversion of the free caustic to carbonate in the solutions undergoing treatment, due to the presence of atmospheric carbon dioxide, and I prefer to regenerate this carbonate into free caustic and return the solution to the circuit in order to effect maximum economies in reagents. The barren solution from the precipitation zone 9 is carried to the junction box 12 as above described, and the regeneration of this barren solution is conveniently carried out in a thickener 24 through the addition of lime from a lime tank 25, to which water may be conven-

iently supplied in the form of barren solution as described above in the case of caustic tanks 14a and 14b. The regenerated barren solution overflowing from the thickener 24 through line 27 is carried to a caustic-regenerated barren solution storage tank 28 from which it may be withdrawn to various portions of the circuit; for example, it may be delivered through a line 29 joining the underflow line 31 from agitator A₁, or through line 32 communicating with the line 22 from thickener T₂ underflow to thickener T₃, or through line 30 to the line 8a leading to ball mills 2. The barren solution which is in excess of the capacity of the caustic regeneration apparatus may be withdrawn through a line 33 from the junction box 12 and admitted alternatively or concurrently to the No. 2 thickener T₂, No. 3 thickener T₃, or agitator A₃, as through lines 34, 35 and 36 respectively, or may be returned ahead of the No. 1 thickener T₁ as through conduit 37 indicated in dot-dash lines.

For the proper practice of the invention I maintain an amount of free caustic in solution in the circuit which is at least greater than that usually employed for "protective alkalinity," and is not less than a concentration corresponding to five pounds of sodium hydroxide per ton of solution (one-quarter of one per cent by weight of the solution), and preferably carry the concentration in the neighborhood of that corresponding to ten pounds of sodium hydroxide per ton of solution (one-half of one per cent). Caustic concentrations as high as 40 pounds per ton (two per cent) or more, are useful, with some increase in total recovery of precious metal values. As an example of the increase in recovery obtained according to the present process, one particular ore having a gold content of approximately 0.2 ounce per ton was laboratory tested by conventional cyanidation; an extraction of approximately 80 per cent was obtained. Laboratory tests on the same sample using from thirty to forty pounds of NaOH per ton of solution, at room temperature, and using ten pounds of NaOH per ton of solution at approximately 90° F., showed an extraction of from 88 per cent to 90 per cent.

According to the preferred practice of the invention I maintain the solutions undergoing treatment at a temperature somewhat greater than ordinary water temperature and preferably at least in the neighborhood of 90° F. At this temperature, a caustic concentration in the neighborhood of one-half of one per cent (10 pounds per ton of solution) has approximately the same effectiveness as far as total precious metal recovery is concerned as does a two per cent concentration solution at temperatures in the neighborhood of 60° F. Any suitable heating means may be provided for supplying heat to the solution undergoing treatment, at any desired locations in the process.

The caustic may be supplied as sodium hydroxide, or any other hydroxide of an alkali metal. For the purpose of simplicity, I have referred to the alkalinity in terms of sodium hydroxide merely as illustrative of the degree of alkalinity produced in the solution.

I preferably maintain a cyanide concentration on the order of two and one-half pounds throughout the circuit, and it will be appreciated that this cyanide can be added at any position. In the above-described preferred embodiment of this invention, the high caustic concentration is maintained throughout the agi-

tator series A₁, A₂, and A₃, wherein regeneration of cyanide takes place as the result of aeration, and it has been found that this regeneration is effective to materially increase the cyanide content. For example, in actual practice of this invention on plant scale, wherein the discharge from No. 1 thickener ran an average of 2.57 pounds of cyanide (as sodium cyanide) per ton of solution, the discharge from the No. 3 agitator ran 3.39 pounds of cyanide per ton of solution as an average over the same period.

In its preferred application, the present invention contemplates the use of the high caustic concentration, together with cyanide, in the ball-milling or other operation in which the final comminution of the ore is obtained, and it is believed that the principal proportion of the solution effect takes place in the comminution step and in the subsequent classifiers. The process of the present invention is applicable where conventional cyanidation is practiced, using the conventional forms of apparatus. It will be appreciated that fresh caustic may be supplied to the circuit instead of employing the caustic regeneration step as herein specifically set forth, but a preferred practice of the invention contemplates the continuous regeneration of caustic from the alkali carbonate compounds which tend to accumulate throughout the circuit.

I claim:

1. The process of recovering precious metals from ores which comprises subjecting such an ore to the solvent action of a cyanide solution containing an alkali metal hydroxide in a concentration corresponding to between five and forty pounds of sodium hydroxide per ton of solution, and substantially recovering such precious metal from the resulting solution.

2. The process of recovering precious metals from ores which comprises subjecting such an ore to the solvent action of a cyanide solution containing an alkali metal hydroxide in a concentration corresponding to at least five pounds of sodium hydroxide per ton of solution and at a temperature at least in the neighborhood of 90° F., and subsequently recovering such precious metal from the resulting solution.

3. The process of recovering precious metals from ores which comprises subjecting such an ore to a comminuting operation and a subsequent contact operation in the presence of a cyanide solution containing an alkali metal hydroxide in a concentration corresponding to between five and forty pounds of sodium hydroxide per ton of solution, and subsequently recovering such precious metal from the resulting solution.

4. The process for the recovery of precious metal from an ore containing the same which comprises: subjecting such an ore in the form of a pulp to the solvent action of a cyanide solution containing an alkali metal hydroxide in a concentration corresponding to at least five pounds of sodium hydroxide per ton of solution; subjecting such pulp to a thickening operation; separating therefrom a solution containing the principal proportion of such precious metal; recovering such precious metal from such solution; treating at least a portion of the solution separated from the solids, at one point in the circuit, to regenerate alkali metal hydroxide from alkali metal carbonate formed in the solution during the process; and returning such regenerated solution to the circuit for use in the treatment of a further quantity of ore.

5. A process for the recovery of precious metal from an ore containing the same which comprises: subjecting such an ore to contact with a cyanide solution containing an alkali metal hydroxide in a concentration corresponding to between five and forty pounds of sodium hydroxide per ton of solution, to dissolve precious metal from the ore; separating undissolved solids from the solution containing dissolved precious metal; returning solution separated from the ore to contact with a further quantity of such ore to establish a circuit; recovering precious metal from a portion of the solution separated from the solids; treating at least a portion of the solution separated from the solids, at one point in the circuit, to regenerate alkali metal hydroxide from alkali metal carbonate formed in the solution during the process; and aerating the solution while in contact with the ore and while containing a concentration of alkali metal hydroxide within the above range, at another point in the circuit, to cause regeneration of cyanide in the solution.

6. A process for the recovery of precious metal from an ore containing the same which comprises: subjecting such an ore to contact, in a treatment circuit, with a cyanide solution containing an alkali metal hydroxide in a concentration corresponding to between five and forty

5 pounds of sodium hydroxide per ton of solution, to dissolve precious metal from the ore; separating a portion of the solution containing dissolved precious metal from a thickened product containing undissolved solids and solution; recovering precious metal from said separated portion of the solution; treating said portion of the solution to regenerate alkali metal hydroxide from alkali metal carbonate formed in the solution during the process; returning the so-regenerated solution to the circuit; subjecting said thickened product to aeration to cause regeneration of cyanide therein; separating the solution from the undissolved solids of said aerated thickened product, and returning said separated solution to the circuit.

7. A process for the recovery of precious metal from an ore containing the same which comprises: subjecting such an ore to contact with a cyanide solution containing an alkali metal hydroxide in a concentration corresponding to between five and forty pounds of sodium hydroxide per ton of solution, and aerating at least a portion of the solution while in contact with the ore and while maintaining in the solution a concentration of alkali metal hydroxide within the aforesaid range.

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CERTIFICATE OF CORRECTION.

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It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 2, first column, line 38-39, for "approxmately" read --approximately--; and second column, line 37, claim 1, for "substantially" read --subsequently--; page 3, second column, line 14, claim 6, for "areated" read --aerated--; line 24, claim 7, for "porton" read --portion--; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 13th day of October, A. D. 1942.

(Seal)

Henry Van Arsdale,
Acting Commissioner of Patents.