

5: Bromine – chemical leaching of gold

Bromine was fairly popular for recovering gold in the late 1800s and early 1900s but declined in the face of competition from cyanide and mercury amalgamation.

Some bromine leaching methods are outlined below.

The Schaeffer method of bromine leaching was invented by Charles A. Schaeffer of New York State and patented in 1882 (US #267,723). Bromine in aqueous solution is used to leach the gold as gold bromide in solution over 24 hours. Silver bromide forms as sludge. The gold is recovered by precipitation by adding oxalic acid or iron sulphate to the pregnant solution. By putting sludge into solution with sodium or calcium hyposulphite, silver can be precipitated by adding calcium sulphide. Bromine is a highly corrosive fuming liquid generating a suffocating vapour, making this method hazardous.

The Engelhardt method of bromine leaching was invented by Ernest C. Engelhardt of South Dakota and patented in 1893 (US #509,368) and uses bromine in dilute hydrochloric acid to leach the gold as gold bromide in solution. Adding acid increases the solubility of bromine from 2-3%_{vol} to 13-15%_{vol} and the process shortened.

The MacArthur method of bromine leaching was invented by John S. MacArthur of Scotland and patented in 1889 (US #411,047) and uses "perbromide of iron" in aqueous solution to leach the gold as gold bromide in solution in a vat heated close to boiling point. Silver, copper, lead and zinc must be removed first by ferric salts. The leach is reused until exhausted; then the "perbromide of iron" is regenerated using bromine. Gold is recovered by filtering the pregnant solution through coke or charcoal.

The Fink and Putnam method of bromine leaching was invented by Colin G. Fink and Garth Louis Putnam of New York and patented in 1942 (US #2,283,198). They discovered leaching gold in aqueous bromine solutions is accelerated by chloride and bromide ions.

Operation

The Fink and Putnam method in outline is as follows. First the ore is finely powdered and preferably roasted. Carbonates need not be removed as bromine solvents can dissolve gold in the presence of carbonates.

1st stage – leaching gold into solution

Bromine and sodium bromide are sourced from specialised suppliers. Elemental bromine is particularly hazardous and extremely difficult to store or transport safely. Sodium bromide is more stable and cheaper.

The powdered ore is added to water in a leach tank. The leachate is prepared by adding sodium chloride @ 100 grams/litre, sodium bromide @ 1gram/litre and finally chlorine @ 1.4 grams/litre. Throughout the first 15 minutes, sulphuric acid is added @ 1.25 grams/litre to maintain acidity. The reactive mixture is allowed to stand for a further ten minutes for leaching to finish. In tests 23-carat gold leaf dissolved in barely four minutes, and only 11.1% was lost to the tailings.

2nd stage – recovering gold from solution

To recover the gold from the pregnant solution, several methods are available: sodium metabisulphate, zinc metal (chunks, bars or powder), oxalic acid, ferrosulphate or sodium nitrate.

The solvent power of the barren liquid is restored by either adding chlorine or a hypochlorite and a mineral acid. According to the patent, "Except for losses due to vaporisation and solution left in the tailings, practically all of the free and combined bromine is recovered."

Adoption by placer gold miners

Bromine leaching is a neglected method for recovering placer gold [41], and the author is unaware of any companies, recreational miners or artisanal miners doing so.

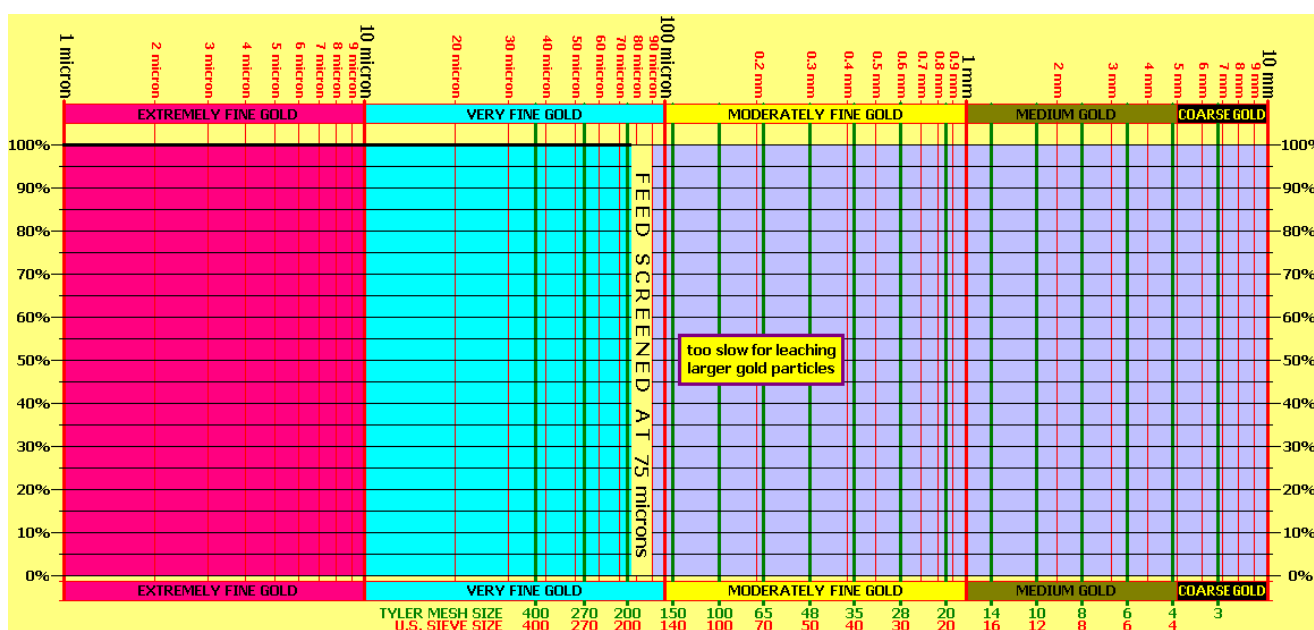


Figure 19. GOLD RECOVERY BY BROMINE LEACHING
 Bromine can dissolve (leach) >90% of gold smaller than about 75µ, but is too slow for leaching larger gold. (compiler: Robin Grayson)