

8: Nitric acid – chemical cleaning of gold



Figure 22. NITRIC ACID CLEANING
Extremely toxic fumes being generated by hot concentrated nitric acid poured onto dry concentrate. After a few seconds the brown fumes are completely broken down to harmless nitrogen. Artisanal miners in Kyrgyzstan (photo: Peter Appel of GEUS)

Hot concentrated nitric acid (HNO₃) helps to recover fine gold from concentrates. Peter Appel of the Denmark-Greenland Geological Survey noted the method being used by artisanal gold miners in Kyrgyzstan to liberate gold from sulphide ores [18]. It appears over 90% of gold of 100µ to 300µ is recoverable, but tests are needed to confirm what percentage of <100µ can be recovered. However if mercury is present, from previous processing, from contamination or from native mercury or cinnabar, then potentially explosive chemicals may form.

Nitric acid has been used in gold recovery for at least 150 years as a minor process step. Paul B. Queneau and John D. Prater of Utah invented a nitric acid method of recovering base metals and gold, patented in 1974 (US #3,793,429) assigned to Kennecott Copper. This method adds nitric acid continuously to decompose pyrite and arsenopyrite to liberate copper, gold etc. but achieves only 80% gold recovery, and requires the feed to be <53µ.

These limitations were overcome by Rein Raudsepp, Ernest Peters and Morris J.V. Beattie of Vancouver whose nitric acid method was patented in 1987 (US #4,647,307), achieving 99.3% gold recovery in laboratory conditions. However the patented process is complex and it does not seem to have become commercialised.

Operation

The concentrate must be dry and as free of magnetite as possible. The concentrate is dried by placing it in a heat-resistant metal pan on a stove. After being allowed to cool, a magnet removes the magnetite (Fe₃O₄).

The operator must have special training and wear protective clothing and eye-protection in accordance with local regulations and international norms. The 'acid site' must be out-of-doors in a well-lit fenced off area away from other people. All non-essential personnel must be excluded to minimise exposure to risk. Only one operator is needed, but a second operative should be within 10 metres to respond to any emergency. It should not be attempted if raining, snowing or in high wind.

The concentrate is put in a heat-resistant, acid-resistant, pan on a small stove inside the 'acid site' and warmed up. Then the operator uses a long-handled pot to pour hot, concentrated nitric acid into the pan of dry concentrate. The operator refrains from leaning forward and must wear protective clothing and eye-protectors. Immediately reaction starts, the operator steps back and vacates the area BEFORE heavy brown fumes appear.

The brown fumes are of nitrogen oxides and are EXTREMELY TOXIC and even trace amounts cause severe lung problems. The process is exceedingly dangerous. However, if the process is carried out outdoors in an open place then the brown fumes are blown away after a few minutes. After a short time in the atmosphere the brown fumes disintegrate into harmless nitrogen and oxygen.

Adoption by placer gold miners

The nitric acid method does not appear to be being used by placer mining companies but is being used by artisanal placer gold miners in parts of South America and elsewhere [45].

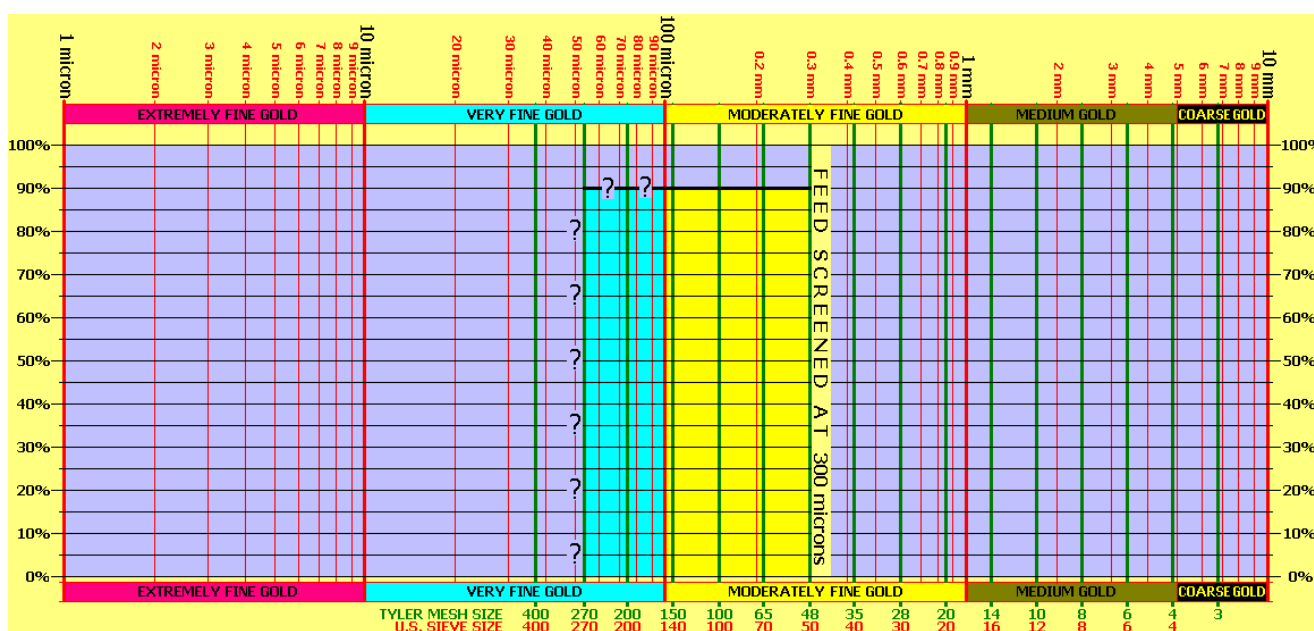


Figure 23. GOLD RECOVERY BY NITRIC ACID CLEANING
Nitric acid cleans gold and aids recovery of >90% of 100-300µ, gold but its effect on <100µ gold needs study. (compiler: Robin Grayson)