**B.T.T. ITALIA srl**
Via G. Pastore, 10 · 52100 Arezzo · Italia
Tel. +39 0575 35.68.41 Fax +39 0575 21.798 www.bttimpianti.it
bttimpianti@bttimpianti.it Capitale sociale € 60.000,00 i.v.·
C.f./P. Iva /Reg. Imprese Arezzo 00327280517 / REA 70797

# *TECHNICAL REPORT MINERAL FLEET PLANT*

*Summary:*



## *1) Introduction*

This technical report is provided by B.T.T. Italia s.r.l. and is exaggerated, but not exhaustive, for the purpose of understanding the operation relating to the plant to be built at the associated mining site.

The process studied and resulting to be at the basis of the operation of the present plant, is the result of analytical and geological studies, which the same B.T.T. Italia s.r.l. carried out in collaboration and partnership with the analysis and R&D laboratory of the Lem Industries company s.p.a. and the scientific departments of the universities of Siena and Turin.

## *2) Theoretical background*

Given the analytical results in our possession, obtained through analyzes, specific studies and tests carried out on the samples of soil supplied to us, it was agreed that the mining process of extraction and concentration of precious metals, such as gold and silver, contained were that which exploited the technique of the flotation.

The flotation process is the most important and versatile mineral processing technique. The flotation process enables the economical mining of low-grade and complex ore bodies due to its high separation efficiency and cost effectiveness. The mining industry is continually expanding to

treat greater tonnages and lower grades. Therefore, in order to enhance the flotation process further, development of practices and equipment is needed. (Tao 2005, Wills & Finch 2016)
The development of flotation equipment is one way to improve the overall flotation efficiency. The flotation machine is required to create suitable conditions to enable bubble-particle contact and enrichment of valuable minerals. These conditions include solids suspension, dispersion of air bubbles, and the right amount of turbulence for particle-bubble collision and attachment. Furthermore, all this should happen so that the process is energy-efficient. The research and development of flotation equipment requires a significant amount of test work, from computer modeling to laboratory testing and pilot scale testing, and further to plant scale testing and validating.

### *3) Principles of flotation*

Froth flotation is the most important and versatile mineral processing technique available. Froth flotation utilizes the differences in the surface properties of minerals to separate valuable minerals from gangue. (Wills & Finch 2016)
Prior to flotation, the ore is crushed and ground to the desired size fraction suitable for flotation. The slurry entering flotation is a mixture of water, solids, and reagents. Reagents are used to enhance or alter the surface properties of the minerals to enable the separation of valuable and unwanted minerals. The reagents are added at the conditioning phase and at different stages of the flotation process. (Gaudin 1957, Wills & Finch 2016).
The basic idea of the flotation process is illustrated in Figure 1, which also illustrates the main components of the mechanical flotation machine. The slurry is fed to the flotation cell where air is introduced to the slurry. The mixing mechanism provides enough turbulence in the pulp phase to promote collision of air bubbles and particles to form bubble-particle aggregates. These aggregates are then transported by buoyancy to the froth phase to be recovered in the concentrate launder. Typically, it is not possible to execute the flotation process in a single flotation cell and therefore several flotation stages are needed. Multiple flotation cells together are referred to as banks and multiple banks in turn comprise a flotation circuit. (Wills & Finch 2016)

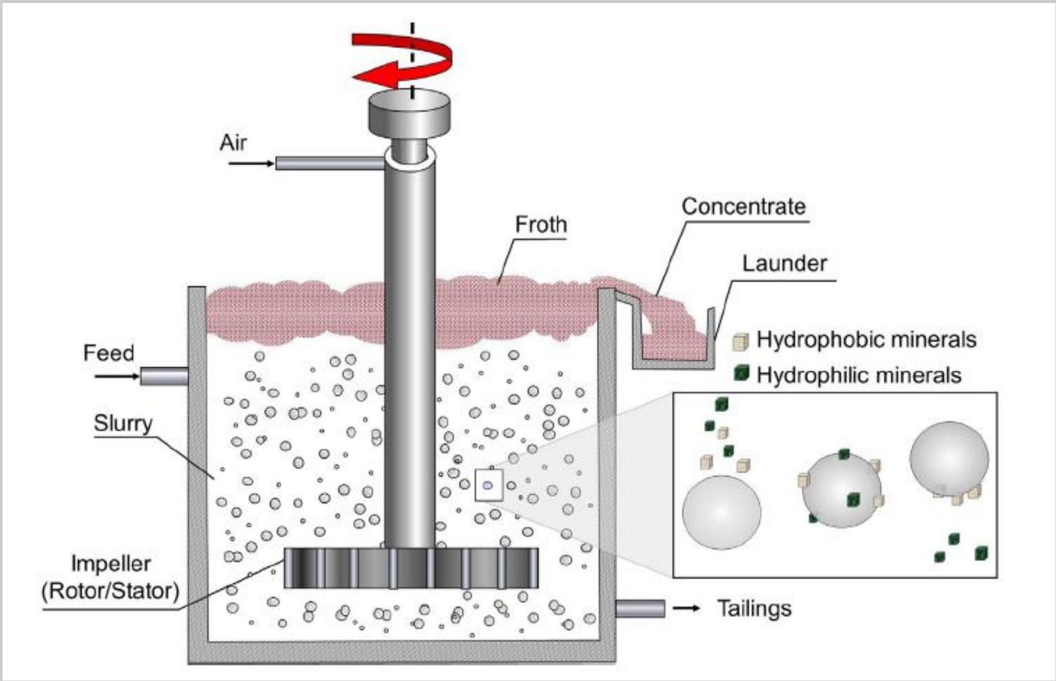



*Figure 1 Principle of froth flotation (Wills & Finch 2016).*

The mineral surface can be either hydrophobic or hydrophilic. If the surface is hydrophobic, the particle attaches to an air bubble and can thus be floated. This selective attachment of valuable minerals to air bubbles, as illustrated in Figure 1, is the most important mechanism in the flotation process and represents the majority of particles that are recovered to the concentrate. Other mechanisms for the recovery of mineral particles to the concentrate are entrainment and entrapment. These latter mechanisms are not selective to the mineral surface properties and thus reduce the separation efficiency of the flotation process. (Tao 2005, Wills & Finch 2016)

In mineral processing, the valuable mineral is usually transferred to the froth, leaving the gangue in the tailings. This is known as direct flotation, and the opposite, reverse flotation, is a process where gangue is transferred to the froth leaving the valuable minerals in the pulp. (Wills & Finch 2016)

### *4) Flotation circuit design and basic testwork requirements*

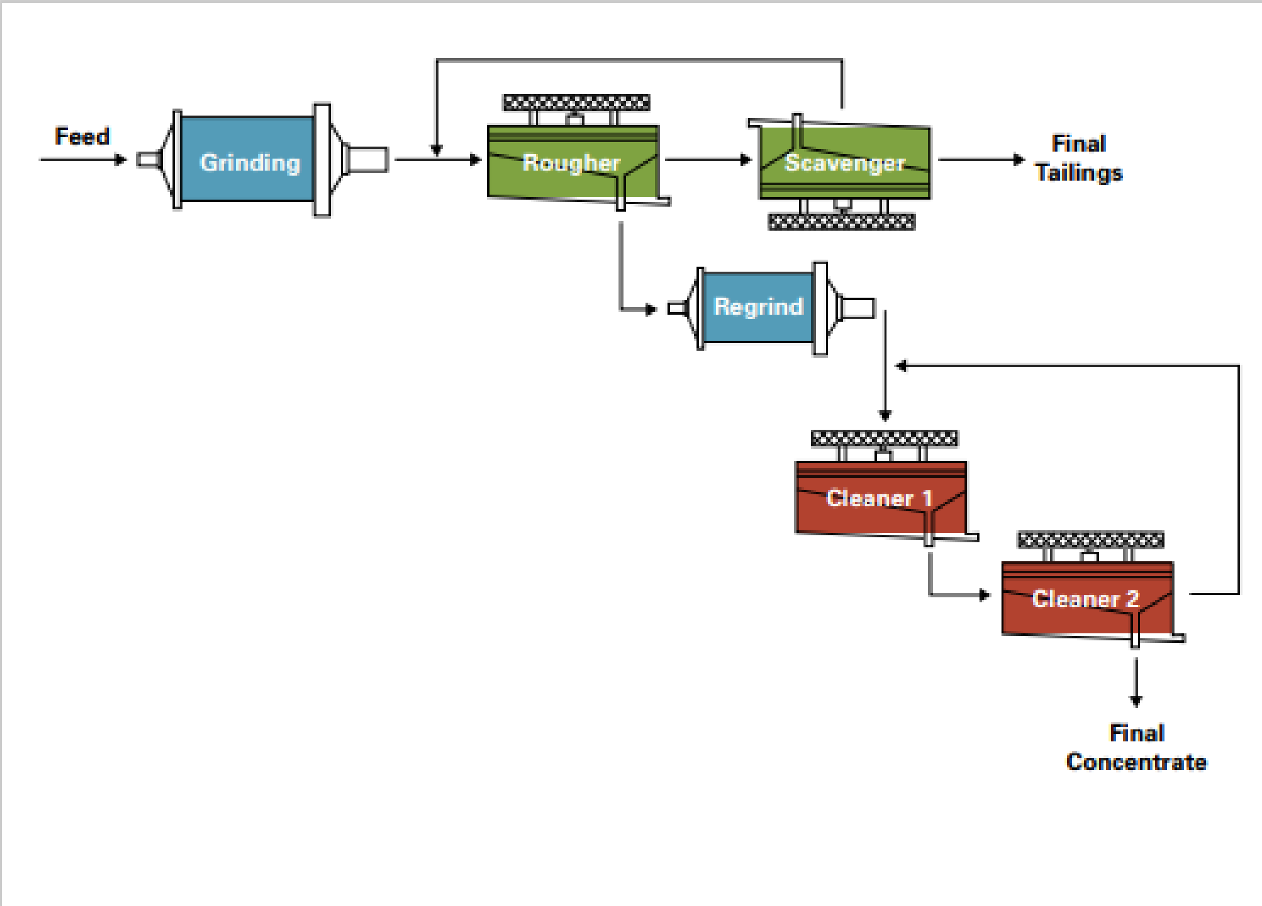
The open circuit batch flotation test work is generally the first step in an investigation.
Testwork necessary to define the design parameters for a flotation circuit generally includes:

- Grindability studies to establish grinding power requirements
- Chemical and mineralogical analyses of test composites to establish ore grades, mineral associations and liberation characteristics
- Reagent evaluations required for rougher and cleaner flotation, including:
- slurry pH
- collector dosages and typesmineral depressants and activatorsfrothers
- Rougher flotation grind-size versus recovery, including flotation of timed concentrates to evaluate flotation retention time requirements
- Cleaner flotation grind-size versus recovery, also with timed flotation concentrates
- Locked-cycle flotation tests under optimised conditions to evaluate the effect of recirculating intermediate test products on overall mineral recovery and concentrate grade
- Thickening tests on flotation tailings and final flotation concentrates
- Filtration tests on the final flotation concentrate.

The first step of this study is to determine an optimal grinding circuit tuning for the maximization of the economic value of the concentrate produced by the subsequent flotation process.
In our case, laboratory tests have shown that a very fine grinding of about 40 microns was necessary to obtain reasonable recoveries.
A flotation circuit is a combination of flotation cells and auxiliary equipment arranged to delivery the optimum results from an ore following grinding and reagent treatment on a continuous basis.
The circuit is designed from the results of laboratory results and pilot plant testing of ore samples.
Therefore, the second step for our purpose is to design and test a pilot plant, specifically a "middle ground" between a pilot plant (on a large scale) and a small-scale extraction plant with a work target of 25 tons / day. (this option is to enter directly into a productive and commercial perspective).

The choice of a small-scale extraction plant (25 tons / day) could be an advantage for the future increase in production (from 25 tons / day to 100 ton/ days and subsequently 400 ton/day) because the costs to expand and modify the plant are lower than compare to a new plant building. In general, you can design all plants to be expandable but only within reason. Going from a 25 ton/day to a 100 ton/day is really a new plant but it is possible to conserve some items or change their purpose and reuse them.
To do this it is very important to choose the right mill to apply the most efficient grinding method to improve release to increase recovery and avoid the production of "sludge" with a low float recovery.

A typical flotation flowsheet might include rougher flotation followed by scavenger flotation. The rougher and scavenger concentrates may be reground to a predetermined liberation size and then subjected to two or three stages of cleaner flotation to produce a final flotation concentrate. Cleaner flotation tailings is an intermediate product and is recycled within the flotation circuit.



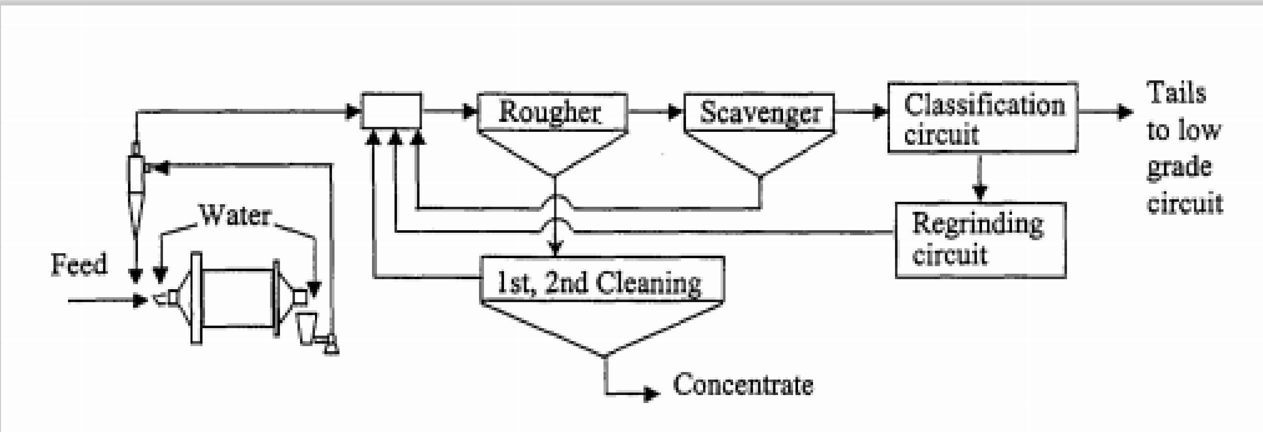




*Figure 2 Two typical flotation flowsheet*

### *5) Implementation notes and conclusion*

The plant, as previously mentioned, will pass through the realization of various intermediate steps up to the final conformation, in which it will be able to treat 400 tons of mining material per day.

The first step will be the construction of a treatment plant for 25 tons per day, consisting of a grinding machine, a ball mill to obtain a powder with a particle size of no more than 50 microns, conveyor belts, mixing tanks, plant hydraulic fluid transport, two-stage flotation cell, mechanical filtration stage with filter press, collection tanks, final treatment of wastewater through the use of granular carbon filter columns for the removal of exhausted foam products.

B.T.T. ITALIA SRL
Via G. Pastore, 10 - 52100 AREZZO
T. 0575 356841 - Fax 0575 21798
Cod. Fisc./P. Iva 00327280517