GOLD PLANTS: THE SEARCH FOR THE BEST RESULTS
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ABSTRACT

This paper presents a discussion about the importance of the gold plant considering the whole mining and shows ways to improve the operational results.

Four principal aspects were studied: suitable and reliable design, appropriate control of the main processes involved in the plant, evaluation of the performance of these processes (including development of the actions to get the goals) and optimization of the operations in order to achieve results better than those normally obtained.

The search for the best technical and economical results that ensure the continuity of the gold operations is, now, the biggest challenger of this industry. The best ways available to get good results at the gold plants are based on development of the innovative, creative and well-controlled actions, as discussed in this paper.

INTRODUCTION

Worldwide has been observed a gradual reduction of gold high grade ore resources and the need to treat more complex and lower grade ores than those processed today. Moreover, the gold price fell down, since 1997, 2nd semester (www.kitco.com, 2000). The current price is around US$ 280.00/oz in 2000. This gold price is the lowest since 1986.

The figure 1 shows the previous and the current scenery of the gold industry and the consequences of the metal price reduction. The figure also presents the need of improvement of active mines in order to increase the productivity (ratio between income and costs) and, therefore, greater operational results. Geological research investments have been reduced in the last years (Murray et alii, 1999).

THE ROLE OF THE GOLD PLANT

The treatment of gold ores is basically a hydrometallurgical process that involves a group of unit operations and processes in aqueous solution to aim at the metal extraction from ores, concentrates or tailings. The plant consists, at first, of the previous physical preparation (crushing, milling, screening, cycloning, gravity concentration in jigs, tabling or others and refractory ores pretreatment). After preparation, follow cyanidation processes (for example: heap, agitated tanks leaching), liquor treatment (activated carbon or resin...
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adsorption) and metal recovery (zinc precipitation,
desorption and electrowinning, smelting and refine).

The gold plant has the role of managing human
resources, materials (equipments, raw materials,
instruments), technology and environment. Methods
(procedures) and measurement processes need to be set
up and periodically revised, too. The plant has authority
concerning these resources and has responsibility to
produce the appropriate results (tons of the ore
processed, metallurgical recovery, operational costs,
employees satisfaction, environmental adequacy and
others). The figure 2 shows the role of the gold plant.

Figure 2 - The role of the gold plant

The gold plant could be understood like a global
management of the resources, and the results would be
straightly related to the performance of each one of the
processes involved and the perfect integration among
them.

THE SEARCH FOR THE BEST RESULTS

The competitive differential among gold plants in
worldwide is based on getting low operational costs in
order to achieving greater economical results since the
metal price is set up by Stock Exchange. The production
is previously defined considering the ROM grade, the
plant processing capacity and the metallurgical
recovery. The income of the project has been become
directly influenced by the variations of the gold price.

Special attention should be given considering very
important factors, as shown in the figure below (Figure
3), to those suitable operational results achieved by gold
plants.

Process design

The flowchart definition is based on physical,
chemical and mineralogical characteristics of the ore
(composition, solubility and minerals association,
previous concentration evaluation, and mainly grade),
production scale, geological resource level and metal
price.

There is an important influence of the ore
mineralogical composition (cyanide consumer minerals
and gold particle size) on the extraction result. A detailed study has to be developed during the project phase of the plant. The effects of minerals like pyrrhotite, marcasite, pyrite, some copper or arsenic soluble sulphides in cyanide solutions and others, have to be evaluated to aim at avoiding problems involving low metallurgical recovery or high cyanide consume. The samples used to define the flowchart must be representative of the ore body to be exploited, specially in case of underground mines. Samples that do not represent the ore during the mine life can cause serious problems in the plant (Work Index higher than expected or low ore competency for using in SAG or FAG milling or modes of gold occurrence, what increase the reagents costs or reduce recovery). In consequence, lower production capacity or higher operational costs occurs.

**Process control**

The group of processes involved in the plant is like a chain composed by links that represent each one of the unit operations. The result depends on the performance of each link and on the integration among them. An adequate control of the processes help to get the expected operational result of each unit operation and, in consequence, the achievement of the planned goals.

The process control is established using the following steps: the identification of each unit operation characteristics (inlet, product specification, transformation mechanism, variables involved), the method definition, the frequency of measuring the performance, the record of the performance and the comparison with the goals, the standardization of the processes and the tasks involved, and the training of operational and maintenance personnel. Therefore, the anomalies prevention concept can be used and the process shows lower deviation. The answer for the problems becomes faster and more effective. In this case, gains of productivity are normally observed.

There is another precious concept that has to be applied in gold plants. It is the internal customer-supplier relationship. For example, each unit operation is customer or supplier of the previous or the following operation, respectively. Each supplier has to be worried about the characteristics of his product and these characteristics have to be inspected by the customer. If the product is out of the specification, the customer sends red signals and the supplier needs to correct the problem as fast as possible. It is very clear when the example is crushing/screening and milling. The particle size of the crushing/screening product has to be adequate to the following operation, the milling, in order to avoid problems with low production or non-conforming milling product (Gomes, 1999-2).

Therefore, the process control is based on the development of the systematic and standard actions to accomplish the process. In addition, the measurement of the performance characteristics have to be done in order to maximize the probability of occurrence of the expected product.

**Process evaluation**

The presentation of benchmarking in graphs like operational costs is very interesting, because it shows that the plant manager has the knowledge of the plant position considering other plants in the world. If the manager knows the gap between his plant and the benchmarking, he can develop efforts, plans and actions to achieve better results and to become more competitive in comparison with the others.

In case of failure in any process (the expected result is not achieved), the causes of the problem has to be evaluated and the Failure Analysis done. Operational problems have to be analysed based on human resources, the machine, the method, the material and the environment.

**Process optimization**

Nowadays, the gold plants have improved their operations to achieve better productivity indices (Gomes, 2000). The main enhancements have been: new processes to treat refractory ores, the replacement of CIP (Carbon in Pulp) to RIP (Resin in Pulp), the breakthrough of the tailings control, the use of leach alternative reagents (Swaminathan et alii, 1993); the selective electrowinning in diluted solutions, commercial bихydration applied to sulphide ores (Natarajan, 1990), the improvement in the analysis and control processes systems, the development of dissolved oxygen, pH and cyanide online measurements, the use of centrifugal concentrators in the gravity concentration operations, the use of the peroxides and pure oxygen during leaching, the implementation of the environmental programs, and others.

**CONCLUSION**

The productivity (ratio between income and operational costs) is the key-word in the gold industry. The success of the processes involved in the gold plants is based on determining the best operational conditions
in each particular system, in the continual accomplishment of these conditions and in the development of the preventive and corrective actions, in real time, in order to achieve the expected results.

It is necessary to know the best performance of the processes that can be achieved, for each kind of ore since each one is unique in its characteristics.

**BIBLIOGRAPHY**


