

Sandioss, an alternative reactive to NaCN for the Au leaching process by agitation for an oxide type mineral

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Resumen

Se estudió la influencia del reactivo Sandioss como alternativa para la lixiviación de oro por agitación de un mineral tipo óxido. Las variables evaluadas fueron: el potencial de hidrogeno (pH) con niveles 7, 9 y 11, la concentración del lixivante "sandioss" a 250 ppm, 500 ppm y 750 ppm, y el tiempo de lixiviación a 12, 24 y 48 horas. Para cada concentración del agente lixivante se realizó una prueba en paralelo con cianuro de sodio a un pH=11 para evitar que el cianuro se volatilice. Las soluciones tomadas fueron analizadas por absorción atómica para determinar el contenido de oro en dicha solución y las colas fueron analizadas por ensayo al fuego. Del resultado de las pruebas de lixiviación se puede concluir que para una mejor extracción de oro con el lixivante sandioss, se obtiene a una concentración de 750 ppm de sandioss, pH de 11 y tiempo de agitación de 48 horas, obtuvo 79,15 % de extracción. Finalmente, con el análisis de varianza a un nivel de 95% de confianza se demuestra que las variables estudiadas influyen significativamente en la extracción de oro y se presenta como una alternativa al uso del NaCN.

Palabras clave: lixiviación, potencial de hidrógeno (pH), concentración, Sandioss

Abstract

The influence of the Sandioss reagent was studied as an alternative for the gold's leaching by agitation of a mineral-type oxide. The evaluated variables were: the hydrogen potential (pH) with levels 7, 9 and 11, the concentration of Sandioss leach at 250 ppm, 500 ppm and 750 ppm, and the leaching time at 12, 24 and 48 hours. For each concentration of the leaching agent, a test was conducted in parallel with sodium cyanide at a pH = 11 to prevent the volatilization of cyanide. The solutions taken were analyzed by atomic absorption to determine the gold content in solution and tails were analyzed by fire assay. From the result of the leaching tests it can be concluded that for a better gold extraction with the Sandioss leaching, it is obtained at a concentration of 750 ppm of Sandioss, pH of 11 and time of 48 hours, obtained 79.15% extraction. Finally, the variance analysis at a level of 95% confidence shows that the variables studied significantly influence the extraction of gold and is presented as an alternative to the use of NaCN

Keywords: leaching, hydrogen potential (pH), concentration, Sandioss.

1. Introduction

The Sodium cyanide allows us a good recovery of gold and silver, but it also has effects on the pollution of the environment (biodiversity, water resources and human health, being one of the consequences of mining practice. To avoid these consequences in the practice of mining researchers have determined through studies other reagents that can be used as a leaching agent and obtain a good recovery percentage of gold and silver, such as Golmax, Jin zhibao, Sandioss, among others. The aim is to evaluate the leaching with Sandioss at different pH, concentrations and time until 48 hours by agitation, maintaining the control parameters similar to sodium cyanide, in order to obtain a better percentage of gold extraction and decrease the costs of the reagents used in the gold leaching process. It was determined the influence of hydrogen potential (pH), the concentration of Sandioss and the leaching time in the percentage of gold's extraction from a type oxide mineral by leaching in agitation.

2. Materials and Methods

Object of study

The object of the study was an oxide-type gold ore from the province of Pataz, department La Libertad, which presents, according to chemical analysis, an average gold grade of 13.30 g/MT.

The ore was treated using leaching by agitation, to do the gold's extraction and its relationship with the hydrogen potential (pH), concentration of Sandioss leach and the leaching time.

Methods and techniques

To carry out the leaching tests with Sandioss of gold ore, the constant monitoring of each one of the variables to be controlled during 48 hours was taken into account, since it is the duration of each experimental test. 1000 kg of gold ore from the province of Pataz was sampled, the ore was dried at 110 ° C + -5 ° C in an oven for 12 hours (ASTM D-2216), then the mechanical preparation of the ore was done in order to obtain the release of valuable particle (Bustamante et al., 2008), the respective quartering was performed to obtain the representative sample, 250 g was sprayed during 5 minutes until obtaining the granulometry of the required mineral. A chemical analysis of the ore was made to obtain head law using the fire test method. Then the alkalinity test was performed to determine the natural pH of mineral. Then the bottles were prepared and each one was added mineral and water in a ratio of 33% solid and 67% liquid (1 to 2). For this case study it was used 500 g of mineral and 1L of water for each bottle and the test was run for 48 hours

The study tests was carried out by leaching the bottle with sodium cyanide, with a pH of 11 for each concentration of 250ppm, 500ppm and 750ppm used to be the standard sample, since the Sandioss does not have a defined chemical composition. Therefore, the replenishment control of leaching reagent was made based on the consumption of sodium cyanide. Each test that was carried out at different concentrations of Sandioss was titrated and analyzed by atomic absorption equipment, for which 25 mL of solution was removed 12, 24 and 48 hours after the start of the test, while the sacrifice test (leaching with sodium cyanide) helped determine the consumption of the leach. Finally was proceeded to make the respective metallurgical balance based on the head law, the solution's laws and the laws of the respective tailings, to determine the percentage of gold extraction. Data processing is carried out with the Minitab 17 program. The experimental design to be used for the analysis of the results of the experimental tests will be a trifactorial design with 3 independent variables (leaching time, concentration of Sandioss leach and hydrogen potential (pH), with three levels for each variable and applied to a single dependent variable (percentage of gold extraction). The number of experimental tests were 54 taking into account that the number of repetitions will be 2 for each variable.

3. Results

Characterization of sample

The values of the chemical composition in gold obtained by fire test for gold are shown in Table 1.

Table 1. Chemical composition of sample

Element	Law (g/MT)
Au	13.30

Main effect of the concentration of Sandioss on the percentage of gold extraction.

The gold extraction values are shown as a function of the concentration of the water-soluble leach In Table 2. From the statistical analysis carried out, it was determined that the concentration of the Sandioss lixiviant (ppm) has a significant effect on the percentage of gold extraction, showing a higher value at a concentration of 750 ppm, with a gold extraction percentage of 49.17%.

Table 2. Sandioss concentration and gold extraction

Concentration of sandioss (ppm)	Au extraction (%)
250	61.66
500	69.71
750	79.15

The relationship of Sandioss leach concentration vs. % Au extraction is shown in Figure 1.

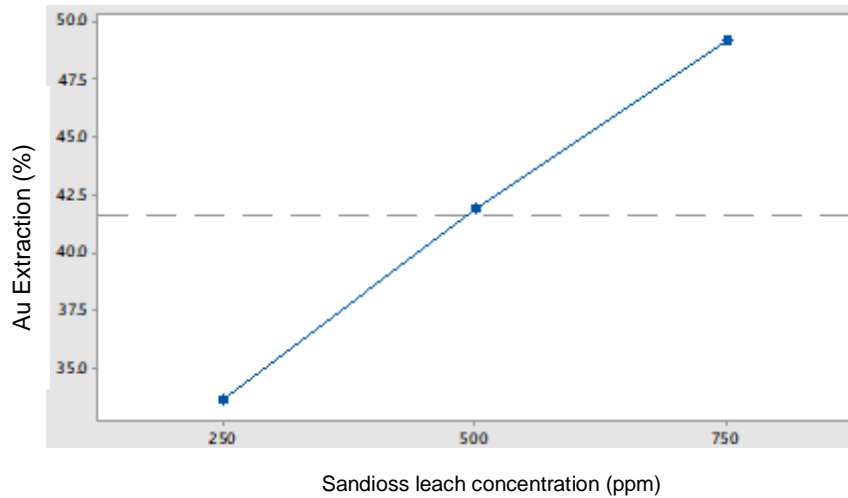


Figure 1. Sandioss leach concentration vs. Au extraction (%)

Main effect of the leaching time on the percentage of gold extraction.

In Table 3, gold extraction values are shown as a function of leaching time. The leaching time (h) has a significant effect on the percentage of gold extraction, showing a higher value at a leaching time of 48 hours, with the percentage of gold extraction to 55.95%.

Table 3. Leaching time and gold recovery

Leaching Time (h)	Au Extraction (%)
12	42.92
24	57.02
48	79.15

The relationship of Leaching time vs. Au extraction (%) is shown in Figure 2.

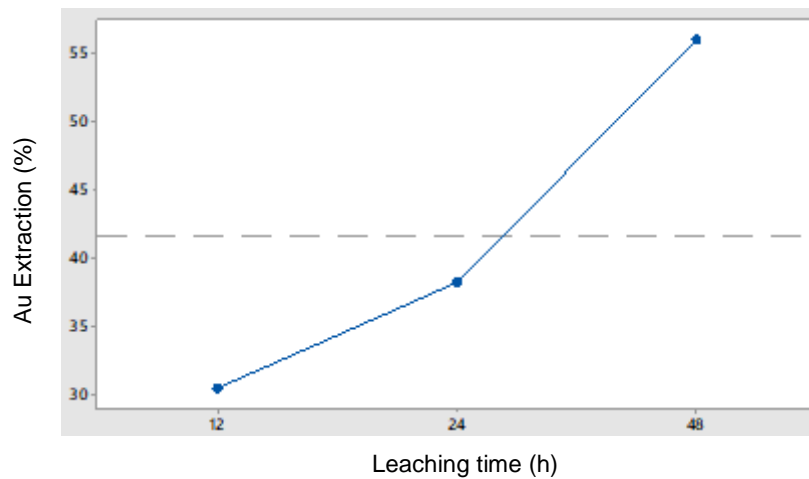


Figure 2. Leaching time vs. Au extraction (%)

Potential main effect of hydrogen on the percentage of gold extraction

In Table 4, the gold recovery values are shown as a function of the hydrogen potential (pH). From the statistical analysis carried out it was determined that the hydrogen potential (pH) has a significant effect on the percentage of gold extraction, showing a higher value at a hydrogen potential (pH) of 11, with the percentage of gold extraction being 50.10 %.

Table 4. Hydrogen Potential (pH) and Gold Extraction

hydrogen potential (pH)	Au extraction (%)
7	46.09
9	70.74
11	79.15

The relationship of Leaching time vs. Au extraction (%) is shown in Figure 3

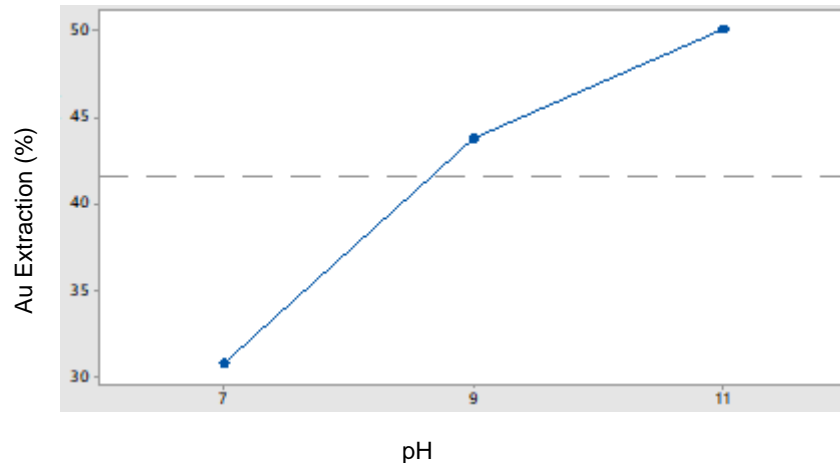


Figure 3. Potential of hydrogen vs gold extraction (%)

4. Conclusions

- The Sandioss concentration significantly influences the percentage of gold extraction. The highest value was achieved with a concentration of 750 ppm.
- The hydrogen potential (pH) significantly influences the percentage of gold extraction for an oxide type mineral by agitation leaching, obtaining the highest extraction percentage at pH 11.
- The leaching time is a very influential variable in the percentage of gold extraction through the process of leaching by agitation. The highest value was achieved at a time of 48 hours.
- The concentration of the water-soluble leach, the hydrogen potential (pH) and the leaching time positively influence the extraction of gold for an oxide type mineral by agitation leaching, obtaining the highest percentage of extraction of 79.14%.

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