**Design and Conception of a Membrane Pilot Plant for the In-Situ Treatment of Bioleaching Solutions.**

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**Highlights**

* Enhancing of sustainability by a new ore extraction downstream method
* In-situ treatment of leaching solutions by selective membrane technology.
* Presentation of a Membrane pilot plant located at an underground mine site.

**1. Introduction**

Regarding the advancement of the industrialized world, the demand of strategic elements for the production of high tech products is rising steadily. Furthermore, the worldwide deposits of high-grade ores are going to be depleted within the next decades. The acceptance for new mining activities in the industrialized countries is very low. Consequently, there are two possibilities: First to enhance the processing of low-grade ores, overburden and waste material from former mining activities. Second to use new mining technologies which are more environmental friendly due to the combination of direct winning of solubilized product stream and in-situ down-stream-processing. Biohydrometallurgy is technically and economically employed for the treatment of ore material with depleted metal content as well as increasing complexity (1-3) which finally leads to a more sustainable technology of winning valuable metals.

A testing site for in-situ bioleaching was established in an underground mine to recover indium and germanium from a zinc sulfide ore vein. The downstream processing of the resulting pregnant leaching solution (PLS) is also realized as in-situ application by means of a membrane pilot plant, which was exclusively designed for this special application (4).

**2. Methods**

In-situ bioleaching is performed at the research and training underground mine ‘‘Reiche Zeche’’ of the Technical University Bergakademie Freiberg. The ore vein is embedded in gneiss as host rock and its main constituents are galena (PbS), sphalerite (ZnS), pyrite (FeS2), arsenopyrite (FeAsS) and chalcopyrite (CuFeS2). Indium is naturally enriched in sphalerite due to geochemical reasons (5).

The PLS is characterized by high concentrations of the main metal ions zinc, iron and copper. On the contrary indium and germanium are less concentrated by several orders of magnitude. The in-situ bioleaching site has been extensively characterized by geoelectric and seismic measurements to determine the spatial dimension of the ore vein.

The nanofiltration (NF) experiments for the technical design of the membrane pilot plant were performed in cross-flow mode with flat-sheet membrane NF99HF (Alfa Laval) using a synthetic leaching solution (Zn, Fe, Cu, Cd, Pb, In, Ge) to guarantee experimental conditions which are close to the real application.

**3. Results and discussion**

When performing lab scale NF experiments in continuous cross-flow mode within a pH range between 2 and 8, the separating behavior of Zn, In and Cu is nearly identical and the retention rate is above 70 %. In contrast, germanium shows a significantly lower retention rate in the pH range under review. The high retention of In, Zn, Cu and Fe indicate a positive membrane charge due to electrostatic repulsion between the positively charged metal cations and the membrane charge (6).

Based on the experimental investigations of about 4 years, a membrane pilot plant including a microfiltration and NF stage was designed and constructed for the in-situ treatment of the PLS at the first level of the research mine (-147m). Regarding the extreme environmental conditions in terms of high humidity, the design and choice of construction material was of special concern. Furthermore, due to the compact design of the membrane pilot plant there is only little space required, which is especially suitable for underground mines.

**4. Conclusions**

Within the scope of current research an in-situ bioleaching testing site has been installed at the research and training mine Reiche Zeche of the Technical University Bergakademie Freiberg including an in-situ treatment of the PLS by using membrane technology. The bioleaching aims to win indium and germanium from a sulfidic ore vein. Lab-scale NF experiments in cross-flow mode showed that the leaching solution is successfully concentrated without a loss of separation performance. The membrane pilot plant was finally designed and constructed based on experimental results with the continuous cross-flow membrane unit.

By using membrane technology in the underground mine PLS is efficiently treated regarding pre-concentration of the valuable metal ions as well as reducing the total amount of process water.

**References**

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