Application Note AN-PAN-1002

Online monitoring of cyanide and gold in gold leaching solution

Cyanidation is a common chemical leaching method for extracting gold from ore. To ensure efficient leaching and gold recovery, precise measurement of cyanide levels is crucial, with automatic refill systems in place for leaching tanks.

Monitoring WAD (weak acid dissociable) cyanide levels provides insight into the metals being processed and aids in optimizing the cyanidation process. This measurement also helps monitor wastewater discharge as well as detoxification efforts which are important to meet environmental regulations.

The use of online process analyzers allows for real-time monitoring of cyanide levels as well as metals in solution (e.g., gold), enabling process operators to make timely adjustments to improve efficiency and comply with strict regulations.

This Process Application Note details the online analysis of cyanide and gold in the gold recovery process. The 2060 TI Process Analyzer and the 2060 XRF Process Analyzer from Metrohm Process Analytics offer precise and efficient measurements, cutting down on time, labor, and human errors.

INTRODUCTION

Cyanide is a widely used industrial chemical, mainly for the mining of gold, silver, and platinum [1]. Cyanide helps to dissolve these metals from their ores in a process known as cyanidation.

This process involves crushing the ore and then leaching precious metals from it using a solution of sodium cyanide (NaCN) or potassium cyanide (KCN) [2]. The cyanide ions (CN^-) form a complex with gold, which dissolves in solution for further extraction in downstream processes (e.g., by electrowinning, Figure 1).

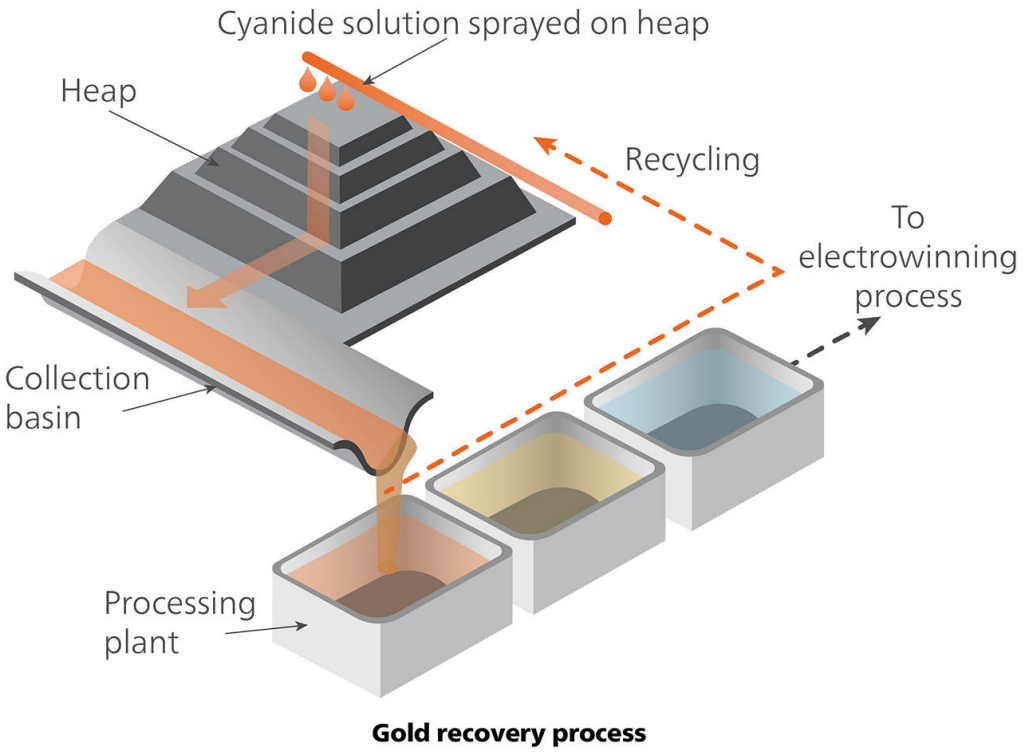

Figure 1. An illustrated diagram of the gold recovery process.

To ensure successful leaching and gold recovery, accurate measurements are necessary to automatically refill cyanide in the leaching tanks and maintain reduced cyanide levels in the mill waste stream.

The measurement of WAD cyanide gives process operators an immediate indication of the WAD metals being processed to further optimize the cyanidation process. WAD readings are also an early indicator for the detoxification plant to optimize the cyanide destruction process coupled with automatic dosage of the cyanide detoxification chemicals.

Additionally, releasing any form of cyanide can cause severe damage to the environment; therefore, strict wastewater monitoring for free cyanide, WAD cyanide, or TCN (total cyanide) is required to comply with plant discharge regulations.

Traditionally, cyanide concentrations have been

monitored using manual laboratory methods (e.g., titration). While capable of providing data, these methods suffer from several disadvantages.

Manual sampling introduces delays in obtaining results, making the data less reflective of the current status of the cyanidation process. Moreover, manual sampling is labor-intensive, dangerous (due to cyanide toxicity), and prone to human error, leading to potential inaccuracies in the measurements. Additionally, the intermittent nature of manual sampling may fail to capture sudden fluctuations in cyanide concentrations, potentially compromising process control and environmental compliance.

By integrating online process analyzers into the refinery, operators can quickly check the cyanide levels in the leaching process and in the wastewater effluent. This helps them make corrections to improve efficiency and reduce harm to the environment.

APPLICATION

Cyanide can be determined in several ways with the 2060 TI Process Analyzer (Figure 2). Free cyanide is analyzed by direct titration or photometric detection depending on the concentrations involved. For more complex total cyanide and WAD determinations, the 2060 TI Process Analyzer can be equipped with an array of digester, condenser, caustic absorber, and photometer modules to guarantee full recoveries of cyanide from complex metal cyanide solutions.

The time-consuming analysis can be completely automated with the 2060 TI Process Analyzer. Benefits include time savings and measurement consistency with no exposure to cyanide, offering safe and trusted measurements throughout the refinery.

Figure 2. 2060 TI Process Analyzer.

Additionally, gold and other metals can be monitored with the 2060 XRF Process Analyzer (Figure 3). Utilizing Energy Dispersive X-ray Fluorescence (EDXRF) technology, this online process analyzer provides exceptional sensitivity when measuring gold in the stripping solution in almost real-time.

Detection limits for XRF analysis are influenced by various factors such as analysis time, sample preparation, and calibration methods. Thanks to its advanced silicon drift detector and synergistic use of multiple analysis techniques, the 2060 XRF Process Analyzer achieves precise and low detection limits, particularly for precious metals like gold.

Incorporating both analysis techniques (i.e., titration/photometry and XRF) in the 2060 XRF Process Analyzer offers users a comprehensive solution for monitoring cyanide levels and metal concentrations in the gold recovery process. This integration enhances plant safety, ensures full recoveries of cyanide from complex solutions, and accelerates return on investment (ROI) by consolidating both methods into one analyzer, thereby reducing footprint and operational costs.

Figure 3. 2060 XRF Process Analyzer.

Table 1. Parameters to monitor in the gold recovery process.

Parameters	Concentration	Technique
Free cyanide	0–200 µg/L	Photometry
WAD Cyanide	1–250 mg/L	Titration
Gold (Au)	mg/L to %*	XRF

REMARKS

The total cyanide method is based on ISO 6703/1 and WAD cyanide on method 4500-CN-Standard Methods for the Examination of Water and Wastewater.

The cyanidation process must operate at pH levels above 10.5, typically ranging from 11 to 12, to prevent the formation of hazardous hydrogen cyanide (HCN) gas. Consequently, reliable pH monitoring is essential in such demanding environments, and Metrohm Process Analytics ProTrode pH sensors excel in providing inline monitoring solutions for this purpose.

CONCLUSION

Cyanide is an important parameter to measure in the gold recovery process and its effluent. The 2060 TI Process Analyzer by Metrohm Process Analytics helps analyze cyanide regularly to overcome errors and ensure compliance with regulations. Additionally, the 2060 XRF Process Analyzer effectively monitors gold levels in the stripping solution.

Together, these online process analyzers provide a comprehensive understanding of the gold recovery process by simultaneously monitoring any form of cyanide and gold in a safe and efficient manner.

REFERENCES

1. *The Safe and Effective Use of Cyanide - Society for Mining, Metallurgy & Exploration.* https://www.smenet.org/what-we-do/technical-briefings/the-safe-and-effective-use-of-cyanide-in-the-minin (accessed 2024-03-20).
2. Hai, X. *The Ultimate Guide to Gold Cyanidation.* https://www.cnlitereagent.com/special-guide/ultimate-guide-gold-cyanidation/ (accessed 2024-03-28).

RELATED APPLICATION NOTES

AN-PAN-1006 Online analysis of zinc, sulfuric acid, and iron during zinc refining

OTHER RELATED DOCUMENTS

8.000.5317 2026 Cyanide Analyzer

AN-I-009 Cyanide in water

BENEFITS FOR ONLINE PROCESS ANALYSIS

- No manual sampling needed, thus less exposure of personnel to dangerous chemicals (cyanide).
- Guarantee compliance with governmental regulations for wastewater effluent.
- Optimize product quality and increase profit with fast response times for process variations.
- Fully automated diagnostics – automatic alarms for when samples are out of specification parameters.

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CONFIGURATION

2060 Process Analyzer

Le 2060 Process Analyzer est un appareil d'analyse par voie humide online adapté à un grand nombre d'applications. Cet appareil d'analyse de processus propose un nouveau concept de modularité reposant sur une plate-forme centrale, dénommée « armoire de base ».

Cette armoire de base se compose de deux parties. La partie supérieure contient un écran tactile et un PC industriel. La partie inférieure contient la partie humide flexible dans laquelle est logé le matériel nécessaire à l'analyse en elle-même. Si la capacité de base de la partie humide n'est pas suffisante pour résoudre un problème d'analyse, vous pouvez ajouter jusqu'à quatre armoires de partie humide supplémentaires à cette armoire de base afin de disposer de suffisamment d'espace pour résoudre les applications les plus difficiles. Les armoires supplémentaires sont configurables de manière à ce que chaque armoire pour partie humide puisse être combinée à une armoire à réactifs avec détection de niveau intégrée (sans contact) afin d'augmenter la disponibilité de l'appareil d'analyse.

Le 2060 Process Analyzer propose différentes techniques de chimie par voie humide : le titrage, le titrage Karl Fischer, la photométrie, la mesure directe et des méthodes d'addition standard.

Pour répondre à toutes les exigences de projet (ou à tous vos besoins), des systèmes de préconditionnement d'échantillons peuvent être fournis afin de garantir une solution analytique robuste. Nous pouvons pour ainsi dire fournir tout système de pré-conditionnement d'échantillon, tels que refroidissement ou chauffage, réduction de la pression, dégazage, filtration et bien plus encore.

2060 XRF Process Analyzer

Le **2060 XRF Process Analyzer** est un appareil d'analyse de processus en ligne non destructif utilisant une technologie de fluorescence X à dispersion d'énergie (EDXRF). Cet analyseur garantit un contrôle précis et pratiquement en temps réel de flux d'échantillons liquides au sein de processus industriels.

Capable de connecter jusqu'à 20 points d'échantillonnage, le **2060 XRF Process Analyzer** facilite une analyse XRF en ligne transparente. Dans le cadre de la plateforme 2060, il intègre parfaitement plusieurs techniques d'analyse dans une seule plateforme unifiée. Découvrez la puissance de l'association XRF avec le titrage ou la photométrie pour obtenir des informations complètes sur les processus comme jamais auparavant.