

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).

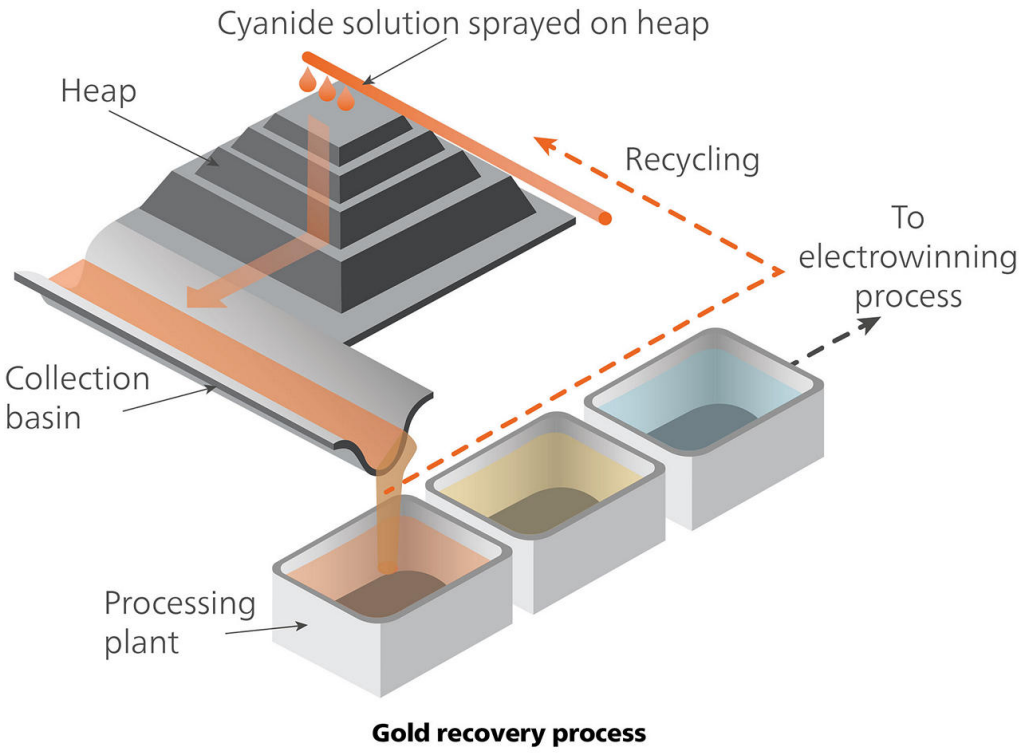


Figure 1. An illustrated diagram of the gold recovery process.

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

The 2060 Process Analyzer is an online wet chemistry analyzer that is suitable for countless applications. This process analyzer offers a new modularity concept consisting of a central platform, which is called a «basic cabinet».

The basic cabinet consists of two parts. The upper part contains a touch screen and an industrial PC. The lower part contains the flexible wet part where the hardware for the actual analysis is housed. If the basic wet part capacity is not sufficient enough to solve an analytical challenge, then the basic cabinet can be expanded to up to four additional wet part cabinets to ensure enough space to solve even the most challenging applications. The additional cabinets can be configured in such a way that each wet part cabinet can be combined with a reagent cabinet with integrated (non-contact) level detection to increase analyzer uptime.

The 2060 process analyzer offers different wet chem techniques: titration, Karl Fischer titration, photometry, direct measurement and standard additions methods.

To meet all project requirements (or to meet all your needs) sample preconditioning systems can be provided to guarantee a robust analytical solution. We can provide any sample preconditioning system, such as cooling or heating, pressure reduction and degassing, filtration, and many more.



2060 XRF Process Analyzer

The 2060 XRF Process Analyzer is a non-destructive online process analyzer employing Energy-Dispersive X-ray Fluorescence (EDXRF) technology. This analyzer ensures precise and nearly real-time monitoring of liquid sample streams within industrial processes.

With the capacity to connect up to 20 sampling points, the 2060 XRF Process Analyzer facilitates seamless online XRF analysis. As part of the 2060 Platform, it seamlessly integrates multiple analysis techniques into one unified platform. Experience the power of combining XRF with titration or photometry for comprehensive process insights like never before.