



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**).

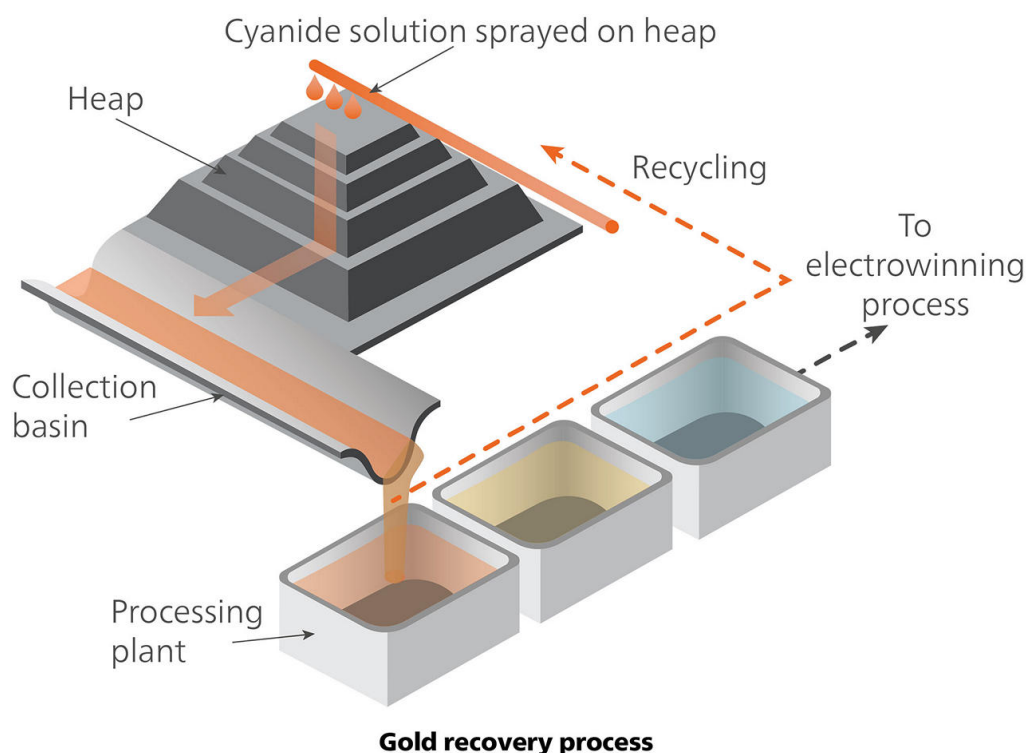


Figure 1. An illustrated diagram of the gold recovery process.

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

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.

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.



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 g/L	Photometry
WAD Cyanide	1–250 mg/L	Titration
Gold (Au)	mg/L to %*	XRF

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

2060 Process Analyzer 是一种在线湿化学分析仪,适用于无数应用。此过程分析仪提供了一个新的模块化概念,由一个称为«主机柜»的中心平台组成。

主机柜由两部分组成。上部包含触摸屏和工业计算机。下部含有柔性取样部,其中放有用于实际分析的硬件。如果主取样部容量不足以应对分析挑战,那么主机柜可以扩展为多达四个额外的取样部机柜,以确保有足够的空间来应对具挑战性的应用。附加机柜的配置方式使每个取样部机柜可以与具有集成(非接触式)液位检测的试剂柜组合使用,以增加分析仪的正常运行时间。

2060 Process Analyzer 提供不同的湿化学技术:滴定法、卡尔费舍尔滴定法、光度测定、直接测量和标准添加法。

为满足所有项目要求(或满足您的所有需求),可提供样品预处理系统,以确保分析解决方案可靠。我们可以提供任何样品预处理系统,如冷却或加热、减压和脱气、过滤等。



2060 XRF Process Analyzer

2060 XRF Process Analyzer 是一款采用能量色散 X 射线荧光 (EDXRF) 技术的无损在线过程分析仪。该分析仪可确保对工业过程的液体样品流进行准确和近乎实时的监测。

2060 XRF Process Analyzer 能够连接多达 20 个采样点,有助于在线 XRF 无缝分析。作为 **2060 平台** 的一部分,它将多种分析技术无缝集成到一个统一的平台中。体验 XRF 与滴定或光度分析相结合的强大功能,非常少有地了解全面的过程。