

The WAD Cynoprobe is Mintek's state of the art cyanide measurement instrument. It is based upon the proven technology of Mintek's Cynoprobe Version 2 Analyser (used to measure 'free' (titrateable) cyanide) and includes additional functionality in that it can measure both 'free' and WAD* cyanide concentrations online.

The outputs from the WAD Cynoprobe can be used as follows:

- The 'free' cyanide concentration reading can be employed as part of a cost-saving cyanide management strategy.
- The WAD cyanide reading can be used to control and optimise the cyanide destruction and recovery process as well as measuring the WAD cyanide discharge levels from the process.
- The 'free' and WAD cyanide outputs can be compared. The difference between these values give an indication of the concentration of WAD metals being processed – useful information when optimising the cyanidation process.

MINTEK has been active in the field of novel instrumentation design, manufacture and installation for industrial plants world-wide since the early 1970's.

The Cynoprobe has produced accurate measurement of 'free' cyanide concentration on a variety of ore types. The Cynoprobe's fast and reliable measurements allow for detection of changes in cyanide concentration very quickly.



The WAD cynoprobe Analyser, Processor and LEX Units.

Mintek's broad Cynoprobe install base includes various installations across Africa, North and South America and Australasia. A reference list is available on request.



* WAD (Weak Acid Dissociable) cyanide refers to those cyanide species measured by specific analytical techniques. WAD cyanide includes those cyanide species liberated at a moderate pH of 4.5 such as HCN(aq) and CN⁻, the majority of Cu, Cd, Ni, Zn, Ag complexes and others with similar low dissociation constants (weak acid dissociable)

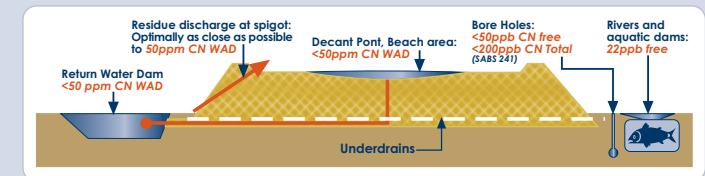
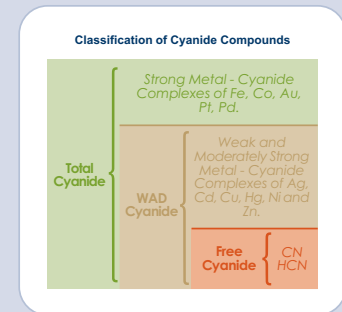
WAD Cyanide and it's effects on the environment.



WAD Cyanide is complex "Weak Acid Dissociable" cyanide, bound to the metals Zn, Cd, Cu, Hg, Ni and Ag. It is liberated at a moderate pH of 4.5 and is potentially toxic to humans and animals.

In the interests of the environment, gold plants voluntarily prescribe to the International Cyanide Management Code ([visit www.cyanidecode.org](http://www.cyanidecode.org) for further information).

The objective of the Code is to improve the management of cyanide used in gold mining and to assist in the protection of human health and the reduction of environmental impacts associated with the use of cyanide. In particular the code specifies the following cyanide concentration limits as shown in the following schematic:

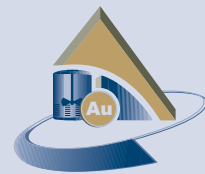


The residue concentration limit of 50ppm is sufficiently protective of terrestrial life (birds, animals and humans). Aquatic life requires a limit of three orders of magnitude lower. This existing limit is likely to be further reduced in the near future.

Gold plants using cyanide should measure WAD Cyanide on-line and destroy WAD cyanide in excess of the applicable limits to ensure compliance with the code.



WAD* CYANIDE ANALYSIS



* Weak Acid Dissociable



Specialists in mineral and metallurgical technology

Measurement Principle

'Free' cyanide

The Cynoprobe uses an amperometric technique to accurately and reliably measure the concentration of cyanide available to leach gold in a pulp medium.

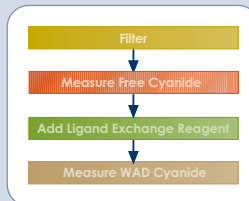
Amperometry	Potentiometric Titration
Cynoprobe measures the cyanide available for the leaching of gold. It not only measures free cyanide but also the cyanide available to leach gold in weak and moderate metal cyanide complexes.	Potentiometric titration measures 'titrateable' cyanide, that is free cyanide and cyanide in weak metal cyanide complexes.
The amperometric technique takes place on a microscopic scale so that the equilibrium between the free cyanides and the cyanides bound to the various metal species does not change.	During titration the free cyanide in solution is consumed by $\text{Ag}(\text{NO}_3)_3$ and a shift in the equilibrium results in some of the cyanides bound to metal species being liberated. This stretches out the end-point of the cyanide concentration, and the titration over detects the presence of cyanide. This is especially problematic when there is a high copper concentration associated with the ore.
Analysis times are very rapid, with a signal update frequency of 3-5 minutes.	The analysis procedure for potentiometric titration is slow and the end point is difficult to detect.
Amperometry does not consume chemicals and is not dependant upon the assumption that reagents are prepared to a specific concentration.	Potentiometric titration consumes $\text{Ag}(\text{NO}_3)_3$ and the measured cyanide concentration is dependant upon the assumption that the $\text{Ag}(\text{NO}_3)_3$ reagent solution has been accurately prepared to a known concentration.

WAD cyanide

The WAD Cynoprobe measurement principle is based on the use of a ligand exchange reagent that liberates WAD cyanide bound to metals such as Zn, Cd, Cu and Ni. The ligand exchange reaction is represented by the following chemical equation:



The plant filtrate is treated with a ligand exchange reagent, to liberate all the WAD cyanide, before measuring the 'free' cyanide concentration via amperometry.



Ligand Exchange Reagent method	Picric acid method
Analysis time: approximately 4 min	Analysis time: approximately 20min
Requires only one reagent that is easily obtainable and simply prepared.	Requires time-consuming preparation of a number of reagents. Picric acid is costly. Picric acid is explosive when it dries out and requires specialised handling.
Simple and quick.	Labour intensive and time consuming.

'Free' Cynoprobe Features:

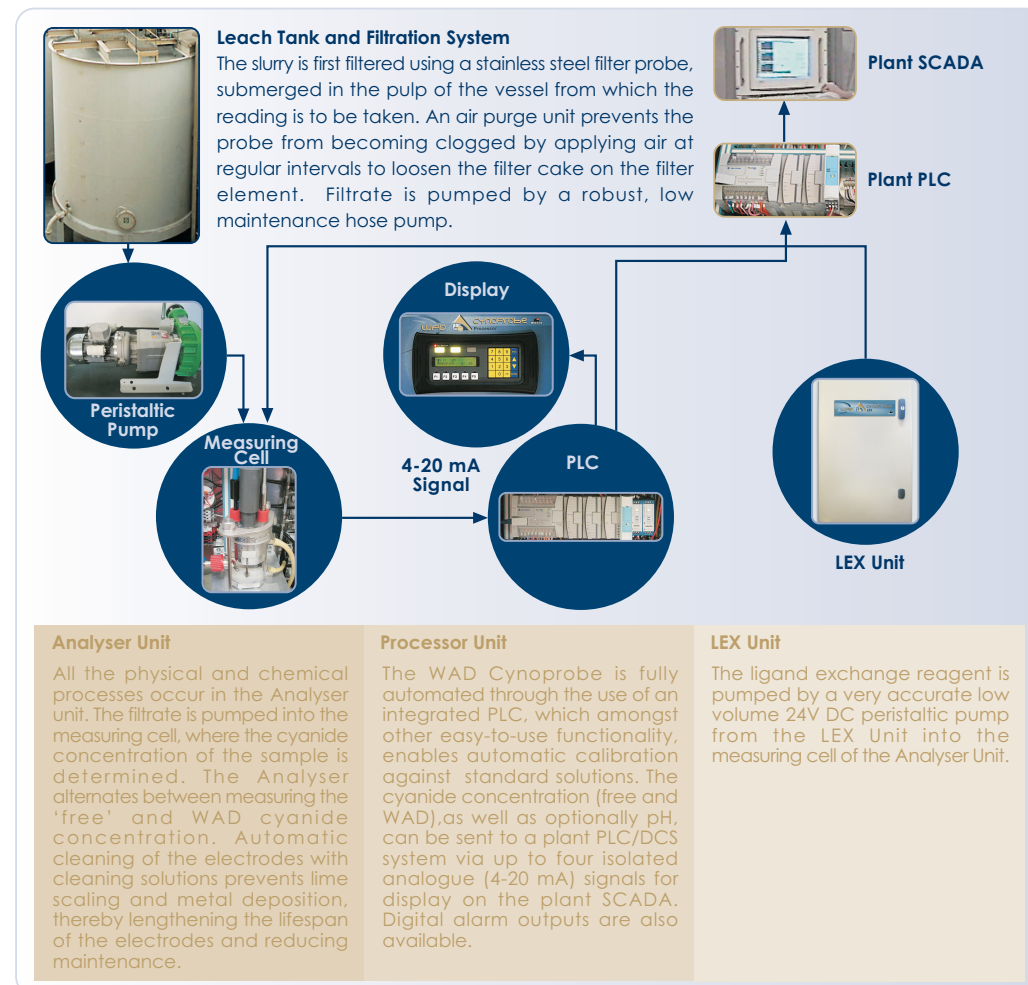
- Simple, robust and reliable.
- Fast analysis time (4 minutes) which is essential for good control.
- Requires minimal maintenance of the filter probe, automatic air cleaning prolongs the filter maintenance cycles.

- Automatic calibration and cleaning cycles.
- Digital display and 4-20mA output.
- The measurement reading may be expressed as either $[\text{CN}^-]$ or $[\text{NaCN}]$.
- Appropriate for CIP, CL, RIP, RIL, Heap Leach, Backfill and Cyanide Destruction circuits.
- Capable of measuring a very wide range of cyanide concentrations.
- Measures the pH of the filtrate.
- Allows for multiplexing of 2 streams for cyanide measurement.
- Custom interface available for visual display in Mintek's StarCS control system.

WAD Cynoprobe Special Features (in addition to those of the 'Free' Cynoprobe):

- The WAD Cynoprobe may be configured by the user to measure both 'free' and WAD cyanide concentration.
- Low cost.

PRINCIPLE OF OPERATION

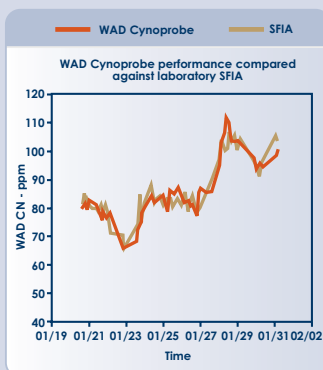


WAD CYANIDE RESULTS

The WAD Cynoprobe has proved accurate and reliable in the analysis of synthetic Cu, Ni and Zn cyanide solutions made up in the laboratory as well as under industrial gold plant conditions during various trials.

The graph below is a comparison between the WAD cyanide reading of the WAD Cynoprobe and laboratory SFIA (segmented flow injection analysis) obtained during an extensive trial on a Witwatersrand Gold plant (South Africa).

The absolute error between the WAD Cynoprobe and SFIA results, after accounting for sample ageing was a mere 4.37 ppm.



BENEFITS TO PLANTS

- Real-time WAD Cyanide measurement can minimise the risk of bird, animal and human life fatalities and be used to control and optimise the cyanide destruction and recovery process.
- Dramatic reduction in cyanide consumption when used in a control scheme.
- Enables compliance with the International Cyanide Code.
- Provides fast and accurate measurement of cyanide concentration.
- Results are highly reproducible, thereby eliminating human error found with manual titrations.
- Minimal running costs.
- Very low level of maintenance is required and can be performed by relatively unskilled operators.
- Low risk, safe instrument, measurement at ambient temperature and pressure.

INSTALLATION REQUIREMENTS

- Must be adequately sheltered to protect the instrument against temperature extremes, process spillage, hosing, etc.
- Should be mounted in a vibration and movement-free area.
- Should be mounted as close to the measurement point as possible (preferably within a 50m radius of the measurement point, although longer distances are possible).

CYANIDE CONTROL

The WAD Cynoprobe outputs up to four analogue (4 – 20mA) signals that can be incorporated into a control strategy to manage the cyanide addition to the circuit as well as cyanide destruction.

Mintek has developed an advanced PC based control system – LeachStar - that can effectively control the cyanide usage in leaching plants.

The LeachStar will not only maintain the desired cyanide setpoint of the addition tank but will timeously account for changes in slurry feed volume and density. Furthermore, the cyanide controller will manage the cyanide profile throughout the leach circuit in an effort to reduce cyanide usage, without compromising gold recovery.

Mintek's Cyanide Destruction Controller can be employed to ensure that WAD cyanide levels remain below prescribed limits. This controller will manipulate destruction reagents and activators in such a way that their consumption will be minimised without exceeding the prescribed WAD cyanide limits.

BUSINESS AND SERVICE CONTRACTS

Mintek's business terms are flexible and can be tailored to suit plant budgetary requirements via rent to own agreements or outright purchase agreements.

All instruments are sold with a comprehensive 1-year warranty.

Furthermore, Mintek is committed to providing excellent after sales service through the following mechanisms:

- Providing complete spares back-up.
- Performing ad-hoc servicing.
- Offering tailor-made service contracts best suited to a client's needs.

Other Services

Mintek's Cyanide Centre offers the following services:

- Gold test work.
- Cyanide speciation.
- Pre- and post analysis services.
- Cyanide emergency analytical services.
- Cyanide destruction tests.
- ICMI gap- or full certification audits and training/awareness modules.

TECHNICAL DATA

- All 3 units (Processor, Analyser and LEX) are ruggedised and designed for wall mounting.
- Electrical connection: 220V, 50/60Hz (Transformer optionally supplied for 110V applications).
- Wide range of concentrations.
- Outputs:
 - Up to four isolated analogue 4-20mA outputs that can be configured for any of:
 - Stream 1 'free' cyanide concentration.
 - Stream 1 WAD cyanide concentration.
 - Stream 1 pH.
 - Stream 2 'free' cyanide concentration.
 - Stream 2 WAD cyanide concentration.
 - Stream 2 pH.
 - Digital alarm flag for remote alarming of instrument faults.

	Height	Width	Depth
 Processor Unit	680mm	350mm	200mm
 Analyser Unit	680mm	350mm	200mm
 LEX Unit	680mm	350mm	200mm
 Peristaltic Pump	300mm	350mm	500mm
 Filter Probe	Probe extensions: 1m Probe head: 0.8m	3/4 inch bsp Probe head: 75mm	

Contact Details:

Website: www.starcs.co.za • email: cynoprobe@mintek.co.za • Tel: + 27 (0)11 709 4379



Specialists in mineral and metallurgical technology