

pH Sensors in Gold Processing

The Power of Sensor Stability



The Effect of pH Sensor Drift in Gold Processing

Leaching gold with cyanide is the most common method of gold recovery from ores, and requires precise electrochemical control of a number of reagents.

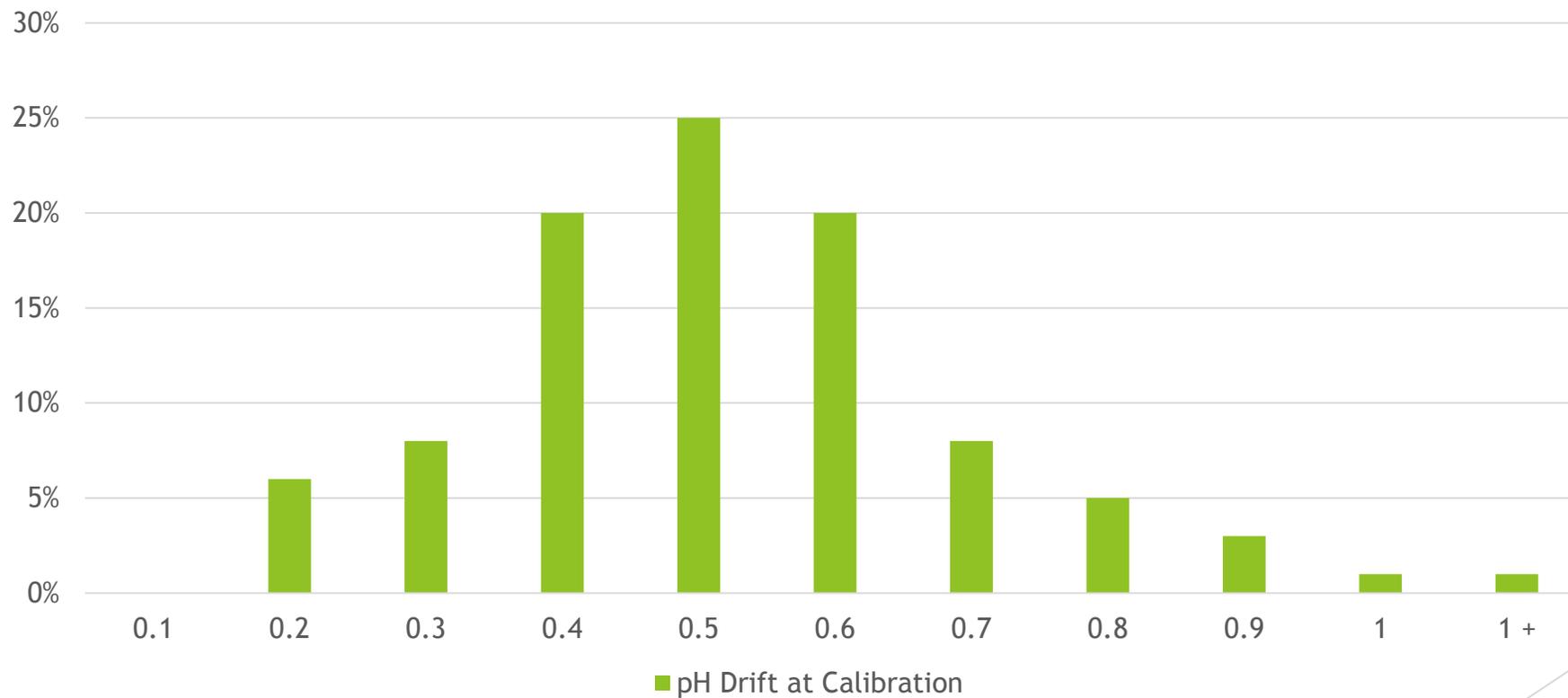
- ▶ Alkaline environments are a must for safety;
- ▶ incorrect pH control can cause **sub-optimal output**,
- ▶ **over-use of reagents**, and
- ▶ the creation **highly dangerous** process environments with the evolution of Hydrogen Cyanide (HCN).

However gold cyanidation is an extremely aggressive process with **harsh chemicals, high pH levels and rough particulates** in the agitated slurry creating an environment that **most liquid analysis sensors cannot withstand**.

pH Sensor Drift - The Nemesis of Tight Process Control

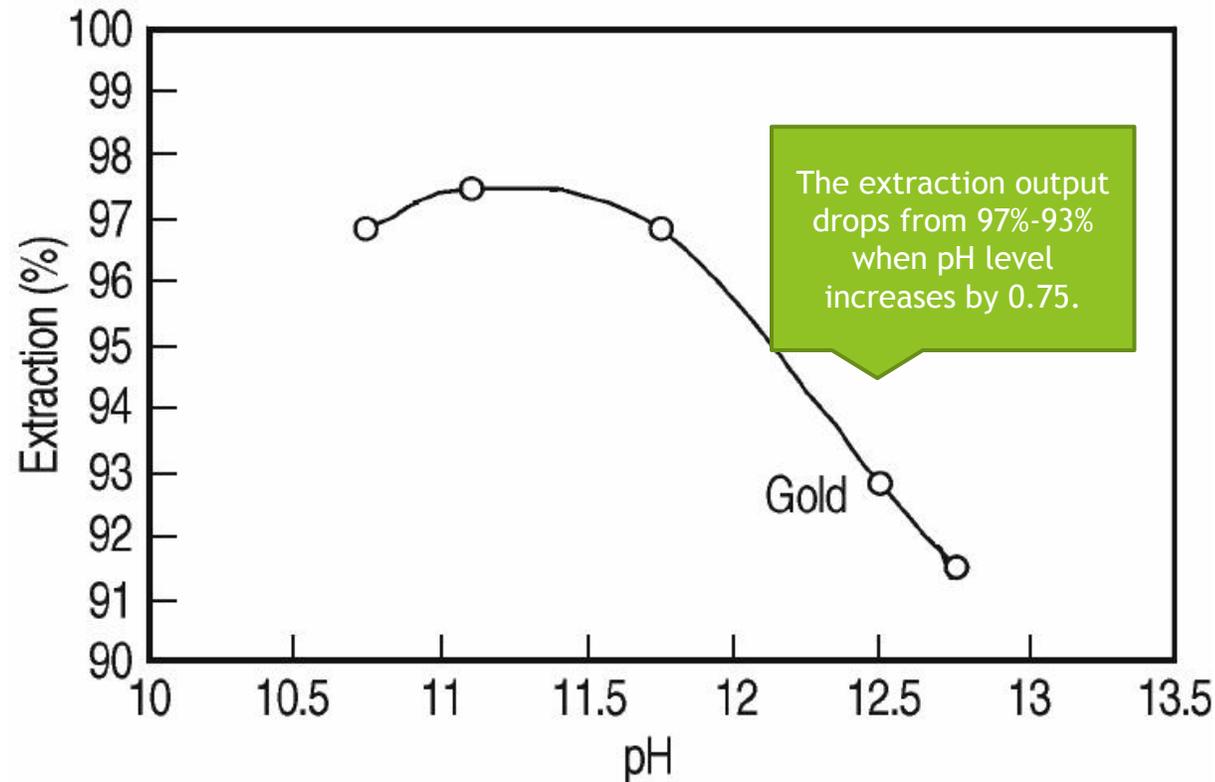
Sensor drift is an **accepted part of electrochemical measurement**. Over time, sensor degradation causes measurement values to “drift” away from the actual pH value of the solution. However, it is important to keep in mind that **any drift in measurement results in the degradation of the process.**

Sensors can drift by as much as 1 pH unit between calibrations, or more...



Sensor drift directly affects...

Production Output

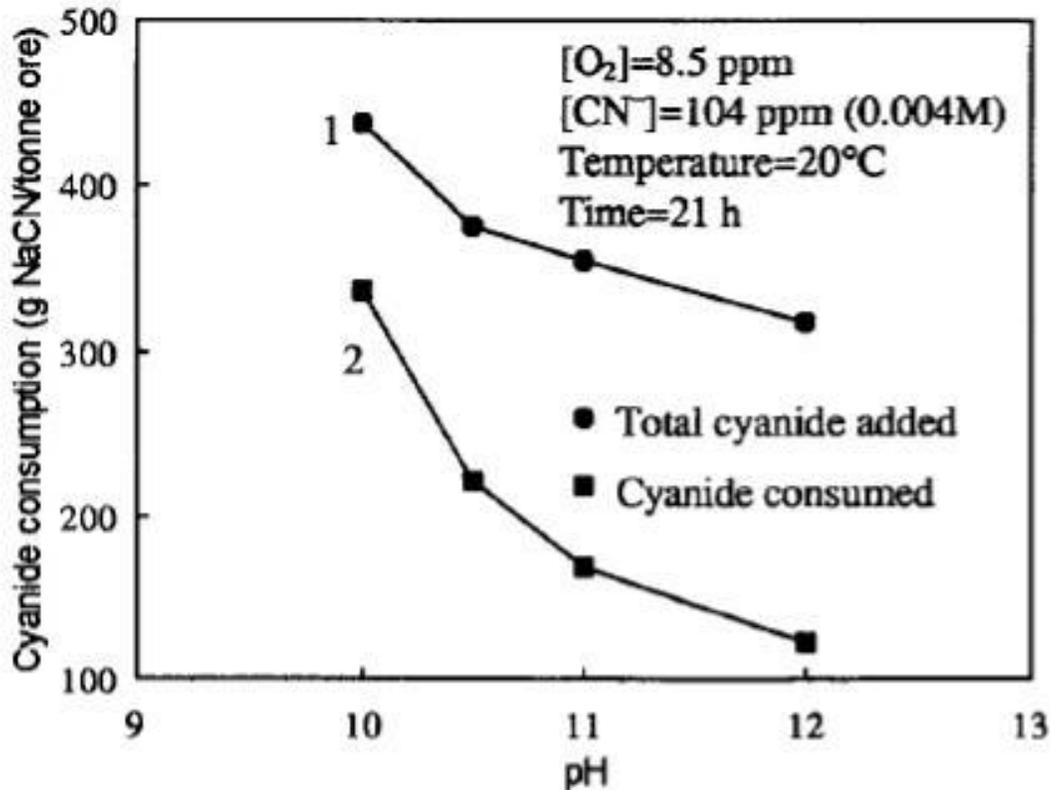


The effect of pH on gold extraction. Condition: 20% solid, 0.6 MPa, 300 min⁻¹, 80 °C, 1% NaCN, 1 h (Parga *et al.*, 2007).

The recovery of gold in the leaching process is the result of a chemical reaction which is pH dependant. Optimum levels of gold extraction can only occur when the pH is at the correct level.

Sensor drift directly affects...

Cyanide Consumption

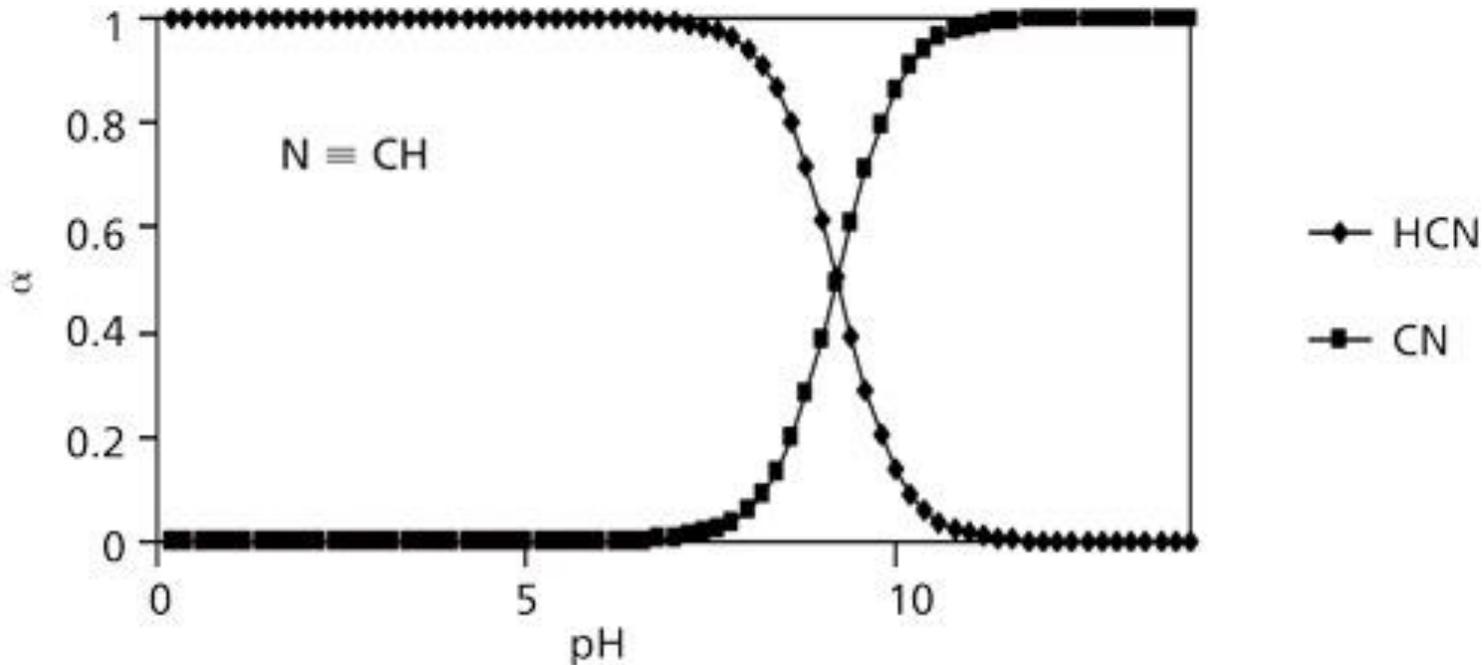


Cyanide consumption drops by over 50% as pH level increases from 10 to 11.

Effect of pH on cyanide consumption (Ling *et al.*, 1996). Note* The optimum pH for leaching should be derived independently for each ore type and leaching system (Marsden and House, 1992).

Use of cyanide, lime and other reagents to cause and control the leaching process are contingent on accurate pH measurement. Overuse of reagents is wasteful, and underuse can result in sub-optimal extraction conditions.

Sensor drift directly affects... Health & Safety



As the pH decreases from 11 to 10, the % formation of HCN increases from 0 to over 10%.

The use of cyanide in the gold extraction process creates additional health and safety concerns. With the stability of the cyanide being pH dependent, with lower pH levels resulting in the formation of dangerous HCN.

Any drop in the pH from 11 will result in the formation of HCN, with the formation of these gases increasing dramatically as the pH level drops further.

Costs Directly Associated with pH Sensor Drift:

- ▶ Lost production output
- ▶ Increased chemical agent consumption
- ▶ Health and Safety of employees

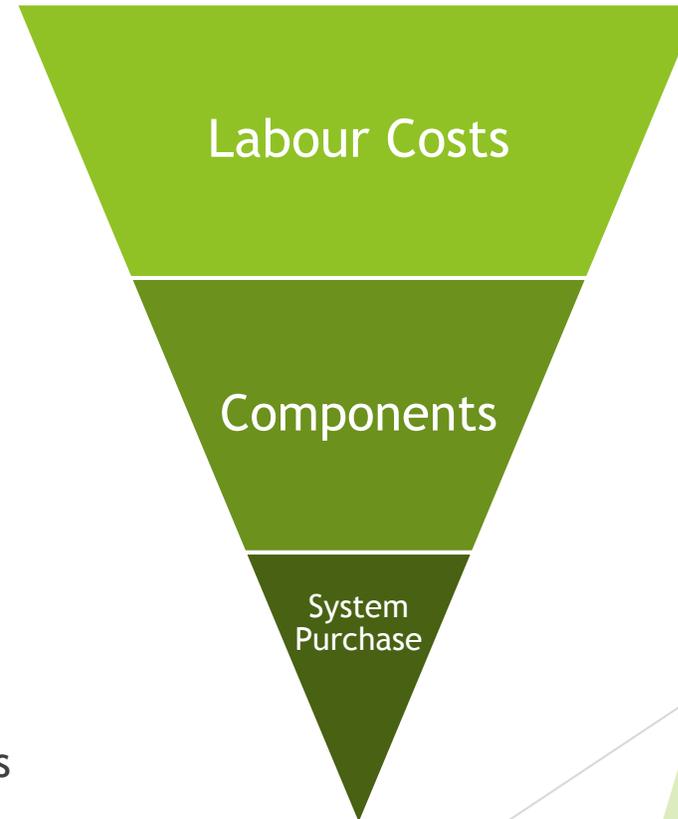
Pursuing stable pH measurement is an expensive process

▶ Labour Costs:

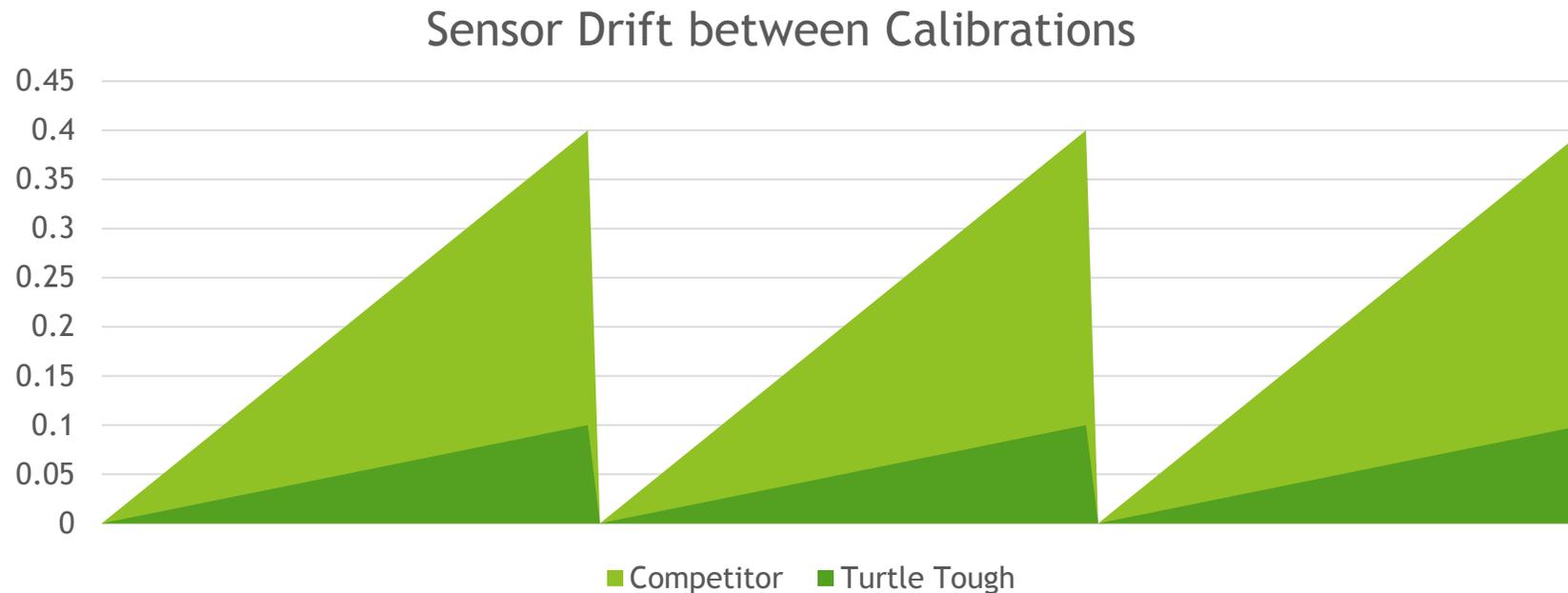
- ▶ Cleaning & Maintenance
- ▶ Calibration
- ▶ Replacing O-rings and seals
- ▶ Switching out broken & aged sensors
- ▶ Gel or electrolyte replenishment

▶ Component Costs:

- ▶ Components
- ▶ Consumables
- ▶ New sensors when breakages or deterioration occurs

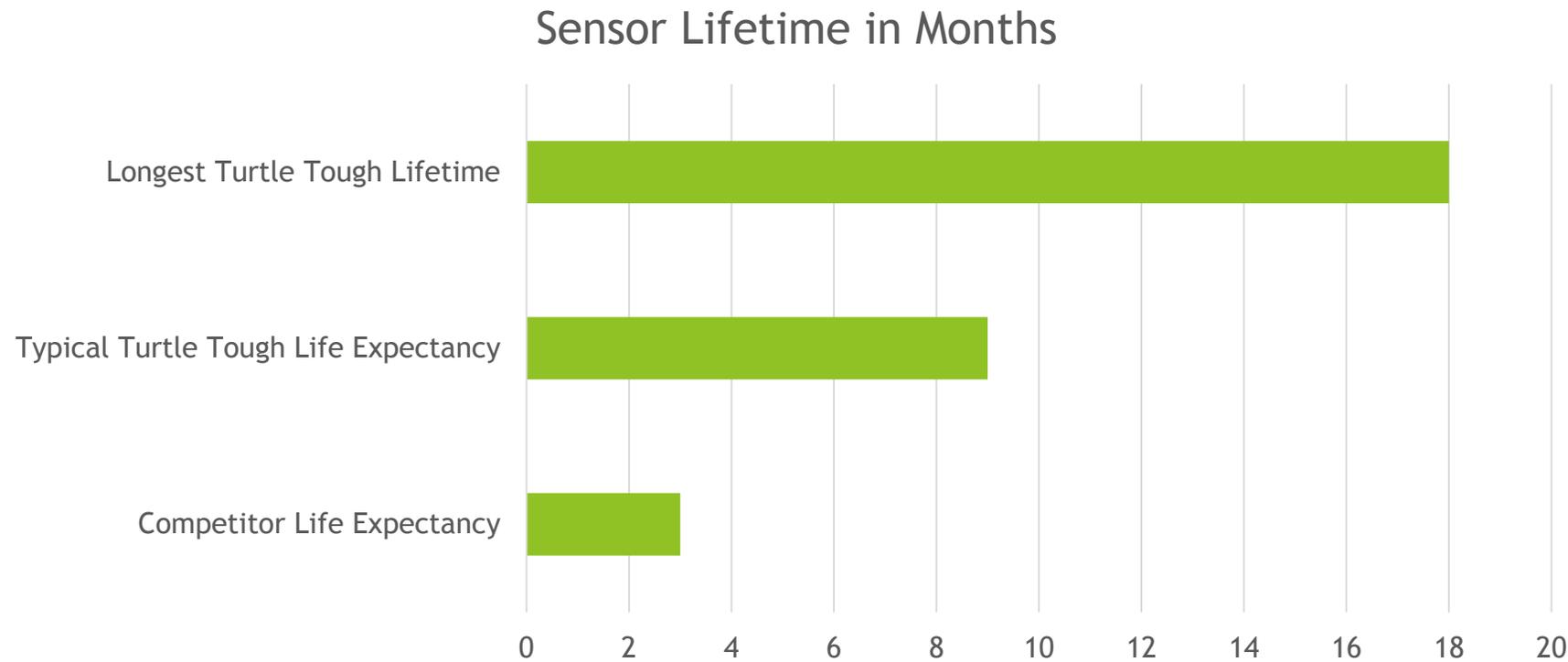


Turtle Tough Sensors provide Maximum Stability in Gold Cyanidation



In Gold Cyanidation, Turtle Tough customers experience drift at a **quarter of the rate** of previously used sensors.

Turtle Tough Sensors provide Maximum Longevity in Gold Cyanidation



This chart is based on data collected by our customers, over the many years.... Sensor life is process dependant and frequent scheduled cleaning is required.

Turtle Tough pH & ORP Sensors are Designed for Gold Cyanidation

- ▶ Turtle Tough pH & ORP Sensors for Gold has been created with
 - ▶ High Cyanide Resistance
 - ▶ Acid/Fluoride Resistance
 - ▶ Ammonia, Chlorine and Sulphide Gas Resistance
 - ▶ Slurry Resistance
 - ▶ High Capacity KYNAR Solid State Reference
 - ▶ Proprietary toughened glass electrode
 - ▶ RADEL body with ¾" Front End - 1" MNPT Back End
 - ▶ -5° C to 105° C temperature range
 - ▶ Triple Junction for extended life in harsh chemical environment



Turtle Tough pH & ORP Systems provide the **Lowest Cost of Ownership** through maximum sensor stability & longevity.

- ▶ Optimised Production Output
- ▶ Optimised chemical agent consumption
- ▶ Health and safety concerns diminished
- ▶ Labour costs reduced
- ▶ Replenishment of consumables and replaceable components negated
- ▶ Greatly reduced sensor replacement costs