



Why an automated carbon management system is essential for CIL/CIP circuits



Background

Gold operations worldwide are rapidly moving to collecting quality data with the goal of automating their process plant operations. The development of an automated carbon system is the first step to minimising soluble gold losses in your plant. To ensure the carbon distribution in your CIL/CIP circuit is optimised, the Carbon Scout technology has been successfully launched and proven in site installations to measure carbon density across all tanks. Prior to the development of Carbon Scout, carbon density measurements have been taken manually by plant operators. However, there are many reasons why manual handling results in poor accuracy, consistency and reliability of carbon density samples as well presenting potential safety issues.

Downside of manual carbon sampling

Analysis of the downside of manual sample handling has identified the following factors:

- 1) Reduction in sample frequency particularly when other urgent matters require the attention of operators
- 2) Poor consistency and quality of data with different operators using different processes to measure the result, providing a non-standard analysis
- 3) Safety issues connected with operators presence of cyanide – potential for high HCN levels on top of tanks
- 4) Physical danger associating with dipping the manual sampling unit into the CIL/CIP tank
- 5) Safety issues associated with climbing stairs

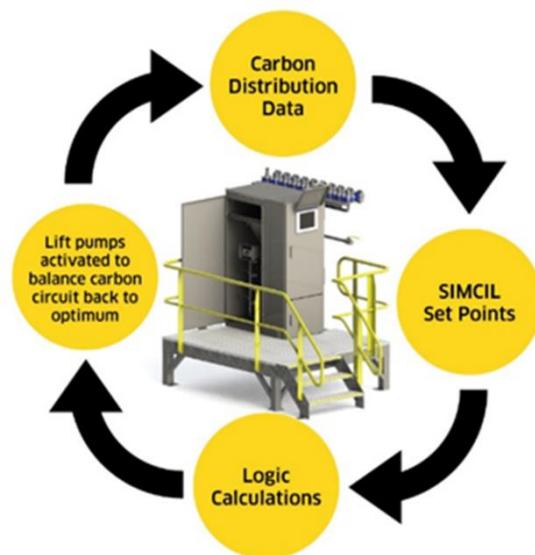


Figure 1: Carbon Scout cycle of automation

History, development and objectives of the Carbon Scout

As a consequence of the difficulty in reliability, accuracy and consistency resulting from manual sampling of carbon density data, and in response to requests from gold operations, Curtin University's Dr Teresa McGrath and Adjunct Professor Bill Staunton developed the Carbon Scout. The objectives they set out to achieve were to 1) Minimise soluble losses in the Carbon-in-Leach/CIL circuit, 2) and Minimise operating costs; and 3) optimise carbon management, distribution and inventory. 4) establish a platform that allows for automation of carbon movement.

In September 2016, Gekko Systems were appointed as the partner for Carbon Scout commercialisation which formalised a collaboration between Gekko Systems and Curtin University. The collaboration was the culmination of 15 years of close relations through the AMIRA P420 program gold processing research. Gekko Systems, under the leadership of our Technical Director, Sandy Gray, was an early industry sponsor and has played a key role in the direction of the P420 program for 18 years since commencement of sponsorship in 2001.

The technology can be used in conjunction with SIMCIL modelling (also developed by AMIRA P420 and available to sponsors) to determine set points to decrease soluble gold losses in tailings streams. More accurate carbon readings drive more accurate gold in circuit inventories and therefore more accurate metallurgical accounting balances.



Figure 2: Carbon Scout installations

Manual Vs Automated Carbon Movements from Case Study Site

Manual Carbon Movements

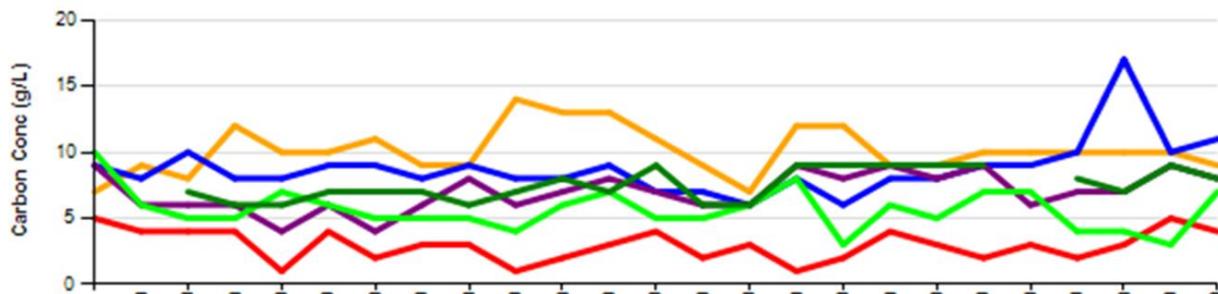


Figure 3: Carbon movements using Manual carbon measurement

Automated Carbon Movements

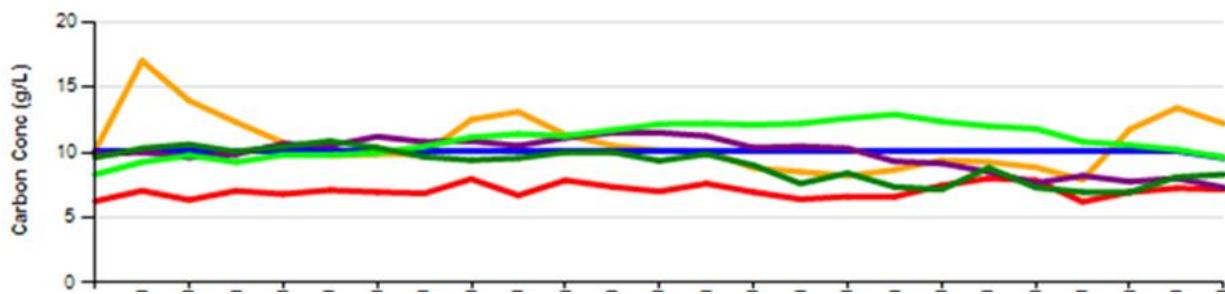


Figure 4: Carbon movements using Carbon Scout and automated carbon measurement

Case Study of Carbon Scout installation – Australasia

The financial returns for the carbon scout have been proven to be highly beneficial and range from USD\$200,000 to \$2,000,000 per annum representing a minimum return of 200% per annum. In this example, soluble losses declined from 0.0113 ppm Au to 0.0098 Au, or 13% increase in gold solution recovery.

Average gold solution loss 12 months pre-install = 0.0113ppm Au

Average gold solution loss 12 months post-install = 0.0098ppm Au

Percent increase in gold solution recovery = 13%

Plant throughput = ~10Mtpa

Throughput tonnes/annum		Solution Loss (g Au/t solution)			
		0.001	0.002	0.005	0.01
1,000,000	ounces	32	64	161	322
	value	\$48,232	\$96,463	\$241,158	\$482,315
2,000,000	ounces	64	129	322	643
	value	\$96,463	\$192,926	\$482,315	\$964,630
5,000,000	ounces	161	322	804	1,608
	value	\$241,158	\$482,315	\$1,205,788	\$2,411,576
10,000,000	ounces	322	643	1,608	3,215
	value	\$482,315	\$964,630	\$2,411,576	\$4,823,151

Figure 5: Economic gains from reducing soluble gold loss tails (Assumption: All figures in USD: gold price USD \$1500 /oz)

The advantages of Carbon Scout vs Carbon probe technology

Carbon Scout is a complete ground station that physically measures the carbon density, dissolved DO and pH in each tank every hour to provide a continuous profile, which allows for automation of carbon transfers. A measurement is taken every hour in every tank.

An optional extra for clients is the potential to add Olympus XRF capability to measure gold concentrations on carbon

Carbon probes do not take physical samples, relying on ultra-sonic measurement through slurry. These units require frequent calibration to provide for consistent data.

Furthermore, carbon probe technology do not provide additional data on DO and pH.

A probe is required in every tank relative to Carbon Scout which has a “downcomer” pipe from the top of each tank which is then measured in a central, ground level sampling station.

The Carbon Scout ground station provides an opportunity for manual samples to be taken at ground level for other sampling requirements such as carbon samples to be submitted to the lab, checking carbon density samples, solids and solutions samples for tank profiles and any other survey type data required.

Carbon Scout Mark 5 unit - released in May 2019

Since the appointment of Gekko as Curtin's commercialisation partner for the Carbon Scout, Gekko's award winning design engineering and manufacturing team have been working progressively to improve unit operability, reliability, and quality as well as increase the range of standard and optional features.

Features:

- Engineering integration package
- Carbon concentration (g/L) measurement per tank
- pH measurement per tank
- Dissolved Oxygen (DO) measurement per tank
- Manual and automatic modes of operation
- Manual sampling of in-tank slurry
- Trending and data management with integration to plant's main control system
- Full software control
- Dashboards
- Can be linked to your SCADA system
- Ease of installation

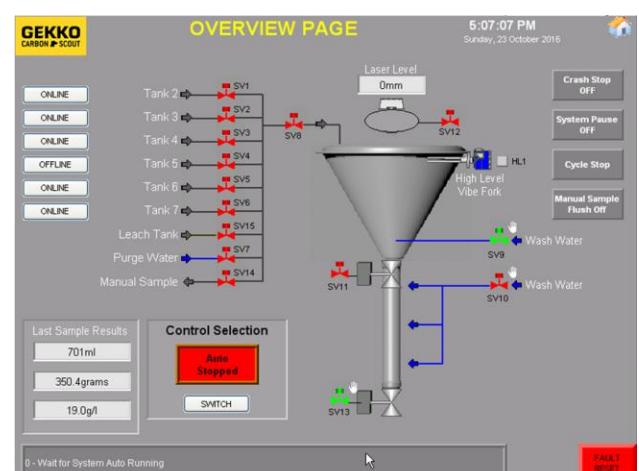


Figure 6: Screen shots from software package
Carbon Scout Overview Page

Recent System developments

- Optional full automated carbon movement SCADA package including engineering, installation, software and programming
- Optional integrated XRF technology to measure gold loading (Au – ppm) on carbon
- Optional measurement of slurry density

Benefits

The ability to obtain consistent carbon density data measured systematically over time through the proven Carbon Scout technology, in conjunction with the fully automated software package, allows for soluble gold losses to be minimised and gold recoveries and subsequent profits to be improved.

Investing in Gekko's full automation package will support the delivery of a full automated carbon movement package quickly with minimal fuss, allowing you and your team to have time to focus on other important areas of your operation

Ground level installations provides improved health and safety benefits – less need for operators to access top of tanks, less exposure to cyanide containing slurry;

Operators are freed up from manual carbon sampling for more critical tasks

Gold-in-circuit (GIC) surveys can now be done at ground level with improved metallurgical accounting; and

Longer-term potential to add analytical and other monitoring capabilities (e.g. XRF technology for Au loading on carbon).

Ease of Use and installation

The Gekko product development team recognise that the real benefit for site is the full installation of an automated carbon movement system. To that end, our automation team have developed software and programming features that allow you to relax and leave the full engineering installation and automation programming to the expert team at Gekko.

Four steps to automating your carbon movement:

- Step 1: Installing a proprietary Curtin-Gekko Carbon Scout unit is essential to accurately and consistently measure your carbon density in each tank
- Step 2: Allow the Gekko automation team to connect the Carbon Scout to your process control system and install programming
- Step 3: Identify your carbon density target in each tank
- Step 4: Utilise Gekko automation and control logic to automatically move carbon across your CIL/CIP circuit to desired levels and add carbon if required to final tank

Where the full package is purchased, Gekko's experienced team will assist in the engineering and installation, commissioning of the unit and installation, programming of the automation and control logic resulting in a timely, smooth and low fuss solution.

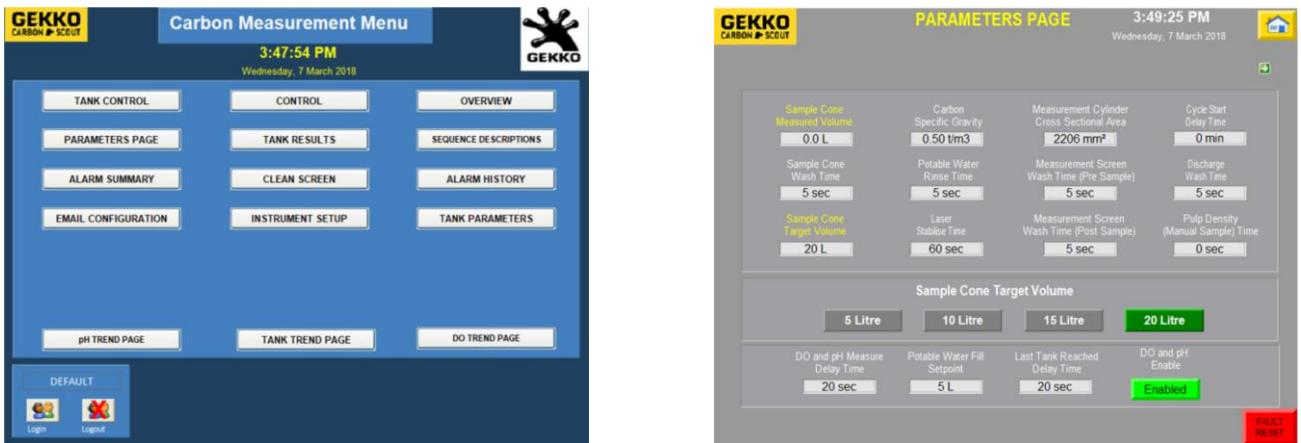


Figure 7: Carbon Scout Measurement and Parameter options

Carbon Scout Product Developer profiles:

Our team of product inventors, designers and developers are world class experts in gold processing, gold technology product development and commercialisation and include:

Sandy Gray: Technical Director Gekko Systems

Mr Gray is a world recognised thought leader and product designer in the gold and heavy mineral processing sector. He is the recipient of the prestigious Clunies Ross Science Award (Australia), The AusIMM Mineral Operating Technique Award and AusIMM Excellence Awards, The International Mining Hall of Fame Inductee, Separation (USA), and the IOM3 2019 Futer's Gold Medal Recipient (UK).

Dr Teresa McGrath, Project Director, AMIRA P420

Co-inventor of the Carbon Scout, Teresa has spent the last 10 years as an integral part of the gold team at Curtin University. In addition to her PhD, she has extensive industry experience across the global gold industry with plant surveys and technical training utilising learnings from the P420 program and the models developed under the program umbrella. Dr McGrath has recently taken on the Project Directors role for the AMIRA P420G.



Adjunct Professor Bill Staunton, Curtin University

Co-inventor of the Carbon Scout, Bill is regarded as an expert in gold processing worldwide. Through his specialty in process measurement and optimisation, he has consulted to most of the major gold mining companies. Previously Bill spent 15 years as the Project Director of the AMIRA P420 and whilst still intimately involved he has transitioned to industry consulting. His key skills in gravity separation, leaching systems and carbon adsorption circuits makes him invaluable as a resource to the gold industry.

Wayne Lodge: Product Manager, Carbon Scout, Gekko Systems

Wayne Lodge is the Manager, Metallurgical Services at Gekko Systems, holding a BAppSc in Chemistry and an MBus in Business, with over 30 years' experience in Laboratory analysis and Metallurgy. His technical background has seen him hold key positions in quality assurance, technical and operations and general management.



Figure 8: Curtin University and Gekko sign the collaboration and commercialisation agreement in September 2016
L-R, Dr Teresa McGrath (Curtin), Adj Prof Bill Staunton (Curtin), Elizabeth Lewis-Gray (Gekko). Sandy Gray (Gekko), Dr Chris Moran (Curtin), Vice Chancellor Deborah Terry (Curtin University)



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