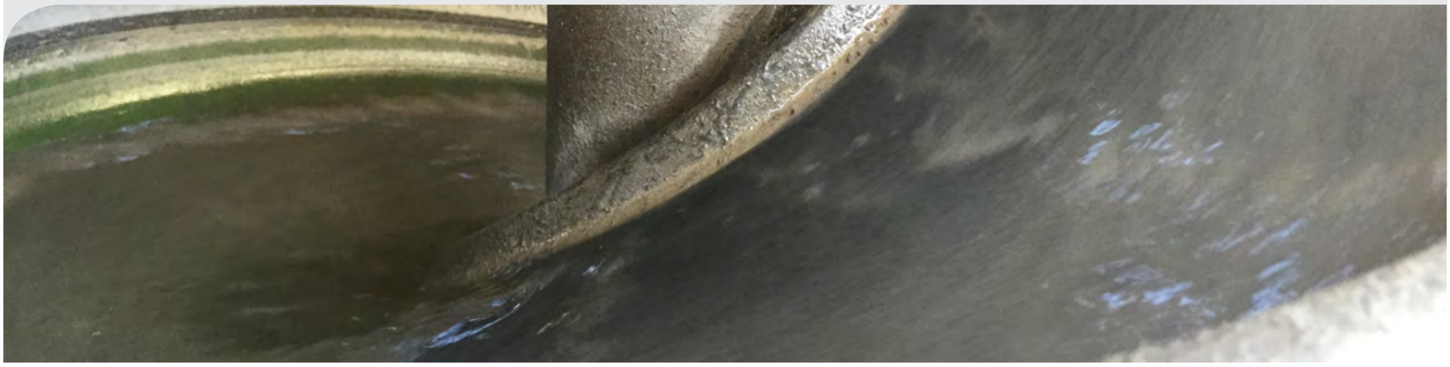


BLUE CUBE QUARTERLY.

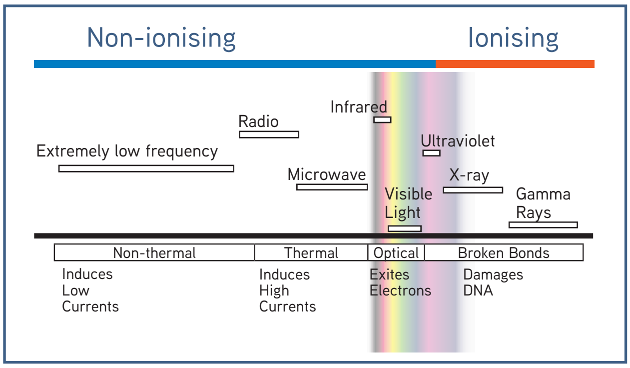
2016 | Second Edition

HEALTH & SAFETY

The long and short of wavelengths

Visible light was for centuries the only electromagnetic radiation (energy emitted from a source) known to mankind. William Herschel discovered infrared radiation only in 1800. From then on many discoveries were made to eventually reveal the electromagnetic spectrum that includes wavelengths from the order of magnitude of 10^3 to 10^{-12} m. It also became evident that electromagnetic radiation at low frequencies (with long wavelengths) transfer low energy and at high frequencies (with short wavelengths) transfer high energy.

The electromagnetic spectrum can roughly be divided in two parts, non-ionising and ionising radiation. Ionisation occurs when an electron is completely removed from atoms or molecules due to high photon energy, typically around 10-33 eV.



Non-ionising radiation only carries enough energy to excite the movement of an electron to a higher energy state. It includes radio waves, microwaves, infrared, visible light (including lasers) and the lower part of ultraviolet light. They have the longer wavelengths and the lower frequencies in the electromagnetic spectrum.

The health risks of the lower energy radiation is significantly lower than for higher energy radiation, but the ultraviolet radiation supplied by the sun causes molecular damage to a person's skin. There are three types of ultraviolet radiation: UV-A which causes cancer and premature skin ageing, UV-B which discolours (tans) skin and UV-C which is absorbed by the earth's atmosphere. Sunscreen contains zinc oxide or titanium oxide that reflects the ultraviolet radiation away from the skin.

Ionising radiation has enough energy to remove a tightly bound electron from the orbit of an atom, resulting in a charged atom. It includes gamma rays, X-rays and the higher part of ultraviolet light.

Exposure to ionizing radiation causes damage to living tissue as it alters the chemical structure of living cells. It can result in mutation, radiation sickness, hair loss, blood changes, cancer, and even death.

Shielding should be applied if radiation exposure can not be avoided. The purpose of the shielding is to absorb the radiation and typically consists of barriers of lead, concrete or water.

Resources:

http://www.nuclear-power.net/nuclear-power/reactor-physics/atomic-nuclear-physics/radiation/shielding-of-ionizing-radiation/

https://commons.wikimedia.org/w/index.php?curid=45834629

Editor: Karen Keet | kk@bluecubesystems.com

SAMPLING & EVALUATION

Considerations for sampling system design

By Coert Kruger, Manager Evaluation, Anglo American Platinum

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"In many cases, while operations 'believe' they have designed their sampling systems correctly, they generally do it only for the main valuable minerals, and not the deleterious minerals. Because reconciliations with the main valuable minerals appear okay, this leads the operation to believe it is also okay for the deleterious minerals, which is not necessarily the case. Unfortunately this can impact the mine plan models, particularly if the mine needs to minimize the deleterious mineral due to its impact on the processing plant recovery."

Dunglison, Michael; Head of Metals Accounting,
Anglo American; 2016

Material types have different material characteristics and therefore require the correct sampling equipment to extract an increment from the bulk or moving stream. These increments, combined and collected over a specified time period become the primary sample of our bulk product. A material stream will have a variety of particle sizes and there may or may not be a range chemical compositions associated with a particle size range. The sampling gurus of the world have advocated that we need to know our 'sampling constant' in order to understand our material characteristics. The sampling constant is defined as the quantitative measure of the material type's heterogeneity.

Heterogeneity means that a material type can be composed of different parts of different kinds, having widely dissimilar elements. In addition it can be composed of different substances or the same substance, but just in different phases, i.e. solid ice and liquid water. Following the sampling theory as described by Dr Geoff Lyman, an approach of Intrinsic and Distributional heterogeneity is one way to break down your material characteristics. In the mining industry, we are mostly stuck with the first type of heterogeneity or material characteristic. However, that same stream may also be in different phases. For example, a concentrate stream can be slurry or a filtered cake. Another example is a 'run of mine' ore stream as feed to a mill with the mill discharge being slurry of that ore. The heterogeneity between a run of mine ore is significantly bigger than the slurry phase of that same ore after milling. You want to sample the stream with the lowest sampling constant, but that is not always the case as we first need to establish what the sampling objectives are. Understanding the sampling constant associated with each stream is the first step to a successful sampling plant and protocol. It is advisable to consult in determining your sampling constant if an in-house specialist is not available.

Knowing the material heterogeneity, the operation first need to establish the sampling objectives and the following set of questions may be helpful (although not limited to) to break down your requirements:

- Why do we need to sample
  - Decision making, quantification or quality
  - Is moisture a key component
  - Will the operation be able to do what they need to do in the absence of a sample?
- What is the interval of importance
  - Seconds, minutes, hours, days
- What are the minerals of importance
  - The key is to look at long term requirements and include the minerals that may impact downstream as impurities.
  - Moisture
- How quick do I need a result back
  - Do we have the analytical capability
- What is the impact on business if we get it wrong?
  - Financial impact
  - Safety

In the majority of cases, we have success when sampling design formed part of the primary stages of plant design. The biggest mistake often made is to fit a sampling system to a plant design. The plant design should be fit around the sampling system. The reason for this is the physical properties of the material stream to be sampled. Is the material type a sticky cake, slurry, a free flowing powder, a coarsely crushed product etc. The list can go on and on, but unfortunately, the range of available and acceptable sampling equipment in the market is limited and conceptional designs with plant specific sizing are normally what happen. Should we ignore the heterogeneity and/or physical properties, we may end up or be forced to take a sample at a convenient rather than appropriate location and often doing so by the incorrect application of sampling equipment for what it was intended for.

A careful and systematic approach must be adopted in deciding upon a sampling system that will deliver to expectations.

PROCESS FOCUS

Chrome beneficiation from PGM flotation tailings

Contributions by Jack du Toit and Brian Whitehead***

**Chrome Traders*

***Northam Platinum*

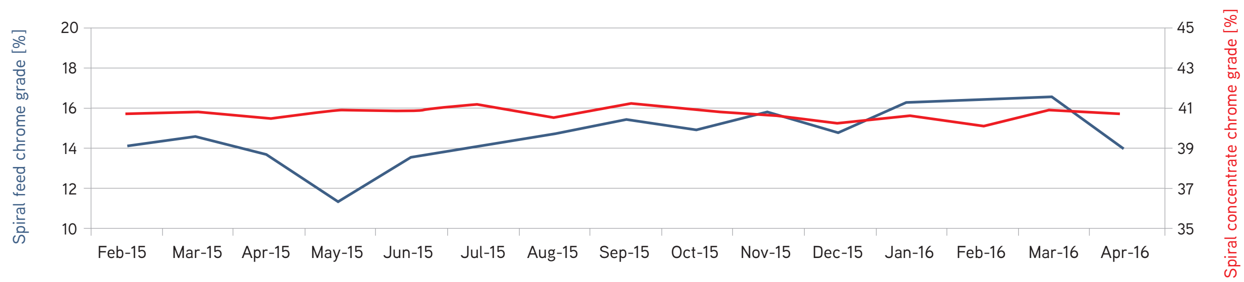
Platinum Group Metals (PGMs) concentrators in the Eastern Limb of the Bushveld Complex in South Africa treat UG2 ore that contains a high chrome content. Chrome has a low beneficiation cost compared to other metals and is therefore an integral part of the extraction process on UG2 ores during these difficult economic times.

The PGMs are typically associated with sulphides and are separated through several steps of froth flotation. Some of the chrome in the PGM Concentrator feed end up in the PGM concentrate through entrainment. The bulk of the chrome is however in the tailings of the flotation circuit from where it is recovered through several steps of rougher and cleaner wet spirals (spiral concentrators).

At Booysendal the feed grade to the spiral concentrator typically varies between 11 and 16% chrome (range of 5%) with a silica grade in the region of 33%. The deslimed material is fed to the top of the spiral concentrator and is separated radially on the basis of density and size as the slurry gravitates downward. Cutter bars are used at the bottom of the spirals to direct the flow into either concentrate, middling or tailing streams.

The particle size distribution of the feed to the spiral concentrator play an important role. An example of a complication caused by particle size is a large silica particle that will despite having a much lower density than chrome, report to the middling or concentrate streams. The fine chrome particles (typically associated with UG2 ore) just as easily report to the middling and tailing streams.

Despite the challenges of particle size and a variable feed grade, the product grade of the last 14 months was controlled within a range of 1% chrome.



The results were achieved through manual adjustments on the cutter positions. Real-time indications from a MQi Slurry analyser installed on the product stream were used as a guide for these adjustments.

The product has a specification of 40.5% chrome (with less than 5% silica) and is exported to China for the manufacturing of stainless steel.

TECHNOLOGY EXPLAINED

Differences between 4-20mA and Profibus

By Jody Crow, ProcessIQ

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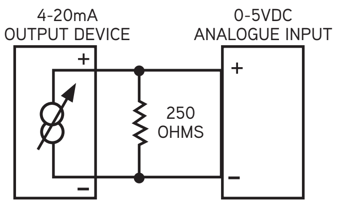
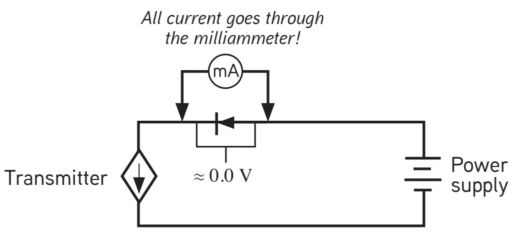
4-20mA:

4-20mA (analogue) signals can be transmitted using a few methods, for example voltage and current. Current is usually chosen for its ability to remain constant in a series circuit. The current is offset by 4 milliamperes. The reason for this is to distinguish the difference between a fault and a signal of zero. So you will find that 4mA represents 0% and 20mA represents 100%. Some PLC's and DCS systems require a voltage signal input. This is easily achieved by allowing the current signal to pass through a resistor. So for example using a 250 ohm resistor you would convert a 4-20mA signal to a 1-5V signal.



The measurement of the current signal needs to be measured in series, or else the current will be divided between the two paths and it can produce undesired results, such as a short circuit or inaccurate readings. There are types of instrumentation that allow measurements to be taken without breaking the line. They have this ability because of a diode placed in the circuit. When a multi-meter is placed over the diode (in parallel to the diode), the voltage drop over the diode becomes zero volts. This is lower than the voltage required for a current to flow through a diode (0.7V). The diode now behaves as an open circuit, the process happens so quickly that it seems as if the measurement is in parallel but in fact the multi-meter is in series.



Profibus:

Profibus is a digital communication protocol used in industrial automation. All communication can be done over a two wire system. Devices can be 'daisy chained' together so this means that its not necessary to run the whole length of cable for each new device.

Communication takes place via a master slave relationship. The masters usually being the controllers and the slaves usually being devices such as actuators and sensors.

Signals on the Profibus are addressed so that the message is only received by the device to which it was intended.

The Profibus signal, being a digital one, has the advantage of displaying exactly the reading that the transmitter sends and is not subject to errors introduced by converting between digital and analogue (as in the 4-20mA signal). Because Profibus is a protocol its possible to even communicate over fibre optics.

4-20mA vs Profibus:

4-20mA (analogue):

- Analogue signals can be easier to fault find
  - Only a multi-meter is needed in most cases.
- Analogue signals are widely used in the industry.

Profibus:

- Though more complicated to fault find, Profibus has a lot more tools availible to diagnose complex problems.
- The signals are addressed, so the signal only goes where intended.
- Uses a bus topology which eliminates the need for a full length line to each device.
- Has a lot of options availible for hazardous environments.
- Can be transmitted over fibre optics
- Can be more accurate, as it reads the digital value from the sensor.

Internal training sessions

- **Internal training sessions were held at the Blue Cube Systems Office recently.**
- (Left) Daniel vd Spuy, Lize Cillie, Jody Crow and Fernando Nieuwveldt.
- (Above) Jody Crow, Frans Jansen, Zakaria Mellas and Greg Gomez.

Congratulations

Francois Jansen (Frans) received his **10 year service award** from Francois du Plessis (Managing Director).

Mosima Mathibe with Sinyinza Masuzyo and Whyson Musonda from Mopani Concentrator in Zambia.

Mosima Mathibe with Aloma Rudman from Northam Platinum Zondereinde Mine.

BLUECUBE
measure • control • optimise