

FLORIDA 420

INLINE ELEMENTAL ANALYSIS



Introduction

J&C Bachmann GmbH is a globally active enterprise specialized in the development of measurement devices, especially for industry and mining use. Our expertise in X-ray-based measurement is recognized all over the world. Beside own subsidiaries J&C Bachmann cooperates with specialized companies in mining countries. These companies are capable to perform test work with demonstration units on their premises as well as to install, to calibrate and to maintain J&C Bachmann´s devices.

ScanMin Africa (Pty) Ltd in Roodeport, Johannesburg, South Africa is one of these partners. This company specializes in the supply and support of on-line real-time analysers used in different mining and mineral beneficiation processes. Scanmin is now a global company operating in many different countries with installations in China, Russia, Australia, and sub Saharan Africa.

The combination of these companies provide equipment that adhere to German standards of design and efficiency serviced by a South African company that understands the local conditions and provides competitive service models.



Synopsis and Purpose of the Document

This report describes the way how factory testing of customer's samples will be done with the FLORIDA online elemental analyzer. It provides detail on the test process and provides results of blind tests performed after calibration. The factory test's purpose is always to prove that FLORIDA can successfully measure the samples provided since the matrix of elements in the sample affects strongly the performance of the measurement.

Summary FLORIDA 420

On-line monitoring of the grade is a necessity for cost-efficient production.

The XRF analyzer FLORIDA adapts the industry-proven X-ray fluorescence analysis used in chemical laboratories for the plant conditions, which enables continuous monitoring of the physical composition of the material in the process. The information provides critical information to monitor, stabilize, control, and optimize the process.

The FLORIDA 420 can be installed directly on a process pipe and does not require a bypass system. A dedicated spool section with an application-specific measurement window is installed. Spool and window are specified to meet the chemical and physical conditions and to protect the sensor system against damage. The systems do not require continuous or regular sampling for its calibration.

The inline installation is dependent on the ability to provide a spool section for the application point. The design is subject to the pressure, flow and temperature of the installation. Therefore a wide variety of window materials and designs were developed for use with FLORIDA.

General Specifications and Benefits

The FLORIDA 420 can be installed in feed, concentrate or tailings process lines. In-Line installation does not require extensive engineering for sampling, sampling lines or bypass systems. Any bias introduced with these additional systems is eliminated as measurement is performed directly in the position of interest. The FLORIDA 420 system is compact and occupies only a small footprint. Demands on services are light; continuous clean 220 VAC is sufficient. FLORIDA uses a compact and reliable X-ray tube and sensor; therefore NO radioactive source is required. Measurement of a range of elements is continuous with output to the control room through industry-standard plant interfaces.

Performance Characteristics

The XRF analyzer FLORIDA operates continuously (24/7). Based on the physical principle the analyzer acquires a spectrum over an adjustable time of typically 2 minutes. At the end of the period the spectrum is evaluated and the concentration of the elements is calculated.

Time period of the measurement can be adjusted between 10 and 240 seconds to meet the plant and the process requirement. Shorter times can be used to monitor fast changes in the process, while longer periods allow to adapt the update interval to the process control scheme. Last readings as well as sliding averages can be published.

Performance

FLORIDA can be used in a large variety of applications; however, accuracies which can be achieved vary with composition of slurries or suspensions.

Responsibilities

Responsibilities for various actions are typically shared between J&C Bachmann and the local experts like Scanmin.

It is always advantageous to measure a set of samples with one of our demonstration units as preparation of a project. Right now, demonstration units are available in Germany and South Africa while China and South America will follow. So samples must not necessarily be sent over long distances for examination. This saves time and costs.

Although the local experts are familiar with the whole test and calibration procedure, the results will also be evaluated by the German team; the final evaluation report will be generated jointly then. It should be stated that beside some "known" samples which will be required for calibration also "unknown" samples should be provided. The results obtained with these samples will show the performance of the measurement best.

Test Facility and Test Rig in South Africa

As already mentioned, tests of African samples can be conducted at Scanmin's facility in Roodepoort where Scanmin installed the J&C Bachmann supplied FLORIDA onto a frame that allows recirculating the sample past the unit's analysis window. The whole system is built in a frame which allows for easy reconfiguration of the test loop.

FLORIDA consists of two parts:

- Control unit
The control unit includes the following components:
 - Measurement controller
 - Power supply with UPS
 - High voltage power supply for the X-ray tube
 - Ethernet and MODBUS interfaces
- Sensor box
which includes
 - X-ray tube
 - X-ray sensing system
 - Measurement chamber

Both parts are linked with a stainless steel hose, length approximately 5 meters. The measurement controller is not equipped with a HMI but serves as WIFI access point. Devices like laptops or smartphones can link directly to the controller and access wirelessly to the instrument using a browser.

All the items apart from the measurement chamber are standard J&C Bachmann supply. The measurement chamber was especially developed for the low volume of material that will be tested in such a test rig. Furthermore, it contains a thin window; this window was selected on its ability to provide maximum XRF



Figure 1: FLORIDA installed at Scanmin 's factory

transmission and detection to increase the potential resolution for measurement of low quantity material e.g. in PGM slurry.

Figure 1 shows the setup as installed. Scanmin designed the system to produce a flow velocity of >0.8 m/s, with a measured flow velocity of 1.8 m/s.

Historic Data and Sample Measurement

As a first step, the knowledge of historic data provided by the customer may be an important asset when developing a chemical or mineralogical model that the analyzer can be compared to. Based on these data a first calibration model will be set up.

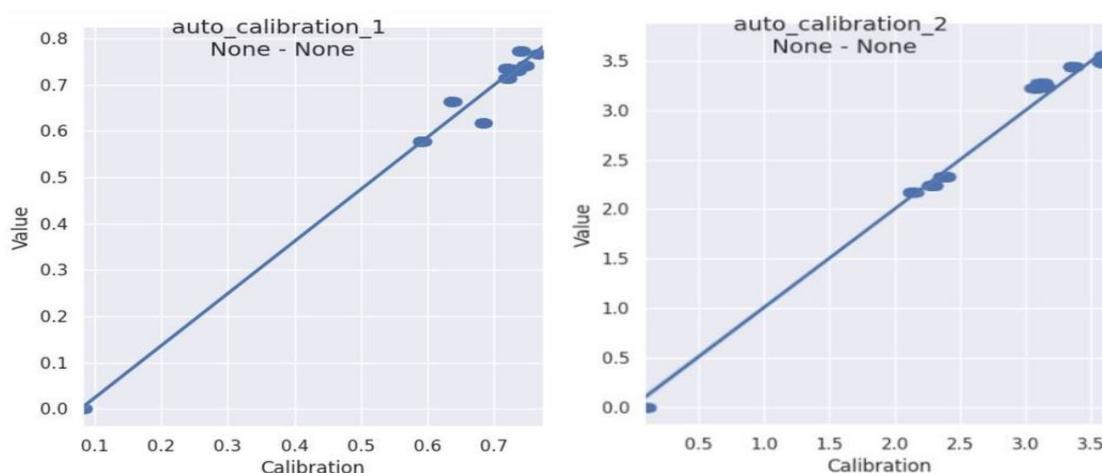
If no historic data are available then the calibration will be based purely on the measurement of known samples. The samples may be fluid ones but they can be also generated from solid material which will be solved in or mixed with water.

The samples will be prepared to concentrations of different solids (e.g. 20, 30, 40 %) according to the conditions in the plant and then presented to the analyzer for 30 minutes, recording one spectrum per minute. Starting with the highest concentration, the samples will be diluted further to lower solids concentration and an analysis cycle of thirty minutes repeated.

Calibration

First calibrations were typically based on approximately 10 scanned samples plus a zero-point measurement of water. Sets of 10 samples represent a low number of data points for calibration development; the number of samples should preferably exceed 30 to have significant statistical value. Moreover, the range of concentrations has to cover the whole range that can be found in the process to be representative, in the best case evenly distributed. Yet, together with the zero-point measurement reasonable calibrations can be obtained for the elements of interest.

Measurement of PGMs is usually a special challenge due to the low concentrations which cannot be measured directly. However, there are many cases where correlations between the base metals and PGMs (+gold) can be used successfully.



The figures above show typical calibration curves for PGM elements using correlations with base metals.

Blind Sample Test Procedure

On completion of calibration development, the calibration coefficients are loaded to the analyzer software. Then, if available, blind samples will be tested. As per the previous methodology, each blind sample will be successively diluted to the solid concentrations of the calibration samples. At each concentration, the samples were circulated for thirty minutes. Afterwards the results will be compared to the (up to then) unknown laboratory values.

Results and discussion

At the end of the test run the FLORIDA system is ready to measure the customer's product continuously – in the laboratory. The calibration as well as the results of the blind samples provide a good estimate of FLORIDA's accuracy and repeatability. This will be the base of further decisions by the customer.

Detection Limits

In general, the detection limits of FLORIDA are about 100ppm for most elements; under good conditions (mixture of only 2 substances) also about 30ppm have been measured accurately.

In special cases even better detection limits may be obtained. If strong correlations can be observed between trace elements and elements in the percent range then these elements can be used to successfully surpass these limits by far; this way it could be proven that FLORIDA is even able to measure concentrations in the ppb (**parts per billion**) range. As an example, the gold content of a deposit in South Africa could be monitored down to 0,2 ppm using the strong correlation to Arsenic in this case.

Receiving more calibration data over time, the range and the quality of the calibration model can be extended; so errors will likely decrease, hence the accuracy improve.

Conclusions

Although the use of online analyzers like FLORIDA is state of the art, the individual measuring tasks vary widely. Furthermore, calibration and performance testing in the plant is a major task:

- Gaining representative samples is mostly not possible; the samples are biased by the insufficient representativity of the sampling method.
- Customer's goal are stable conditions in the process while a good calibration requires sample measurements throughout the measuring range. This is a contradiction.

Therefore a test run on one of the FLORIDA demonstration units installed around the world offers huge advantages:

- real information about the achievable accuracy can be obtained; this gives more confidence than a generalized value;
- detection limits and reaction times can be estimated during the trial. This includes also the determination of the required measuring time;
- the measurement is done with samples from the process. Side effects caused by the elemental matrix will be seen in the trial and can be addressed;
- the system will be delivered in precalibrated condition. This saves time and effort during commissioning;
- Testing of blind samples offer real answers;
- Confidence into the system will be built up even before installation.



Figure 3: FLORIDA installed in flotation plant