MIGRATION FROM NUCLEAR DENSITY GAUGES TO ULTRASONIC DENSITY METERS *

Dirk Aalten[1]
Vitor Braz[2]
Frank Termeulen[3]
Paulo Longo[4]

Abstract
This report serves to highlight the need for a mine to migrate from nuclear density gauges to ultrasonic density meters. This move will mitigate for the high costs incurred in maintaining nuclear density gauges, as well as associated health and environmental impacts. The ultrasonic technology has proven to be a reliable alternative to nuclear instruments and complies with all the strengths of the available nuclear density gauges. The Slurry Density Meter (SDM) of Rhosonics will be outlined in this report using areal customer case. The adoption of a non-nuclear density meter such as the SDM is recommended for a mine to replace the nuclear density gauges when they reach their half-life. Thistransition will significantly reduce operational costs, related administration workload and eliminates the associated health and safety risks on-site at the mineral processing plant.
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[1] *Bachelor of Physical Process Technology, Sales Manager, Sales Department, Rhosonics Analytical BV, Putten, The Netherlands*
[2] *Bachelor of Automation Engineering, Technical Application, Sales Department, Yellow Solutions, Americana São Paulo, Brazil.*
[3] *Bachelor of Business Administration, Marketing Manager, Sales Department, Rhosonics Analytical BV, Putten, The Netherlands*
[4] *Bachelor of Electrical Engineer, Director, Yellow Solutions, Americana Sao Paulo, Brazil.*

1 INTRODUCTION

This paper describes the need for a mining company to migrate from nuclear density gauges to ultrasonic density meters. The limitations of the nuclear sourced devices and the benefits of the non-nuclear measurement device of Rhosonics will be discussed in detail. Additionally, the model SDM (Slurry Density Meter) will be introduced using a real customer case. The migration to non-nuclear density measurement is recommended for mineral processing plants to reduce their operational costs and eliminate health risks.

2 PROBLEM STATEMENT

Many mining sites are currently measuring slurry density using nuclear based density gauges. These density gauges consist of a radiation source that emits a cloud of gamma particles and a sensor that counts the received gamma particles that are either reflected by the test material or pass through it. By calculating the percentage of particles that return to the sensor, the gauge can be calibrated to measure the density and inner structure of the test material.

These nuclear based density gauges have the following limitations:

- High maintenance costs
- Hazardous to human health
- Hazardous to the environment

2.1 Justification

With more stringent global regulations on nuclear sourced devices and with modern technological advancement in ultrasonic engineering, non-nuclear density meters are the only solution for mineral processing plants. As an organization, embracing these non-nuclear density meters will eliminate costs associated with licensing of radiation sources with relevant authorities as well as compliance with relevant radiation handling procedures. Also, there will be no need for regular radiation leak checks, as well as high degree of health and safety checks. Another setback on the use of radiation source is the lack of disposal procedure on the user end, hence another cumbersome process involving tedious paperwork when returning the radiation source to the original equipment manufacturer. On the other hand, adopting radiation free density gauges will create more time for the instruments technicians and safety personnel to focus on other critical areas, whilst the plant is achieving the budgeted production targets.

2.2Choice of ultrasonic density meter

In choosing the non-nuclear density meter a mining customer should look for one that has all the strength of the available nuclear density gauges which are outlined below.

- Durability – abrasion resistant, and with no moving parts
- Should operate in ambient conditions of temperature, pressure, vibration or agitation

- Costs – the cost of the meter should be within reasonable range compared to the nuclear density meter
- Accuracy – the error margin should be as minimum as 0.005 S.G. for density measurement

2.3Non-nuclear Slurry Density Meter (Rhosonics Model SDM)

This in-line instrument can measure the real-time density of a water-based slurry. It uses flow-through technologyand is easy to install. Another major advantage for this ultrasonic density meter is the absence of any nuclear sources, making it friendly to the environment and to human health.

Figure 1. Picture of the Rhosonics model SDM Slurry Density Meter.

In addition to earlier mentioned strengths the ultrasonic density meter has the following attractive features:

- Lowcostofownership
- High accuracyandreproducibility
- Maintenancefree
- *In situ*, no movingparts
- High-end software technology that is easy to operate
- Data loggingcapabilities
- Supports various communication protocols, including Modbus, Profibus& HART

2.4Principle of operation

The instrument measures acoustic impedance of slurryand calculates the density of the slurry real-time during the process. This principle of determining thedensity is only applicable for water-based slurries or slurries were the liquid phase has a constant Total Dissolved Solids (TDS) level. The density is calculated by using the Physical Law of Sir Rayleigh. The Acoustic impedance (Z) is measured andthe Speed of sound of water is known (C), therefore the Density (ρ) can be calculated.

- Law of Sir Rayleigh: Acoustic impedance (Z) = Speed of sound (C) x Density (ρ).

The sensor is made of stainless steel and ceramic material and has no moving or intrusive parts, and is hence wear resistant. Ceramic composite material makes the ultrasonic signal smooth and more powerful. Installation is possible on large pipes (32 inch and above) by means of wafer cells, spool pieces or a weld-on piece.

2.5Application example

Compañía MineraPoderosa S.A. needed to measure and control the slurry density in the discharge pipe line of a tailings thickener in order to improve the filtering stage of their Mineral Processing Plant in Peru. The ultrasonic density meter of Rhosonics was installed by means of an UHPE ultrasonic wafer cell which is mounted between flanges.

Figure 2. The Rhosonics model SDM Slurry Density Meter at MineraPoderosa in Peru.

The Peruvian Gold mining company wanted a non-nuclear density meter (SDM) of Rhosonics for this measuring task to control the speed reference of the pumps and closing and opening of automatic valves for recirculation of the slurry when the density is below the desired value.

Further automation of the filtering plant was realized using the ultrasonic density meter, which saves time spent on manual measurements and additionally increases the efficiency of the filters because of an adequate density at the tailings filtering stage. Also, for using this instrument there was no need for any licenses, permits or specialized personnel.

Table 1. Measuring task at Poderosa Gold processing plant

Pipediameter	**80 mm (3inch)**
Pipe material	**Carbon steel alloy (ASTM A53)**
Solids	**60 wt%**
Density	**1.500 – 1.700 g/l**
Temperature	**19°C – 24°C (66°F – 75°F)**

2.6Calibration and accuracy

At the gold processing plant Poderosa in Peru, the calibration of the instrument was done by taking several samples of the process slurry and comparing these values to the density measurements of the instrument. After both density values were compared, the instrument was fine-tuned for reaching a higher accuracy. Thanks to

the excellent installation and calibration of the Slurry Density Meteran accuracy of at least +/- 5 g/l was achieved.

Figure 3. Correct flush mounted installation of the SDM sensor in the UHPE wafer cell.

Figure 4 shows a comparison between the laboratory density value and the SDM density value. The calibration point can be easily identified by looking at the measurement results in the middle of the graph. Both lines are coming together in the moment when the instrument settings were adjusted.

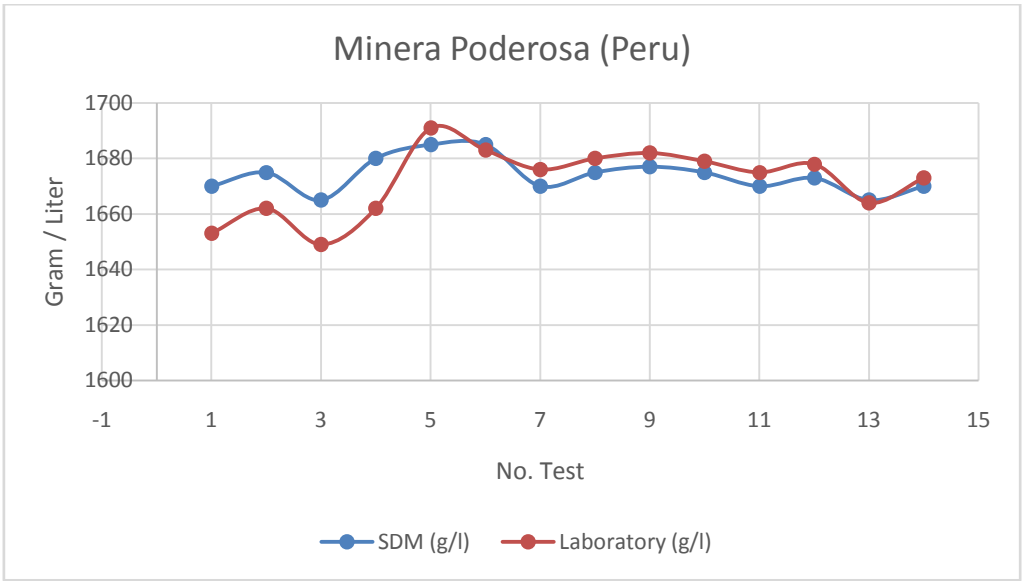

Figure 4. The Rhosonics density measurements compared to laboratory values at MineraPoderosa.

3 CONCLUSION

The ultrasonic measurement instrument of Rhosonics (model SDM) has been tested in the field and proven to be a good alternative to the nuclear density gauges. The ultrasonic density meter can resist ambient conditions, is durable and abrasion resistant while achieving the same density value tolerances as the nuclear gauge. By embracing this new technology, there will be no health or environmental impacts and initial and administrative costs which are associated with handling the nuclear sources will be reduced. All costs and risks associated with handling the radiation source can be totally eliminated through use of non-nuclear density gauges like the model SDM Slurry Density Meter of Rhosonics.