002

RM CASE STUDY // **002**

NON-NUCLEAR VS NUCLEAR

APPLICATION: MINING
LOCATION: AUSTRALIA

SOLUTION USED: RED METER
REPLACED: NONE

DESCRIPTION:

An established mining company wished to conduct a study within one of its operations to compare the capability of the Red Meterr with that of a Nuclear Density Meter. The company's intent was to use the instruments to measure the Specific Gravity changes in various densities of mining media generated as part of its production operation.

REDMETERS

INTRO

A Red Meter was installed in series with a Nuclear Density Meter in order to determine the correlation, accuracy and precision of the instruments.

The installation took place within the mining operation, and the evaluation period was approximately 60 days. Neither device was serviced, recalibrated or removed from operation within the prescribed time, however the mining operation itself was halted on a number of occasions as part of its ordinary operation.

This document describes the objectives and results while drawing a number of conclusions based on the data acquired during this evaluation and other recent evaluations.

MAIN OBJECTIVES

1. Monitor the performance of both instruments over an extended period of time in varying process conditions.
2. Calculate the mean and standard deviation from the real time data reported by the Red Meter.
3. Compare the Red Meter data with the mean and standard deviation calculated from the data generated by the nuclear density meter.
4. Draw conclusions with respect to the precision, accuracy, and repeatability of each method.
5. Note any additional observations regarding the utility of each device.

TEST CONDITIONS & EQUIPMENT

The Apparatus and specific tools and preparations employed were as follows:

1. A typical production process line within a typical mining operation.
2. Pressure gauge, flow meter and other typical process control devices were used.
3. All critical components in the system were calibrated at the beginning of the evaluation period.
4. A Red Meter was installed fully anchored and calibrated.
5. A Nuclear Density Meter had already been installed adjacent to the location of the Red Meter.
6. The instruments were installed in an ambient environment. The operational line pressure was 242±8psig.
7. All operators were fitted with eye protection, ear protection and all other necessary safety equipment required by the mining company.

FIGURE 1:
RED METER INSTALLATION CONFIGURATION

Displaying basic configuration of the Red Meter as it was inserted into the mining operation's process.

PROCEDURE

Three (3) sections of the mining production process were examined. The operational segments analyzed represented 2 different sets of process conditions in order to assess the ability of each instrument to adapt to changing process variations.

To maximize the accuracy of the test, each section analyzed constituted at least 20 hours of continuous operation. As the Red Meter acquires data at rate of 3 readings per second, 20 hours of operation equates to more than 210,000 recorded data points.

PROCESS RUNS DESCRIBED

- **SECTION A**
  The initial process analysis was conducted on the first part of the process run (Process 1), and yielded an average SG of approximately 1.3 at an average line pressure of approximately 242±8psig. The Section A evaluation continued uninterrupted for approximately 21 hours and accumulated more than 225,000 data points.
- **SECTION B**
  Process 2 was initiated after a shutdown period. Process 2 had considerably lighter slurry registering an average SG of approximately 1.1 and at an average line pressure of approximately 242±8psig. This section ran uninterrupted for approximately 32 hours and yielded more than 345,000 data points.
- **SECTION C**
  This section consisted of a restart of Process 2 following a brief shutdown. Subsequently the process ran uninterrupted for approximately 20 hours, and resulted in more than 215,000 data points acquired.

The total number of data points captured over the course of the study exceeded 750,000.

TABLE 1:
UNINTERRUPTED RUN TIME VS. SECTION ANALYZED

Table 1 shows the details of the three sections selected and the uninterrupted run time associated with each section.

SECTION	DURATION HOURS	DATA POINTS RECORDED	PROCESS REFERENCE
A	21	226,800	1
B	32	345,600	2
C	20	216,000	2

● NON-NUCLEAR (RED METER) ● NUCLEAR DENSITY METER

FIGURE 2:
SPECIFIC GRAVITY MEASUREMENT
RED METER VS. NUCLEAR DENSITY METER

Statistical analysis was conducted on both sets of data in order to determine the level of correlation between the instruments. Note that the graph shown reports only above 0.9 SG, therefore the disparity between data sets may appear larger than the actual variance.

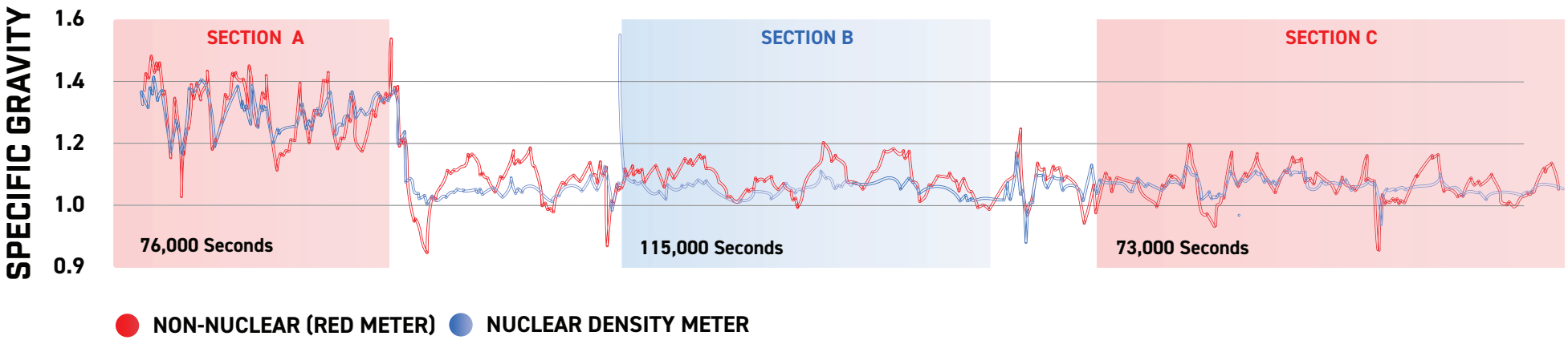

Figure 2 shows the results for the Red Meter (Red) and the Nuclear Density Meter (Blue.)

The plot generated by the Red Meter is referred to as the “RM Signature”. Due to the real time acquisition of data, the RM Signature may be used to diagnose process variation issues, troubleshoot equipment problems and measure and monitor process capability. The Red Meter may also serve as an irrefutable record of performance, depending on the monitored process and customer requirements.

TABLE 2:
SG DATA ANALYSES
- PROCESS SECTIONS A, B AND C

Table 2 shows a comparison of the mean and standard deviation of both data populations. The variance of each instrument is highlighted for clarity.

					VARIANCE - RED METER VS. NUCLEAR.			
SECTION	NUCLEAR GAGE		RED METER		MEAN		STANDARD DEVIATION	
	MEAN	STD. DEV.	MEAN	STD. DEV.	MEASURED SG	PERCENT	MEASURED SG	PERCENT
A	1.321	0.047	1.321	0.047	-0.009	-0.7%	0.033	69%
B	1.102	0.018	1.102	0.018	0.027	2.4%	0.024	135%
C	1.119	0.022	1.119	0.022	-0.002	-0.2%	0.022	99%

STD. DEV. = STANDARD DEVIATION SG = SPECIFIC GRAVITY

DISCUSSION OF RESULTS

From the extensive number of data points shown in Figure 2, the trend and average of both meters appear to track and compare favorably to each other.

One can clearly observe the process change in Figure 2 as the Specific Gravity of the media transitioned from 1.3 SG in Section A to approximately 1.1 SG in Sections B and C. In separate testing, the Red Meter was capable of identifying similar variations in wetter slurries, drier slurries and even dry mixes, when employed to determine mixing effectiveness and efficiency.

In order to obtain more definitive process indicators, the statistical analyses of Sections A, B and C reported in Table 2 were compared. It can be clearly seen from the data that both devices measured the SG to within 2.4% of each other over the 750,000+ data points recorded.

When one considers the Standard Deviation however, a stark difference between the instruments can be observed. The process Standard Deviation measured by the Red Meter was as much as 135% greater than that of the Nuclear Density Meter. This may be quite significant to a process engineer who is tasked with monitoring and controlling any continuous process.
In order to examine the disparity in closer detail, an excerpt from the graph shown in Figure 2 is presented in Figure 3. This closer analysis magnifies the detail over a much smaller sample of 6,000 data points.

It can be clearly seen from the figure that while both meters appear to be reading similar trends and averages, the Red Meter does in fact appear to be more “sensitive”, revealing more detail about the process in question and providing a clearer indication of the true Cp and Cpk. This reinforces the observations of mean and standard deviation noted in Table 2.

CONCLUSIONS

- The accuracy of the Red Meter vs. the Nuclear Density Meter in this slurry was similar
- The Precision of the Red Meter vs. the Nuclear Density Meter in this Slurry was superior
- The RM Signature can readily identify process variations
- The Red Meter may serve as a real time process issue detection and/or prevention device
- The Red Meter can generate valuable RM Signature data on dry or wet slurries
- The Red Meter has been employed to characterize the effectiveness of mixing dry mixes
- The Red Meter enables process accuracy and precision which can be actively measured in real time
- The Red Meter May be used in processes as an irrefutable process record & SPC device (Statistical Process Control)

FIGURE 3:
6,000 DATA POINT EXCERPT
ENABLES CLOSER INSPECTION