

Wireless Heap Leach Monitoring and Control

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Abstract

Heap Leach solution extraction is a cost-efficient process for recovering metals in various ores, including copper, gold, and uranium. While the concept is easy to understand, until now it has not been possible to execute flow control and monitoring over the entire operation. Traditionally a single flow meter has been used to measure flow to the pad, while monitoring of the distribution of the solution on the pad and through the pad has been lacking. This means that accurate solution distribution on the pad requires labour-intensive operations to regulate valves and check for leaks and pipe breaks, and assumes no “ponding” within the pad during daylight hours. Instrumentation capable of withstanding the rigours on the pads exposed to weather, sun, and corrosive solutions, and able to communicate process variables reliably and accurately, has been missing.

Using WirelessHART instrumentation, Emerson’s complete solution has been able to measure and control the flow of extractive solutions to the pad, the distribution on the pad, pore pressure and temperature in the pad, and flows off the pad. Activation of valves wirelessly, and monitoring and controlling vertical wells and air blowers have all been accomplished with wireless instrumentation. WirelessHART has been used for communication to create a mesh network capable of accurately measuring and transmitting process variables and diagnostics. Hence, the operation of leach pads can now be controlled and monitored 24/7, making leach pads safer.

Beyond the obvious productivity and reporting advantages, the ability to monitor and control around the clock improves health and safety. It also bolsters the environmental stewardship that is so necessary in today’s world, where social license is required to operate. Having knowledge of all aspects of a leach pad’s operations in real time brings a mine operations into the 21st century.

Introduction

Heap leaching is an efficient process for recovering metals in various ores including copper, gold, and uranium. Leach pad instrumentation with WirelessHART pressure and flow meters has made a difference with more efficient operations, and has improved safety and health. It has safeguarded the environment by enabling the measurement of the actual usage and distribution of raffinate, reduced time spent on the pad

by employees, and enabled operations to be alerted to hazardous situations. This paper will focus on copper heap leaching, but the lessons learned are transmissible to other leaching metals.

While the concept of heap leaching is easy to understand, until now it has not been possible to execute flow control and monitoring over the entire operation. Traditionally, wired flow meters have been used to measure solution flow to the pad and flow from the pad, with everything in between left to guesswork and computer models. Distribution on the pad and other process variables have been unknown, or extrapolated from just a few measurement points. Accurate flow and pressure distribution on the pad required labour-intensive operations to regulate pressure, adjust valves and flows, and note the pressure or flow rate on a leach pad that could contain many square miles of surface area. Checking for leaks, broken pipes, and plugged pipes can only be conducted during daylight hours; even then, it exposes employees to safety, health, and environmental risks. Until now we have not had instruments capable of withstanding the harsh environment on the pad, exposed to weather, sun, and corrosive solutions, yet able to reliably communicate process variables accurately. With WirelessHART, flow and pressure in a single device transmits process variables every minute.

Heap leaching

Heap leaching is defined as the use of a solution to extract desired metals from an ore that has been crushed to a degree and stacked. Various solutions have been used, depending on the metal being recovered, with sulfuric acid the choice for extracting copper from copper ore.

Copper heap leaching uses a weak sulfuric acid (raffinate) to free copper from the surrounding ore in the leach pad. The solution is pumped to the top of the pad, and then spread over the surface using sprinklers (wobblers) or drip lines. From the surface the raffinate percolates down through the pad, picking up copper along the way. Finally it exits the pad at the bottom, and then pools in ponds. The copper-laden solution is now pregnant leach solution (PLS).

The PLS has made its way through the pad and picked up dissolved copper. Next the PLS is concentrated and enriched in the solvent extraction process. In this process, the PLS is mixed with an organic solution, which pulls the copper out of the PLS. The PLS is then recirculated back to the leach pad as raffinate. The next process is the reverse of the first. The organic solution is mixed with a weak electrolyte, and the copper is pulled into the weak electrolyte, creating a concentrated copper solution, which is now termed rich electrolyte. This is conveyed to the tank house for electro winning.

With the introduction of WirelessHART flow meters and pressure transmitters to the pad distribution system, many benefits can be realized, including more efficient operations, improved safety and health, and enhanced environmental stewardship.

Efficient operations

The ability to know what the flow rates are throughout the pad, and the pressures that they are operating at, allows for improved management and more efficient operations. Some ores may require more solution due to acid-neutralizing minerals, and the flows can then be directed accordingly. Some areas may need flows reduced due to ponding, and again that can be corrected and monitored. Over time, a historian can trend the application rates and areas and then compare them to expected yield. When yields do not match forecasts, it is possible to review flows and pressure over any time period, even back to when they were first installed. This can help to identify errors in applications. Conversely, when no issue is found, it becomes evident that it is necessary to look elsewhere for the shortfall. Without data to work from, forecasting can be little more than an educated guess.

Efficiencies are further enhanced if flow and pressure are known; then plugged lines can be spotted and corrective action can be taken long before suboptimal leaching occurs. Conversely, if enough solution has reached the area to meet targets, then plugged lines may be allowed until fresh ore is stacked.

Safety and health

Typically, the distribution system can only be evaluated for integrity and correct flow and pressure, and then manually adjusted, during the day when employees are on the pad. Once the sun sets or inclement weather arrives, the pad is unmanned and without monitors. This is where WirelessHART instrumentation can fill in the gap and provide monitoring of essential parameters like flow and pressure. By relaying pressure and flow to operations, the instruments can detect problems like a ruptured pipe, which could lead to destabilizing events (erosion, pad stability, etc.). Quickly identifying the issue can enable the initiation of a process to stop flows and minimize damage.

Adding instrumentation to the pad means that fewer working hours will be required for routine inspections. Looking for pipe breaks, plugged drip emitter walkdowns, ponding, or dry areas requires more employees on the pad, which means required PPE and exposure to the elements and other hazards. Sun and heat, or storms and lightning, are hazards that can impact a crew on the pad year-round. Similarly, uneven pad surfaces can result in tripping hazards and injuries, and lost time. Lastly, due to the ore mineralization, hazardous gas may be present. This needs to be monitored, but exposing crews to even low levels of gas should be avoided.

Environmental hazards

Pipes, from small drip lines to larger distribution lines, crisscross a typical leach pad and can pose an environmental risk – from small leaks to catastrophic failures. Leaks from broken lines can run off the pad

and off the property. This can result in fines and expensive clean-up work. If the operation is relying on reports from human observers, a large line that ruptures may not be dealt with quickly enough to prevent damage to the pad, or to prevent runoff from going into national waters. Picking up errors quickly with instrumentation enables a faster response and therefore ensures less damage.

Perhaps one of the most serious leach pad events is liquefaction of a portion of the pad, which can result in damage, lost equipment, injuries, and even death. Liquefaction is the sudden loss of cohesion of solid ground, which turns into flowing mud due to the pad being saturated. Liquefaction can happen suddenly and without warning, endangering everyone on the pad and in the vicinity. The change can be a result of high levels of solution, or lower levels of solution in the pad if triggered by an earthquake. The time and effort to repair the pad and get back into production means lost revenue and redirected resources.

WirelessHART

The mining operations that have installed WirelessHART instrumentation have benefited from better operational visibility, fewer crews exposed to hazards, and better environmental outcomes. WirelessHART is similar to the wired HART version that has been in use in the industry since the 1980s. There are an estimated 40 million wired HART devices installed worldwide, in industries as diverse as chemicals and refining to food and beverage, pharmaceuticals, and oil fields. Because of this, crews are familiar with how HART operates. The Wireless version is an extension of this already known protocol.

Emerson has developed over 65 different WirelessHART instruments to monitor all areas including flow meters, pressure transmitters, temperature transmitters, discrete switches, and more. The WirelessHART network uses the 2.4 GHz ISM frequency, and is an open protocol that is managed by the FieldComm Group. All WirelessHART devices have robust, multi-tiered, always-on security, which is provided through advanced standards-based encryption, authentication, verification, key management, and anti-jamming techniques. Security is built-in and cannot be switched off.

The field device that is the center piece for leach pad flow and pressure measurement is the Emerson 3051SMV WirelessHART differential pressure (DP) flow meter. Using advanced electronics to measure the differential pressure across an orifice plate or Annubar, flow is calculated and then transmitted. There is also a second sensor in the unit that measures static pressure. These two variables, flow and pressure, are transmitted back to a Gateway, where it is received and then sent directly to the mining operations process control. The 3051SMV flow meter is a unique instrument, and when mounted to the 405C Conditioning Orifice Plate presents a capability unmatched by any other wireless instrument. The 405C conditioning orifice plate features a patented design that enables accurate measurement with reduced pipe straight run. This orifice plate is compact and easy-to-install, and features self-centering mechanisms for optimal

accuracy. This combination of the 3051SMV and 405C then gives a 1 – 2 punch that is unmatched in industry; flow and pressure delivered via WirelessHART



Figure 1



Figure 2

Summary

What then have been the results? To date, several mines in the USA have installed multiple flow meter/pressure transmitter units on their pads, turning what was a data desert with no information into a data avalanche. Starting twelve years ago, these mines have increased their recoveries, reduced negative events related to safety, health, and the environment, and improved water management and process transparency.

Before the introduction of WirelessHART instrumentation on leach pads little data was available to evaluate strategies and leaching campaigns. WirelessHART has added thousands of data points daily and, over time, millions of data points, allowing timely evaluation of adherence to leaching plans. This process transparency is only possible with timely and accurate data, from which conclusions can be drawn.

The ability to control application rates and distribution and get that data back is central to process transparency. The WirelessHART networks have the security and reliability to deliver process data with integrity. This results in higher recovery rates, reduced adverse events in safety, health, and environment, and better water management.