WHITE PAPER

Uncover Sound Water Management Strategies for Mining

Balancing large water requirements against water scarcity and quality is vital for mining operators to maximize efficiency and minimize water-related impacts to the bottom line. By modeling water needs and better understanding water quality, operators can define effective water management strategies that help avoid operating issues and keep business impacts at bay.

Introduction

In 2013, the CDP — an organization that supports companies and cities in reporting the environmental impact of major corporations — published a survey indicating 64% of mining industry respondents had experienced detrimental water-related impacts to their business in the previous five years. In the CDP 2019 Metals and Mining Report, the nonprofit confirmed the risks remain with an average of 44% of industry respondents having suffered water-related financial losses amounting to $11.8 billion over the past five years.

Understanding water needs and quality is essential to creating programs that balance the large water requirements of successful mining operations. The right approach to water management and treatment can help alleviate operating issues and keeps business impacts at bay while also maximizing mining operation efficiency.

Gauging Water Needs

From mineral processing and slurry transport to dust control, mining operations require significant amounts of both process and potable water to meet various operational needs. The first step toward understanding and gaining control of a water system is the development of a water model.

A water model should be a living document, typically in spreadsheet format, to accommodate seasonal water source changes (such as rainfall and evaporative losses during different times of the year) and allow operators to model different water need scenarios. The development of a water model helps identify each major unit in the mining operation, whether that unit is using water or treating water, and can include:

- Ball mills
- Flotation systems
- Tailing ponds
- Boiler pretreatment
- Wastewater treatment
- Water reuse treatment systems
- Cooling water systems
- Other operation units

The model should not only include each operating unit that requires or uses water but also identify where the water goes after each process in an operation. For example, a cooling tower will have two outlets for the water it uses: the blowdown and the evaporation. This is important as, while evaporated water is lost to the environment, blowdown water either may be available for reuse or must be accounted for in the wastewater stream.

Because water use is demand-driven, the model must be developed to identify how much water each unit operation will require. A steam-driven system, for example, will need a certain amount of steam to accomplish its work. This water demand must be reflected in the model to determine the size of the boiler makeup system that will impact pretreatment, which will then further affect influent requirements. Starting with the end in mind and working backward helps to create a more comprehensive and robust water model for mining operations.

Weighing Water Quality

Water quality requirements can be dictated by the unit operation it serves, such as boiler feedwater, or can be impacted by the process from where the water is coming from, such as a tailings pond. Quality also can be determined by what water source is available, whether from a river or well water supply.

Understanding a water system for mining requires knowing the quality of the water throughout the operation. Assessing the quality of water is necessary to determine if it will be suitable for the application or if the water will require additional treatment.

While understanding water quality usually begins with water analysis, not all water analyses are adequate or even accurate. For daily operational control, testing with basic equipment may be sufficient, but it is unlikely the test will be good enough for system design purposes or regulatory reporting.

Designing an optimal water management system or operations unit typically requires an extensive array of constituents to be evaluated, which is beyond the capability of most operational or field labs.

Analysis for regulatory permits usually requires a certified and independent lab with traceable standards and reported quality control.

Increasing Water Quality Confidence

For operators faced with water analysis that may be of unknown origins or questionable accuracy, a few tests exist that can be performed to help increase confidence in the analysis or identify inaccuracies.

Figure 1 is an example of a water quality review and compares the number of cations to anions on an equivalent basis that should balance. The data also correlates the projected quantity of dissolved solids to the amount measured.

Cation	mg/l	epl	Anion	mg/l	epl
Calcium	84.8	4.24	Bicarbonate	334.8	5.49
Magnesium	36.9	3.02	Carbonate	0	0.00
Sodium	17.8	0.77	Hydroxide	0	0.00
Potassium	2..9	0.07	Chloride	36.1	1.02
Iron	0.2	0.01	Sulfate	97.5	2.03
Manganese	0.109	0.00	Nitrate	23.5	0.38
Aluminum	0	0.00	Fluoride	0.2	0.01
Barium	0	0.00			
Copper	0	0.00			
Lead	0	0.00			
Zinc	0	0.00			
Total	142.709	8.12		492.102	8.93
			Silica	59.8	
pH	8				
Reported TDS (gravimetric)	472				
TDS	694.654				
TDS (gravimetric estimated)	524.49				
Anion/cation ratio	1.09878				
TDS reported/estimated	0.89991				
Tempetature, oC	20				
Langeliers Index	0.6961				
Ryzner Index	6.6078				
Puckorius Index	6.49519				
Larson-Skold	1.38696				
pHs	7.3039				

An adjustment is made in the table comparison due to the laboratory method to determine total dissolved solids (TDS). The TDS is a gravimetric test that causes the decomposition of the bicarbonate that would not compare well to the summation of the individual ions where this decomposition does not occur.

A mine operator should not expect exact values (indicated in ratios of exactly 1.0) in both the ionic balance and the TDS comparison. Instead, it is generally accepted that if these ratios are within a range of 0.9 to 1.1, the confidence of the analysis is good. If ratios are significantly off, the analyses may either be inaccurate or missing a significant component.

Managing Water Resources

In addition to modeling how water is used and understanding how water quality may impact processes, mining operators must embrace water conservation strategies to manage water requirements and optimize operations.

Whether dealing with fresh makeup water availability or wastewater discharge issues, operators may be required to reduce water demand, use fewer water sources or both. To accomplish this task, mining operators need to find ways to reduce water use or demand within operations, reuse water that may otherwise have been sent to wastewater, or reclaim waste streams by nontraditional means.

- **Reduce water use:** Using the water model, operators can identify areas of potential water reduction in mining operations. Water use reduction may be as simple as turning down water flows or providing intermittent flows where continuous water streams had been used but not necessarily required. Water reduction is also achievable by using less desirable makeup sources, such as brackish water or seawater, which may require plant operation changes, including the implementation of desalination systems.
- **Reuse of water:** Opportunities exist in most operations to maximize water usage by reusing water for different parts of the mining process. Taking a stream from one process that may have previously been sent to waste (such as reverse osmosis reject) and reusing the water in another application (such as dust control) is an effective way to reuse water. Potential water reuse applications can be identified where the water requires little if any treatment before being reused.
- **Water reclamation:** Reclaiming water used in one part of the mining process and using it in another application greatly aids in creating a sustainable operation. However, a water reclamation system generally requires significant treatment of a stream that had previously been considered wastewater. An example includes the treatment of a wastewater stream to remove organic contaminants before being used in a cooling tower as makeup. Another form of reclaim is the implementation of thermal zero liquid discharge (ZLD) technologies to remove solid salt waste stream contaminants and use of the fairly pure condensate in plant operations. Evaluating the water model and reclamation opportunities can help operators better manage water requirements.

Conclusion

Mining operations are faced with many issues and potential business impacts resulting from water availability, use and quality. Understanding the water model for an operation, assessing water quality, and determining ways to reduce, reuse or reclaim water within a plant allow operators to develop water conservation programs that effectively manage risk and maximize efficiency.

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