CLOSING THE DISTANCE

Steve Brewer and Danny Quintero, Emerson, USA, consider advanced valve and actuation strategies for copper mining operations.

Copper mining operations are increasingly defined by the need to maintain reliable production under physically demanding and geographically dispersed conditions. Across North America and other major mining regions, operators face declining ore grades, intensified water recovery requirements, and growing pressure to improve environmental performance while sustaining throughput. These forces place significant demands on mineral processing infrastructure, particularly on final control equipment that must operate continuously in abrasive, corrosive, and remote environments.

Fluid control equipment in copper mining is routinely exposed to solids-laden slurries, aggressive chemicals, and wide process variability. Dewatering and water reuse initiatives, while essential for sustainability, often increase slurry density and abrasiveness, accelerating wear and elevating the risk of unplanned downtime. Under these conditions, valves and actuators can no longer be treated as passive components. Their reliability has become a critical determinant of operational availability, personnel safety, and environmental compliance.

Operational challenges in copper mining service

The severity of copper mining duty is most apparent in tailings handling and slurry transport systems. Tailings distribution systems convey dense, abrasive material over long distances, often at elevated pressures driven by

Figure 1. Detail of Clarkson knife gate valve with Bettis XTE actuator.

pumping requirements and site topography. These conditions concentrate erosion at isolation and diversion points, particularly where flow is intermittent or subject to backpressure. Valve designs not intended for high-solids service can experience rapid degradation, leading to leakage, loss of control, or seizure.

Solids accumulation further complicates valve operation by increasing actuation loads and restricting movement, especially in applications where valves remain in fixed positions for extended periods. In parallel, chemical exposure in leaching, solvent extraction, and water recovery circuits introduce corrosion mechanisms that challenge standard materials of construction. Acidic or caustic solutions, often combined with suspended solids, demand careful material selection to prevent premature failure.

Geography amplifies these challenges. Many copper mining assets are distributed across vast sites that include milling, tailings storage facilities, leach pads, and remote water management infrastructure. Historically, these locations have relied on manual operation or locally powered actuation due to limited access to electrical and communications infrastructure. Manual intervention increases operator exposure to hazardous environments and can delay corrective action, while limited visibility into valve condition restricts proactive maintenance planning.

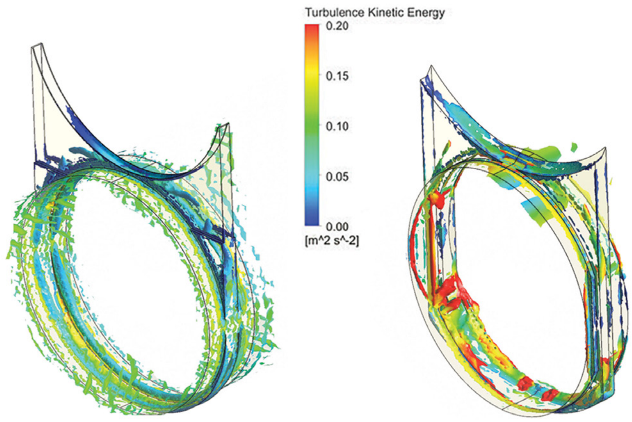

Figure 2. Next generation knife gate valves have been developed to handle severe service conditions.

Figure 3. Example of the varied material types that valves must manage in abrasive slurry management.

Industry drivers reshaping valve and actuation requirements

Several industrywide trends are reshaping expectations for fluid control equipment in copper mining. Electrification across transportation, energy, and infrastructure sectors continues to drive demand for copper, placing a premium on production stability and asset availability. At the same time, water scarcity and heightened environmental oversight have intensified the scrutiny of tailings management, effluent control, and water reuse performance.

These pressures are reflected in evolving design and maintenance strategies. Higher pressure class isolation valves are increasingly specified to accommodate long-distance slurry transport, while zero leakage performance is emphasised to reduce environmental risk and water loss.

Condition based maintenance strategies are gaining traction as operators seek to move beyond reactive interventions toward predictive approaches that reduce downtime and optimise spare parts usage.

Within this context, automation has expanded beyond centralised process control. Distributed assets require solutions that combine mechanical durability with automation readiness, enabling reliable operation even where traditional infrastructure is limited.

Integrating mechanical robustness and automation readiness

Effective valve and actuation strategies for copper mining begin with mechanical robustness. Severe service isolation valves used in tailings and slurry applications must accommodate high solids concentrations, irregular particle size distributions, and pressure fluctuations without creating internal geometries that accelerate erosion or trap material. Full port designs that allow solids to pass freely are essential for minimising wear and maintaining operability.

Wear management features play a central role in extending service life. Hardened and replaceable wear components inhibit erosion at sacrificial interfaces that can be addressed during planned maintenance rather than requiring full valve replacement. Advanced sealing architectures protect elastomers from direct slurry impingement while maintaining shutoff integrity under cycling conditions. Bidirectional sealing capability is increasingly important in systems subject to pump reversals or variable backpressure.

In applications where flow modulation is required, such as slurry distribution or process control, valve designs must balance control performance with erosion resistance. Hardened trims, robust shaft support, and appropriate velocity management reduce wear while maintaining stable regulation. As mining operations become more geographically dispersed, automation readiness has become a key differentiator in valve and actuation selection.

Managing corrosive chemical service and water recovery

Chemical handling systems present a different set of challenges. Leaching and solvent extraction circuits expose valves to corrosive media that can rapidly degrade unprotected metallic components. In these services, lined valve designs and corrosion resistant materials are often required to maintain containment integrity and prevent leakage. Isolating process media from valve bodies and actuation components reduces corrosion risk, supports longer service life, and reduces maintenance intervals.

Water recovery systems add further complexity through variable solids content, scaling tendencies, and mixed water sources. Reliable isolation and control are essential to minimise water loss and ensure consistent process performance. As filtration practices become more common, valves in these circuits are subjected to higher cycling frequencies and greater variability in operating conditions. Designs that tolerate frequent actuation and support maintainability are increasingly important.

Figure 4. Advances in monitoring technology improve speed of response and employee safety.

Extending visibility through distributed intelligence

Digital connectivity has become a critical enabler for remote valve management. Wireless communication technologies allow valve and actuator data to be integrated into asset management systems without extensive cabling, enabling remote status monitoring, diagnostics, and configuration. This visibility allows maintenance teams to prioritise interventions based on actual equipment conditions rather than fixed schedules.

An emerging trend in remote mining applications is distributed, or edge-based, control. By executing control functions locally at the actuator level, systems can maintain stable operation even when communications with centralised control systems are intermittent. This approach reduces latency, improves resilience, and supports targeted automation in high consequence applications without requiring full control system expansion.

Remote valve automation in a Western United States copper heap leach operation

A copper mining operation in the Western United States manages multiple heap leach pads distributed across a large geographic area. Raffinate and pregnant leach solution flows are controlled through networks of isolation and control valves located far from centralised infrastructure.

Historically, solution distribution required manual adjustment. Operators travelled long distances to access individual valves, often across uneven terrain and in proximity to chemical exposure. Adjustments were infrequent, leading to variability within solution application rates and delayed response to changing operating conditions. Limited power availability and the absence of wired communications infrastructure constrained traditional automation.

To improve consistency and reduce manual intervention, Emerson recommended implementation of electric actuators on selected solution control valves serving remote leach pad headers. The actuators were configured for local control using process feedback from wireless instrumentation, enabling closed loop regulation at the point of use. Solar and battery systems supplied power, allowing continuous off-grid operation.

Wireless communication integrated actuator status, valve position, and diagnostics into the site's asset management platform, providing remote visibility without routine field inspections. Control functions executed locally at the actuator reduced dependence on continuous communications and ensured stable operation during intermittent network outages. The deployment improved consistency in solution distribution, reduced manual valve adjustments, and lowered personnel exposure to hazardous areas.

Outlook on copper mining operations

The evolution of copper mining operations is increasingly shaped by digitalisation, sustainability initiatives, and the realities of operating in remote environments. As ore bodies become more complex and water management requirements intensify, operators are placing greater emphasis on technologies that support predictive maintenance, higher equipment utilisation, and reduced personnel exposure.

Valves and actuators operating in tailings, leaching, thickening, and water recovery circuits will remain central to this transformation. Equipment that combines severe-service mechanical design with embedded diagnostics and automation readiness enables condition-based maintenance strategies that reduce unplanned downtime and extend asset life.

Conclusion

Copper mining operations depend on reliable fluid control to sustain throughput, protect personnel, and meet environmental obligations under increasingly demanding conditions. Abrasive slurries, corrosive chemicals, and remote locations place exceptional demands on valves and actuation systems, making application-specific selection and lifecycle support essential.

Advances in severe-service valve design, electric actuation, and digital connectivity are enabling operators to close the distance between centralised teams and remote assets. When applied strategically to high consequence applications, these technologies support safer operations, improved reliability, and more sustainable copper production. GMR