High-Performance Control Valves for Water Addition Processes in Ore Mining



Pulp and slurry density control, throughput management and reagent mixing require valves specifically engineered for severe service applications.

1. Introduction

Modern mining operations necessitate substantial water usage for various critical processes and operational needs. Water holds several advantages in mineral processing due to its cost-effectiveness, energy efficiency and versatility in various processes. Some of the key applications in mining that require water addition are:

Grinding and Classification:

- Slurry Formation – Water is added to the ore in grinding mills to form slurry for easy handling and processing.
- Density control – Water is added to adjust the density of the feed slurry to optimize particle classification and separation efficiency.
- Throughput management – Proper water addition ensures hydrocyclones operate within their designed capacity.

Flotation:

- Pulp density control – Water is added to maintain the slurry's optimal density for effective mineral separation from the ore.
- Reagent mixing – Water facilitates the mixing and dispersion of flotation reagents for even distribution within the slurry.

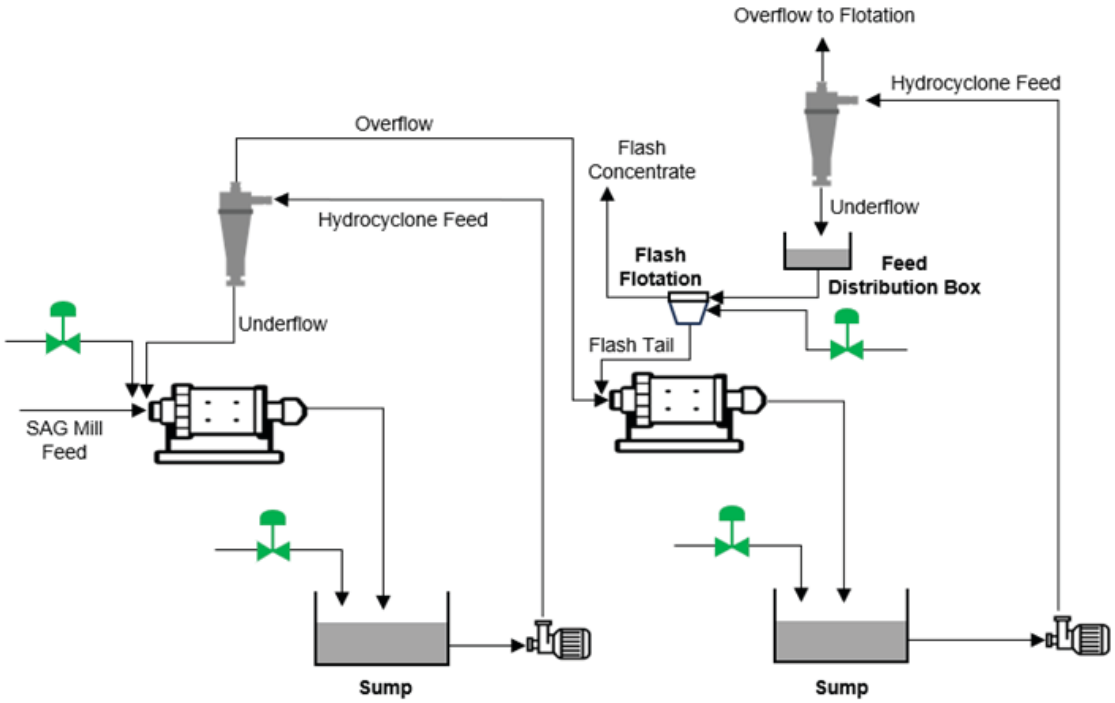


Figure 1. Grinding and Classification

2. Grinding and Classification

The purposes of the grinding and classification in ore mining are to:

- Increase recovery rates of valuable minerals during extraction.
- Reduce energy consumption in subsequent stages of processing by optimizing the particle size.
- Achieve consistent particle size to improve the quality and purity of the final product by facilitating more effective separation of valuable minerals.

With water addition, the variability of product size and percentage of solids can be decreased. Controlling slurry density during grinding and classification allows for optimal particle classification in hydrocyclones. Slurry density must be within the targets and parameters defined by the process. Diluting the slurry with water helps minimize middle-sized particles, preventing grinding inefficiencies caused by an overload of solids. The correct amount of water avoids density discharge from the mill and recirculating load maintaining water tonnage/water ratio for optimal grind , with enough water to flush fines out of the mill without pooling inside the mill.

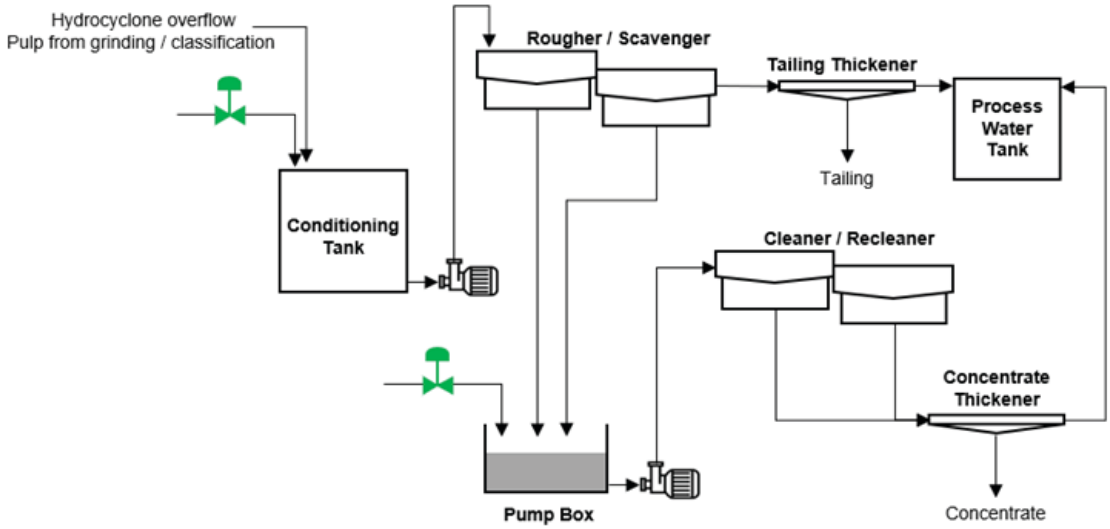


Figure 2. Flotation

3. Flotation

Water addition valves are commonly used in froth flotation circuits in the ore mining industry. Pulp for flotation must conform to two conditions:

- Ore particles should be as close as possible to the size needed for flotation.
- Pulp density must be controlled to minimize power and reagent consumption.

Water addition valves are installed on flotation cells or conditioning tanks to regulate pulp density and maintain solids concentration. This regulation is vital for achieving proper froth thickness and stability, ensuring the correct pulp density before the slurry enters the flotation circuit.

4. Challenges in Water Addition Valve Applications

- **Space Constraints:** Hoppers are often small, requiring the valve to react quickly to prevent emptying or overflowing.
- **Flow Range Requirements:** This application requires a valve with a wide control range. Butterfly valves are often used due to their initial cost advantage, but they frequently fall short in performance. This leads to poor control and cavitation that damages downstream pipework, causing regular downtime and maintenance.
- **Start-up Requirements:** Initially, a large volume of water is needed to prime the system, requiring the valve to accommodate maximum flow rates. When introducing ore, significantly less water is needed during the second start-up stage. Butterfly valves have a usable control range between 25% and 50% of valve travel, with high gain at low travel, leading set point to both under and overshoot. Their linear characteristics perform poorly in this scenario.
- **Process Water Particles:** Process water in the mining industry typically contains particles. This poses a challenge to the water addition valves. In addition to good controllability, water addition valves need to withstand erosion. Any erosion damage could potentially cause leakage and affect operation efficiency. Cavitation conditions could be an issue due to no minimum or no backpressure. Solids could clog obstructive valve trim used. Reclaimed water often has high calcium content that causes scaling.

5. Emerson's Solutions



Figure 3. Fisher™ CV500 Cam Vee-Ball™ Rotary Globe Control Valve with Fisher™ 2052 Actuator and Fisher™ FIELDVUE™ Digital Valve Controller

Fisher CV500 Rotary Globe Control Valve:

- Has a durable solid metal seat ring and cammed V-notch ball that provides tight shutoff
- Patented seat ring design self-centers, self-laps and dynamically aligns with V-notch ball, giving superior life cycle
- Has sealed metal bearings that help prevent particle build-up and valve shaft seizure in severe applications
- A fast-acting valve with an equal percentage characteristic plug offers a large control range. The Fisher CV500, have a wider control range (15%-70%) compared to butterfly valves (30%-50%). They are less prone to cavitation and their equal percentage plug configuration makes them ideal for this application. The Fisher CV500 valves also have a high Cv and a high FL (recovery factor), with longer-lasting seats due to the eccentric ball design.

Fisher FIELDVUE Digital Valve Controller:

- Ensures precise control of valve positioning for rapid adjustments, which crucial for process optimization
- Allows predictive maintenance and reduces downtime through diagnostics features, keeping valve health conditions in check

6. Case Study

A customer experienced frequent damage to butterfly valves in their water addition applications due to cavitation, with an average service life of just three months. In early 2020, they switched to Fisher CV500 Vee-Ball valves, which showed no signs of damage after 12 months. They have since replaced all 42 butterfly valves with Fisher CV500 Vee-Ball valves.

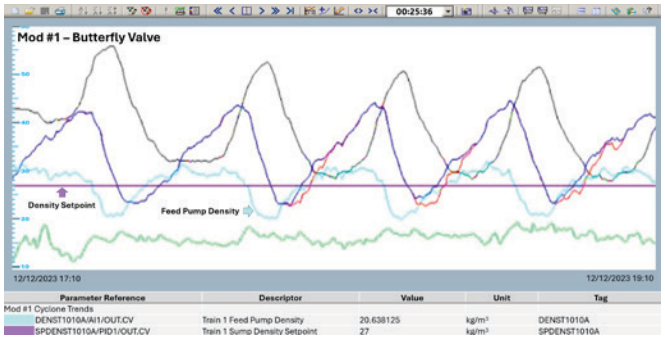
Two Fisher CV500 valves were installed in the water addition application with valve internals upstream (seating area and seat ring) and downstream of the valve after 12 months of service.



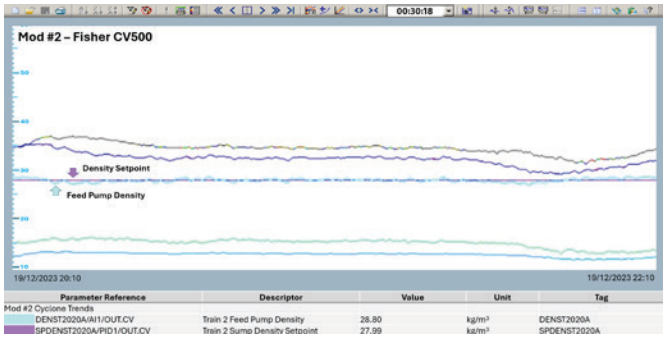




Mod 1 - Butterfly Valve



Mod 2 - Fisher CV500



Aqua Trend – Feed Pump Density ideally equals the Lavender Trend – Sump Density Setpoint

Figure 4. Distributed Control System (DCS) trend comparing two different trains with different valve.

6. Results

Fisher CV500 Cam Vee-Ball valves have a higher initial cost compared to butterfly valves. However, they offer a lower total cost of ownership within 12 months. By reducing the need for frequent replacements and associated expenses, such as lost production and equipment mobilization, the customer experienced more savings. Most importantly, for the first time in the operation's history, the valves enabled the achievement of optimal density for the hydrocyclones, resulting in substantial gains in product yield.

In addition to the above, the customer realized the following benefits:

- **Reduced operational cost:** This was achieved through increased pump efficiency (energy consumption) by controlling the density of the slurry.
- **Reduced maintenance cost:** Optimum density control of slurry prevented clogging and excessive wear on pumps and associated equipment.
- **Reduced wastage:** Minimized / Eliminated environmental contamination.
- **Reduced water usage:** Appropriate water flow control prevented water flooding the belt filter.
- **Optimum moisture control:** Excessive moisture in slurry fines results in reclaimer derailments. For every 1% stockpile moisture, an additional ~$1M/annum for diesel is required for the product transport.

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