FEATURED ARTICLE

# Optimizing Actuator Performance in Harsh Mining Environments

How to overcome maintenance challenges and improve precision control in flotation applications for better performance and increased profitability.

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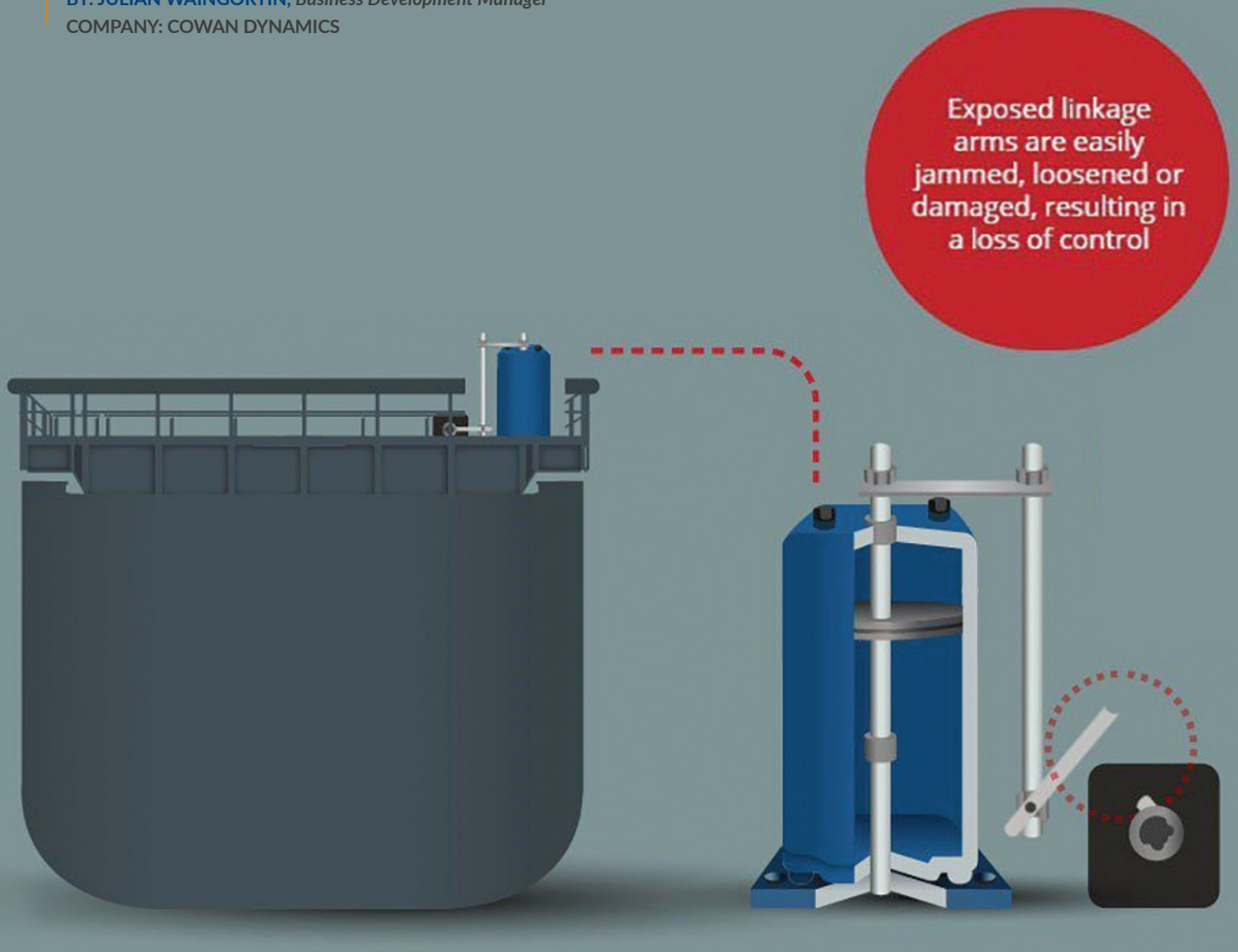



Figure 1: Linkage arm positioner in traditional actuators for dart valves in froth flotation cells.

Mineral processing plants present a particular combination of challenges that require attention, and flotation is one of the critical processes in these operations. Actuators are critical to froth flotation operations, as they can make the difference between a high recovery or a loss of metal. Rusty, old linkage arms causing actuators to overshoot, slow responses from control loops causing them to undershoot, unplanned downtime … sometimes it can seem like any minor disturbance can cause a loss of productivity.

The challenges faced with actuators directly impact mineral recovery, concentrate grade and ultimately, the plant's bottom line. In this article, we will share some insights on the two most pressing issues encountered and the practical solutions that can be implemented, starting with the challenges, as individual solutions usually cover more than one problem.

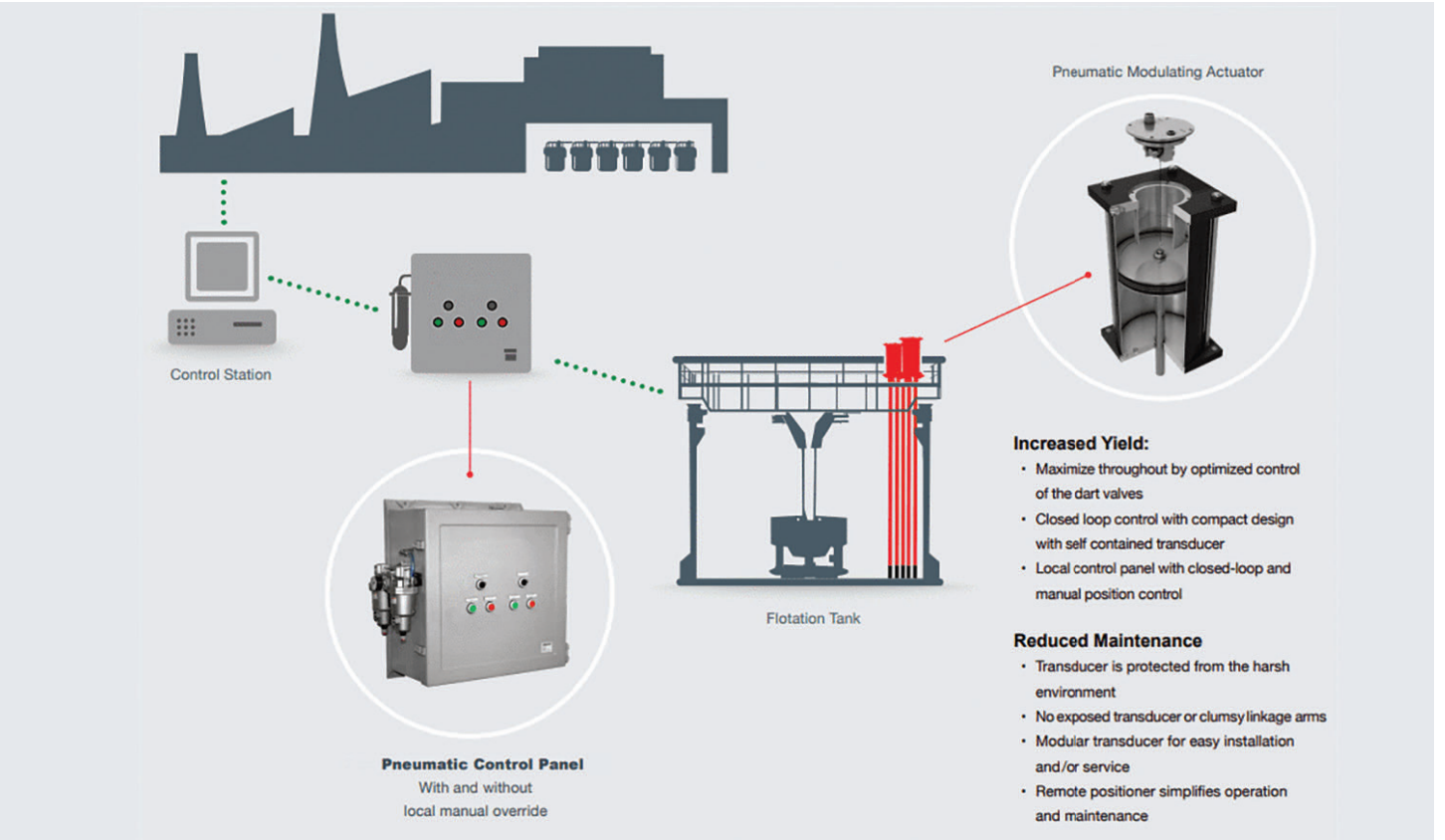
## Maintenance and reliability challenges

In flotation circuits, valve actuators operate in one of the most demanding environments in mining. Operators deal with equipment's constant exposure to corrosive reagents, mineral slurries, dirt and often extreme ambient conditions. Sometimes, what an operator observes as an issue or effect is due to compounding causes, so it is important to understand the core issues before determining a solution. Here are some examples we have observed as the primary challenges operators face.

- **Component wear and degradation:** From our experience in flotation plants, actuator wear is accelerated by exposure to dust and reagent splashing around conditioning tanks. Depending on the operation, it can often be lime or sulfuric acid, though other reagents are also used. Additionally, high humidity environments around flotation cells contribute to internal corrosion, which compounded with vibrations from motors, agitators and rotors, can seriously shorten the life of actuators. Tropical regions or areas with high sun radiation can be punishing, causing heat damage to the electrical components.

  Some operations, like alumina, work with ultrafine particle sizes, which can infiltrate seals, particularly around launders and concentrate pumps. Temperature variations, especially in plants operating in extreme climates, can also contribute to shortened life of actuators.
- **Pneumatic system complications:** In flotation circuits, we have found that pneumatic actuators face additional complications, arising from the very nature of compressed air operations, such as moisture build-up and reagent mist contaminating air lines, or fluctuating air pressure due to competing demands from spargers. In cases where the air lines are contaminated (generally in acidic or alkaline environments), infiltrations in the cylinders or air lines can cause accelerated corrosion. In other cases, exposure to xanthates and other reagents can degrade seals faster than in typical applications.

Figure 2: Schematic of where dart valves are used in froth flotation cell.



- **PFAS in actuators:** At this point we must add some words about PFAS (per- and polyfluoroalkyl substances), the main components of many seals. These are those critical yet often overlooked parts of an actuator that make it work as it should. PTFE (polytetrafluoroethylene) and Viton are PFAS that are under intense scrutiny these days. They are the seals of choice for high-temperature applications. Any alternatives available today will offer reduced performance or will require increased maintenance. (*Ed note: Learn more about what the VMA is doing to help members understand the impacts of impending and existing legislation and regulations on the VMA website.*)
- **Control and positioning accuracy**: Keeping all of the above in mind, control and positioning accuracy add another layer of complication. Limited accuracy can mean the loss of valuable mineral or the dilution of concentrate, whereas high accuracy can rapidly increase the CAPEX and OPEX. This aspect might trigger a negotiation between the metallurgist (the custodian of recovery and throughput) demanding higher accuracy, and the maintenance functions operating under a mandate to reduce costs.

## Precision challenges

Other challenges in these operations may include the items below, ranging from equipment issues to the inherent challenges of working in mining operations due to the size and scale of operations and equipment required.

**Linkage arms:** Older models of actuators used to have a linkage arm, which was exposed to the environment and therefore was vulnerable to dirt, splashing and corrosion. Over time linkage arms become loose, causing a defective level control of the flotation cell by an overshoot or undershoot of the actuator response. At some point unplanned maintenance interventions become more frequent due to the accelerated wear.

In addition to this, linkage arms had a nonlinear response to the signal and therefore the process control was inaccurate in the best of times, or unstable at worst.

A variety of other problems, including interference of magnetic fields generated by large agitator drives, calibration drift due to vibration and more have also been observed. Fortunately, the following are some of the solutions available in the industry today that accommodate for these issues.

**Feedback devices:** The first solution was the introduction of protected feedback devices, such as advanced position transducers and controllers. These have linear or proportional response, are expected to withstand vibration and can be shielded from the magnetic fields in the surroundings.

**Confined installation of transducers:** The second solution arrived when some manufacturers started installing position transducers inside the pneumatic cylinder. This is a simple yet effective configuration where the transducers are shielded from the surroundings and exposed to instrument air only. This is especially effective in corrosive environments. Maintaining these products requires opening the pneumatic cylinder, but the need for maintenance is greatly reduced with this configuration, making it worth the effort relative to previous versions of this product.

**Selecting the right transducer:** There has also been significant improvement in the design and manufacturing of position tranducers. Most popular models are built around magnetic sensors, which offer a linear response signal of 4-20 mA, as is the industry standard, though digital signals are also becoming adopted. Other systems offer a passive resistive response, generally 0-10 kOhm, which can be installed with any communication protocol. These devices offer the additional advantage that they can be installed in explosion-proof applications controlled by remote panels in safe zones. The high resolution available in these types of systems, though slightly less than in a magnetic position transducer, is still more than enough to prevent an overshooting or undershooting response.

Figure 3: 150 psi pneumatic actuator with integrated position transducer. The position transducer is fully enclosed and protected from the corrosive surroundings in a flotation unit in a potash mine in Canada.

One contentious issue here is the speed of response. The controllers must be carefully designed to provide the required actuator speed. A delayed action could cause process instability and lower metallurgical performance. In some of the biggest flotation cells it is often necessary to install volume boosters to provide the required response.

**Fail-safe add-on systems:** A simple solution with increased acceptance is the installation of air spring, fail-safe systems. As an energy reservoir, these systems can provide a tight shutoff and allow for several actuation strokes in the event of an electricity outage or loss of air pressure.

**Quality of compressed air**: The availability of unlimited, constant pressure, clean and moisture-free air supply is a key underlying assumption in all the above considered issues.

Solutions and trade-off assessments for compressed air systems are outside of the scope of this article. Just remember that the presence of moisture, acids or alkaline

substances within the compressed air represent a dormant issue that frequently has a significant impact on the performance of any related equipment, not just actuators. For this reason, most suppliers of pneumatic actuators and automation require the additional of filters to ensure the absence of moisture, acids or alkaline substances within the compressed air. Also, variations in air pressure will affect the speed of response or might cause leaks in an otherwise tight shutoff.

The installation of desiccant air dryers, dedicated air supply systems and additional filtration are options that could be considered. When adequate air quality is not possible, electric actuators might be a viable option, but again, there are pros and cons with them as well.

**Special seals:** Adding specialty seals can go a long way in keeping contaminants away from an actuator's air chambers. Rod scrapers in particular are a valuable addition to the actuator as they have been shown to be highly effective in restricting the ingress of particulate material or extraneous liquids into the pneumatic actuators.

Rod scrapers and multistep seals are generally more effective than rod boots, especially in the presence of ultrafine particulates like alumina or in acidic or alkaline environments.

## Conclusion

Before making big investments, or postponing them indefinitely, the criticality of the valve must be assessed against the related metallurgical performance. A fair evaluation of the cost impact of valve-related process disruptions must include the lost production, lost recovery and higher environmental costs such as excessive tailings disposal and containment, as well as higher cost of water treatment.

For this reason, a good approach is always to test any solutions in pilot areas of reduced impact on the processing plant and the overall process stability.

Remember, in froth flotation, valve actuator performance isn't just about mechanical reliability — it directly impacts your metallurgical results and ultimately, your bottom line. The solutions we have outlined here come from real-world experience and have proven effective in maintaining stable and effective flotation circuit operation in many mines around the world.


### ABOUT THE AUTHOR

Julian Waingortin has been involved in business development in a variety of aspects of the mining industry for the past 18 years. He obtained his BA at the University of Buenos Aires in chemical engineering and his MBA at McGill University in Canada, and he is a member of the Order of Engineers of Quebec. Mr. Waingortin is currently the Business Development Manager for the Americas at Cowan Dynamics.