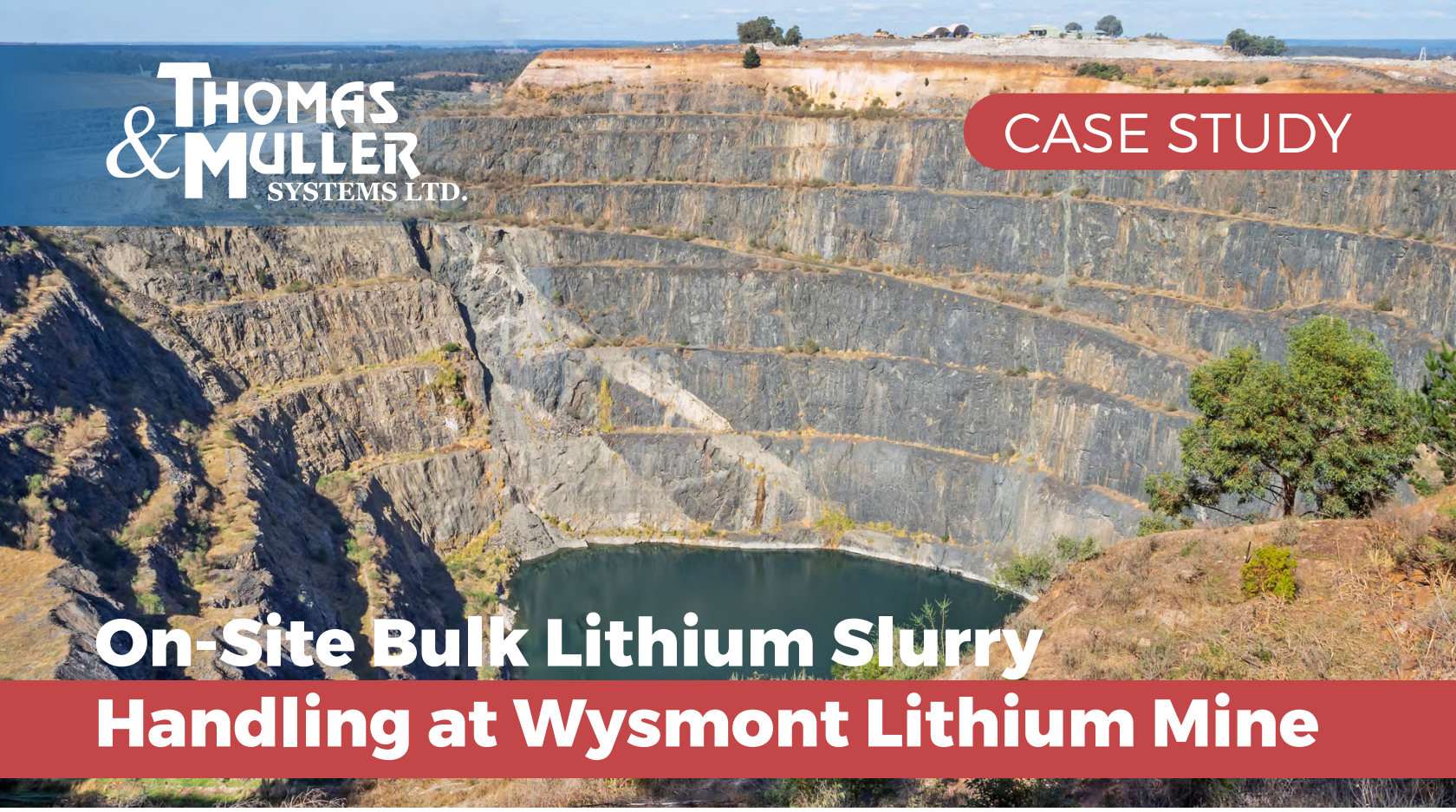


THOMAS & MULLER SYSTEMS LTD.

CASE STUDY

On-Site Bulk Lithium Slurry Handling at Wysmont Lithium Mine

Application:

Battery Manufacturing

Highlights:

Material study performed to size/design inlet

Cohesive and adhesive material (snowball test)

Polished, electropolished equipment to deal with stickiness

Live bottom, mass flow screw feeder, 304 Stainless

One reverse flight

Had to be specially crated for overseas shipping

Screws slave-driven by spur gears

Feed/takeaway: Both feed rate and takeaway chute is key to the functioning of the equipment

Gravity discharge from hopper in chutes

Screw feeds into dryer

Material Transported:

Lithium Slurry

Process Requirements:

12-5/8" Diameter screw, variable pitch, shaft was pinned to maintain low profile

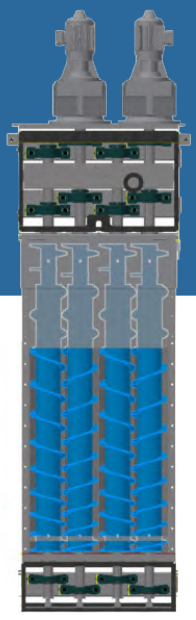
8" pipe

35 lbs/ft3

Moving 5 tons per hour

6 rpm

Hopper lined with Tivar due to the cohesiveness of the material



Mass-Flow Screw design provides uniform feed rate

Screws are counter-rotating and variable pitch

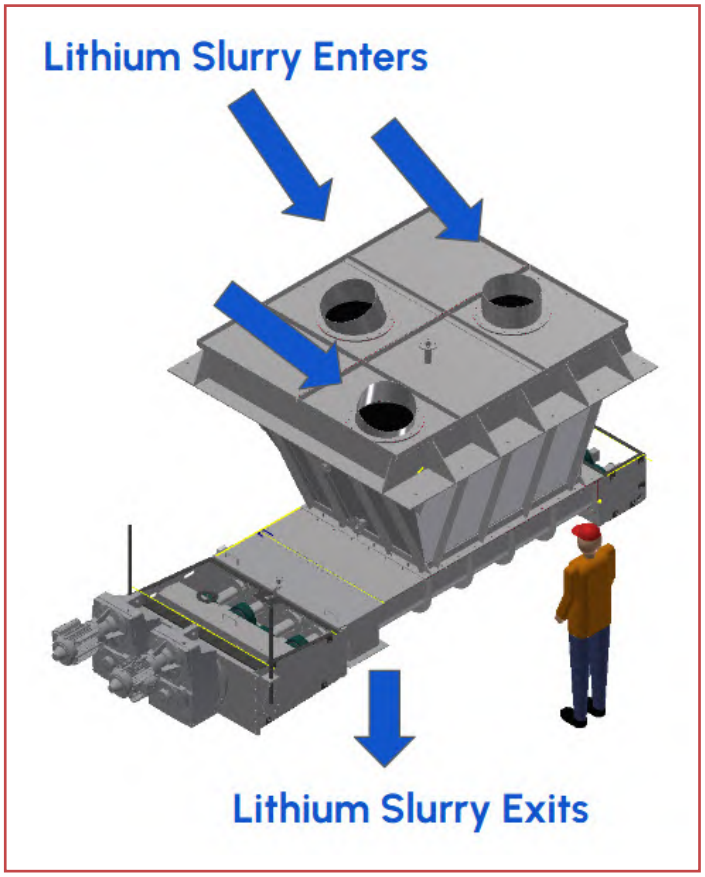
THOMAS & MULLER SYSTEMS LTD.

On-Site Bulk Lithium Slurry Handling at Wysmont Lithium Mine

CASE STUDY

Summary:

Mining, the systematic extraction of earth's minerals, predates the industrial revolution by thousands of years. The entire history of humanity is broadly classified according to the materials we use: the Stone, Bronze, and Iron ages. The Great Pyramid of Giza demonstrates men 5000 years ago had the capacity to transport over 5 million tons of limestone and no one knows how. In the modern world, mines continue to be at the cutting edge of materials handling. Thomas & Muller is proud to be a part of this fascinating and historic industry. We'd like to share some of our experience.



How does one begin to drain this sea of chemical sludge? First, we tested the material to see just what we're dealing with. After performing some basic trials at our facility, we determined a complete materials test and flow report was necessary. Fortunately, Solids Handling Technologies was willing to play with fire and test this hazardous sludge. They performed cohesive property and wall friction tests to determine which opening sizes best promote material flow. Rather than relying on rules of thumb, we were able to confidently design the equipment based on the specific properties of the material in question.

Modern mines cover tens of thousands of square acres and handle millions of tons of product at various stages of processing. As a consequence, internal transport is one of the primary challenges and costs. A common solution is converting solid bulk material into a slurry. Now functioning as a liquid, the material can be pumped through a pipeline. This method is quicker and cheaper than loading, driving, and unloading trucks. Once this slurry has arrived to be processed, it must be dried. **Feeding such dryers requires the slurry to be metered at a precise rate.** Transferring from the turbulent and chaotic pipeline to a carefully fed rate is problematic.

On-Site Bulk Lithium Slurry Handling at Wysmont Lithium Mine

CASE STUDY

One such problem that we've solved involves a lithium mine in Chile. Lithium slurry proves to be a difficult material to handle as it is extremely sticky (both cohesive and adhesive). On site, we like to perform the "snowball" test: pack some material into your hands and throw it at a concrete wall. If the material can be easily formed into a snowball and leaves residue sprayed around its impact, one can say it's sticky. If you have time and resources, true materials testing is advised. Companies like Jenike & Johanson are capable of performing a variety of tests with enough accuracy to take the guesswork out of engineering. This is precisely what we did on this project.

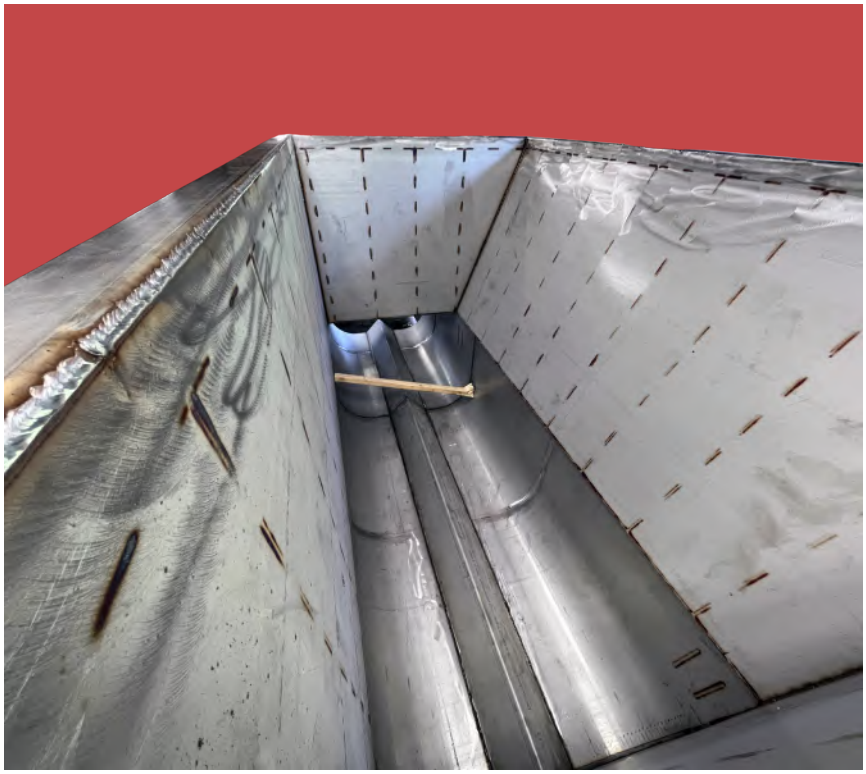
What's necessary when dealing with such problematic material is to achieve "mass-flow". Mass flow is reached when each particle, no matter its location in the hopper, is moving at the same velocity. Luckily, Thomas & Muller has been designing and fabricating mass flow hoppers and screw feeders for decades. This gives us **a vast repertoire of past jobs and experience to draw upon.** Our task was to receive the material from gravity-fed chutes and feed the lithium slurry into the dryer. We designed the equipment with 4 counter-rotating, variable-pitch, 12 ½" diameter screws into a live-bottom hopper.

These screws were polished to a CEMA V standard, and further electropolished due to the adhesive nature of the material. Furthermore, we used coupling pins instead of the normal bolts to minimize their profile and material contact. Each screw also had a reverse flight to ensure the material would discharge properly. The discharge chute itself had to be resized to a larger diameter for material flow.

THOMAS & MULLER SYSTEMS LTD.

On-Site Bulk Lithium Slurry Handling at Wysmont Lithium Mine

CASE STUDY



This project was a success. We continue to advise the customer on design changes and maintenance tips. We have also produced additional equipment downstream to aid with material flow. We look forward to engineering more screw conveying systems in the lithium and mining industries. Helping our customers solve problems and learning in the process has fueled our success for 80 years and 4 generations of family ownership.