PEAK PROCESSES

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Case Study:

Surge Bin Redesign to Eliminate Overflow in Bituminous Coal Handling

Design Validation through Bulk Flow Testing and Liner Optimization

Project Overview

In response to recurring material overflow at a high-impact transfer point within a thermal coal handling system, a new surge bin and hopper were developed to address poor flow performance, downtime, and excessive manual cleanup. The legacy system, constrained by capacity limitations and problematic material hang-ups, routinely allowed coal to back up and spill during equipment stoppages—especially under high moisture conditions. While this surge bin was developed outside of a specific live site, the design process, testing methods, and materials used mirror real-world conditions and offer valuable insight into proper hopper design for problematic materials like wet thermal coal.

Problem Background

Thermal coal—particularly when stored outdoors—can retain high moisture levels, with typical operating conditions reaching up to 20% moisture content. The client's original hopper system failed to manage this variability. The existing design, lined with mild steel and built with insufficient wall angles, encouraged arching and material bridging under stagnant conditions. During breakdowns or scheduled maintenance, coal would sit in the bin for hours—sometimes up to a full day—causing buildup, overflow, and eventual spillage onto surrounding ground areas. These events demanded urgent manpower to clear, reduced overall run time, and posed long-term wear and environmental hazards.

Digital Design and Simulation Process

The first step in solving the problem involved building a detailed 3D model of the proposed hopper and bin geometry. Using industry-standard CAD software, the bin was modeled with significantly increased holding capacity to allow for surge loads during plant downtime. Flow geometries were selected based on bulk material handling principles—specifically using mass flow theory to guide hopper angles and outlet dimensions.

To validate the design and understand how thermal coal would behave in the system, extensive testing was performed using a custom-built flow-ability tester. This allowed for empirical analysis of wall friction and flow function under various compressive loads and moisture conditions. Real thermal coal samples were used, at 20% moisture, to simulate worst-case handling situations.

Key Testing Focus Areas:

Wall Friction Testing: The effective angle of wall friction was determined by testing coal samples against different liner surfaces, including mild steel and TIVAR® 88-2. TIVAR® 88-2 demonstrated a dramatically reduced coefficient of friction, particularly under compaction loads representative of static head pressure in the hopper.

Flow Function Curves: Consolidation tests were conducted to assess the unconfined yield strength of the coal across a range of vertical consolidating stresses. This data was used to construct flow function curves, helping to size the outlet and define critical hopper angles for mass flow behavior.

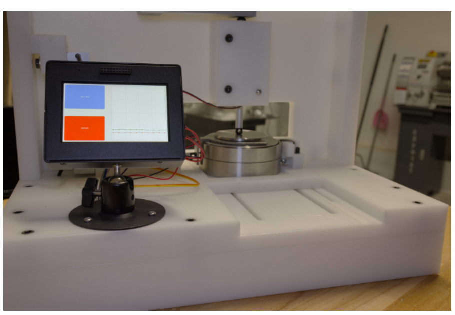
Material Residence Time Simulation: The model included scenarios where coal would remain in the hopper for up to 24 hours. These simulations helped identify risk points for compaction or freeze bonding, and adjustments were made to geometry to minimize dead zones and encourage uniform discharge.

Material Selection: TIVAR® 88-2 vs Mild Steel

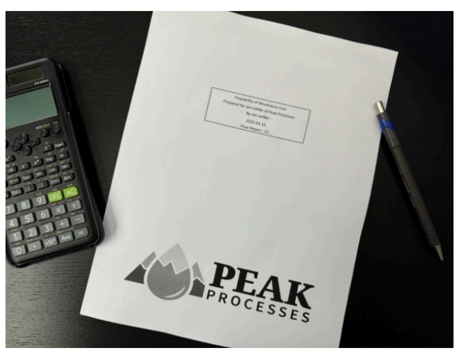
TIVAR® 88-2, a high-performance polyethylene liner, was selected over traditional mild steel after side-by-side testing confirmed:

- Up to 60% reduction in wall friction angle, significantly improving flow reliability.
- Superior wear resistance, extending liner life in abrasive coal environments.
- Decreased buildup, reducing the need for internal lancing, hammering, or air cannons.
- Because the liner doesn't absorb moisture, it prevents the retention of water within the material, eliminating hydro-static pressure and improving flow reliability.

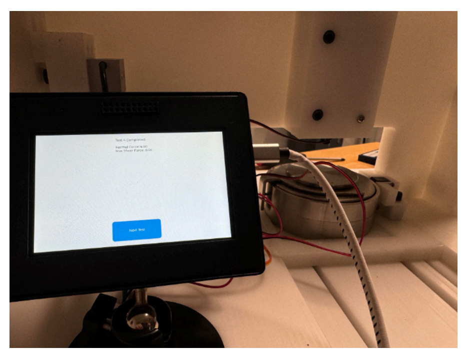
Lining a hopper with TIVAR 88-2 handling thermal coal over leaving it with bare mild carbon steel is an obvious choice.



Our shear tester running a series for the yield locus. Displays real time results on touchscreen.



With the results from the shear tester we can issue a report and give the client the best solution to their flow issue. All the required data to see how we got there is in



Our shear tester is wrapping up a yield locus with the fourth and final result displayed on the screen.

Expected Outcomes and Performance Simulation

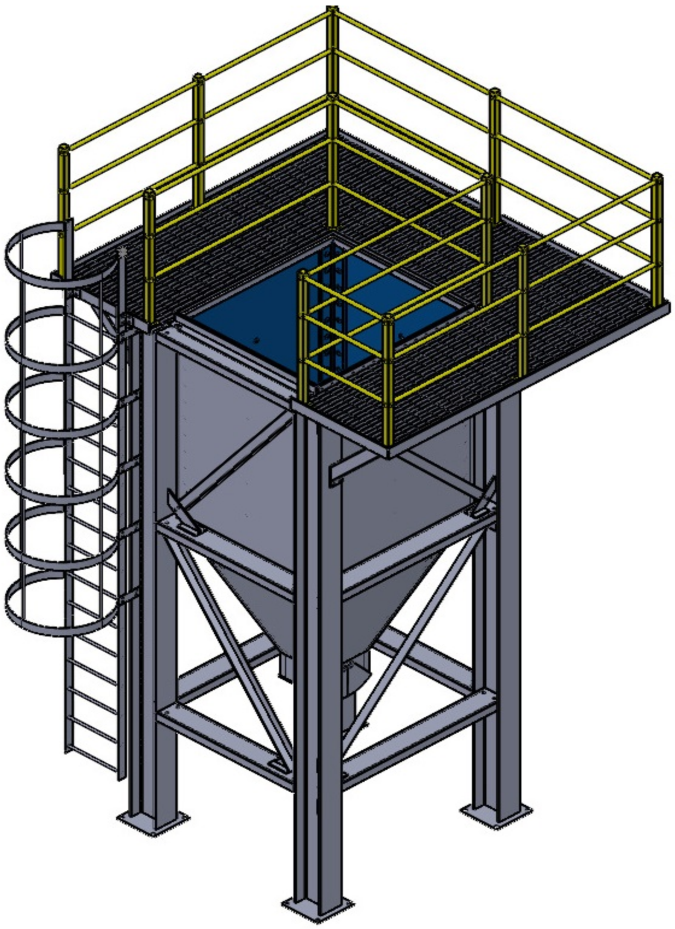
While the bin design has not yet been implemented at the live mine site, the simulated performance under real conditions has yielded promising projections:

- Dramatically reduced downtime due to material hang-ups.
- Minimal manual intervention, with flow blockages occurring only in rare freeze-thaw scenarios — a known and expected challenge for outdoor coal systems.
- Near-total elimination of overflow, thanks to expanded surge capacity and optimized outlet geometry.
- Improved safety and efficiency, with less frequent confined space entries for manual cleaning or material agitation.

Conclusion

This surge bin design showcases the value of integrating digital modeling, bulk material testing, and modern liner technology in tackling complex flow challenges. By simulating real-world performance and grounding the design in rigorous testing data, the solution provides a blueprint for future upgrades at thermal coal operations struggling with material hang-ups and overflow.

Further field trials are encouraged to validate the system in operational conditions, but early findings strongly support the long-term benefits of engineering with flow-first principles.



The 3D model above is the design of the Bituminous Coal surge bin based off of the results from our testing.

Have a question or issue with your current bulk setup? Give us a call.

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