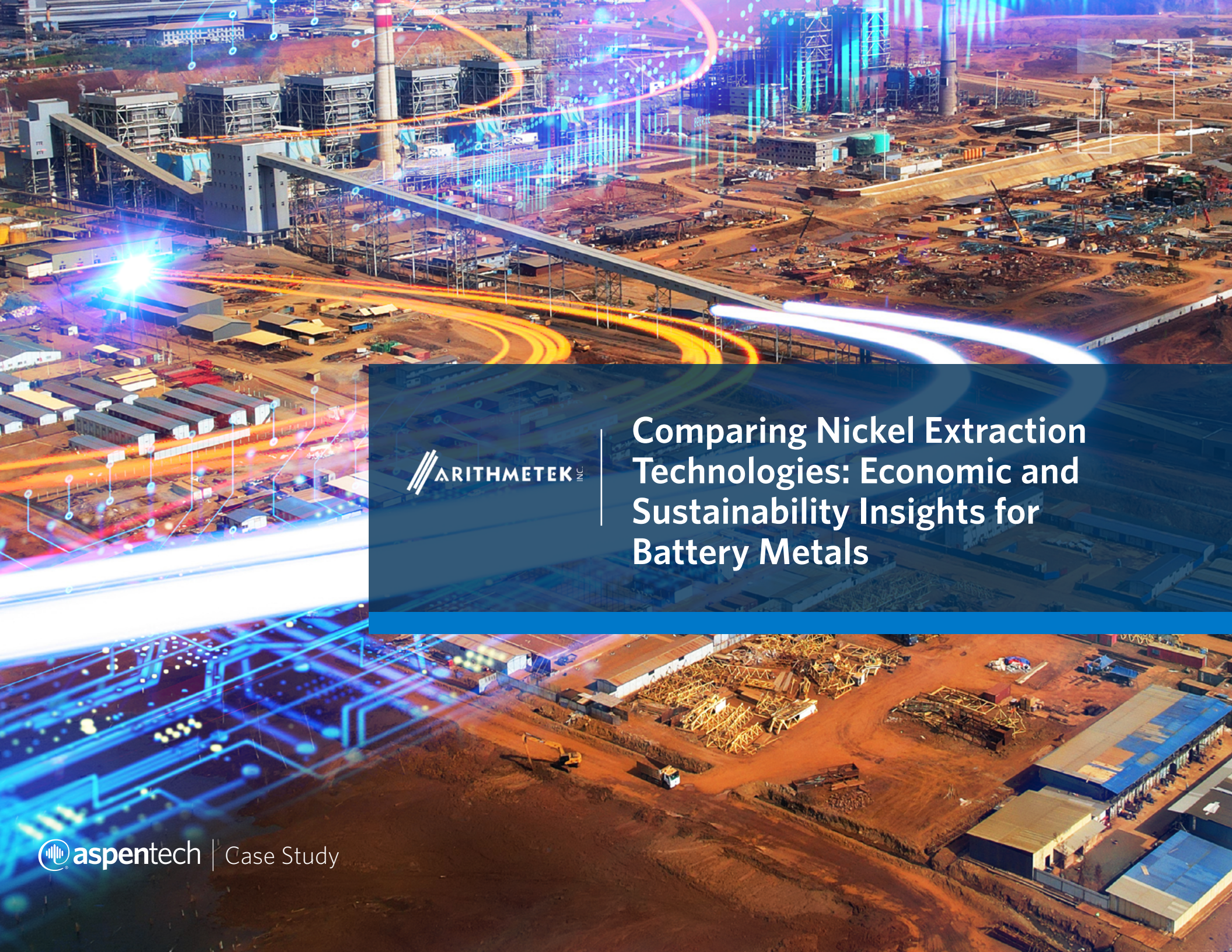


ARITHMETEK INC.

# Comparing Nickel Extraction Technologies: Economic and Sustainability Insights for Battery Metals

aspentech | Case Study

# "Without AspenTech's software my business would not exist in its current form."

Mike Dry, Owner, Arithmetek Inc.

## CHALLENGE

To assess the techno-economic feasibility of a new hydrochloric acid-based method to extract nickel from laterite ores

## SOLUTION

The synergy between Aspen Plus® and Aspen Process Economic Analyzer™ allowed Arithmetek to accurately model the process, calculate mass balances and obtain a baseline for CAPEX and OPEX of the new extraction process and compare them with another established approach

## VALUE CREATED

- Arithmetek earns contracts based on its technical and economic optimization strategies.
- Arithmetek clarified the business case for the new technology, demonstrating that it was not viable.
- Process and cost modeling help Arithmetek's clients select the most appropriate options and properly implement new technology.

# Facing New Challenges for Sustainable Nickel Technologies

Arithmetek Inc. provides specialized consulting services in simulation, modeling and early-stage cost estimation for hydrometallurgical circuits, mineral processing, pyrometallurgy and oil and gas technologies.

In recent years, Arithmetek has also been supporting companies on their journey to net-zero carbon emissions. One of the biggest challenges on this path is the rapidly growing demand for storage batteries, which are essential for harnessing intermittent renewable energy sources like wind and solar. This shift is creating a massive surge in the need for metals critical to battery construction, particularly nickel.

Historically, nickel has been sourced from sulphide ores. However, as these reserves dwindle, the industry is facing increasing pressure to develop economically and environmentally viable methods for processing laterite ores, a significantly more complex and resource-intensive challenge.

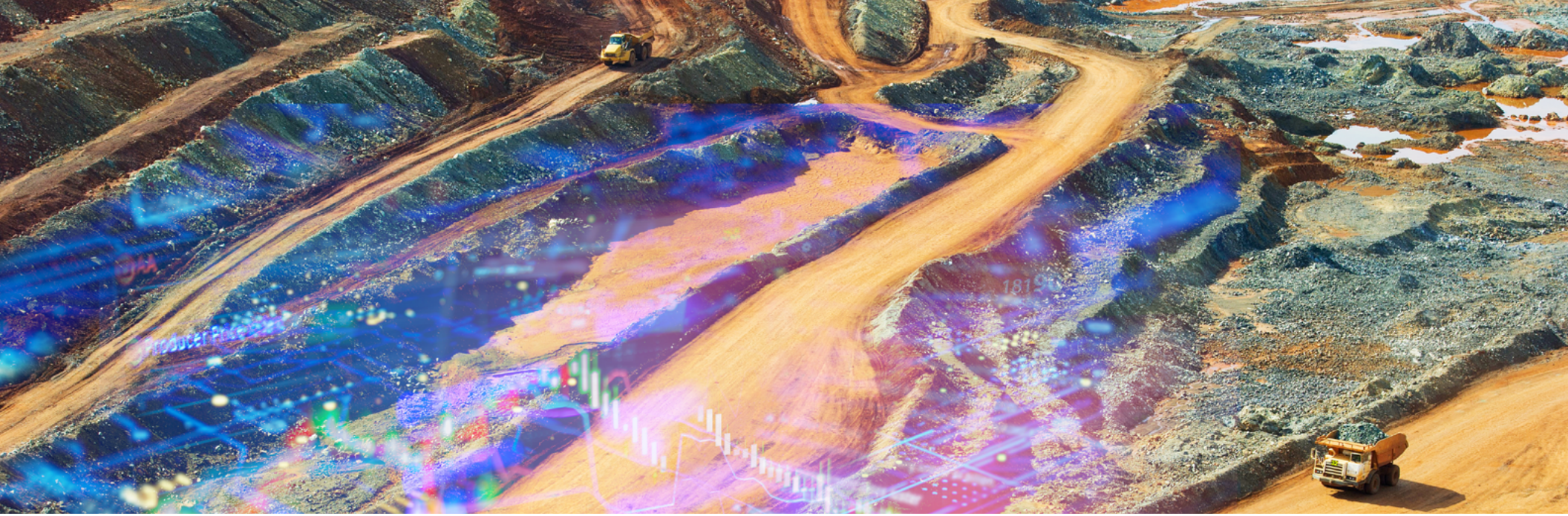
In response, several process routes have been proposed for treating laterite ores such as limonite, saprolite and their blends. One established method is Atmospheric Tank Leaching (ATL), where saprolite is mixed with recycled water and leached in agitated tanks using sulphuric acid.

An alternative process has been proposed, claiming to be a novel low-carbon process:

- Saprolite is leached with hydrochloric acid
- Nickel and cobalt are precipitated as a mixed hydroxide product
- Both hydrochloric acid and sodium hydroxide are regenerated through a chlor-alkali section for reuse upstream

This process was claimed to be a significant step toward reducing carbon intensity and improving circularity in chemical usage.

Arithmetek modelled both process routes—ATL and the new hydrochloric acid-based (HCA) method—and assessed their cost structures. These analyses were critical in evaluating the economic viability and sustainability trade-offs of the new circuit compared to the stablished approach.



# Concurrent Simulation and Cost : Comparing New Technologies with Integrated Workflows

Arithmetek's standard tools for evaluating saprolite processing circuits are Aspen Plus® and Aspen Process Economic Analyzer™ (APEA). With over two decades of experience using Aspen Plus and APEA, Arithmetek has enhanced its workflows by leveraging the seamless integration between the two solutions. This integration enables the direct transfer of process conditions from the simulation model into economic analysis, greatly expediting the generation of preliminary capital and operating cost estimates.

The synergy between Aspen Plus and APEA allows process engineers to refine simulations for optimal product rates and quality while simultaneously evaluating capital and operating costs. This capability is extremely useful for comparing multiple design options and assessing the economic implications of any process modifications.

Using Aspen Plus, Arithmetek developed detailed process models for both circuits to calculate accurate mass and energy balances. These models encompassed all key operations for saprolite

processing, including acid leaching, precipitation, recycling, dissolution and washing from the ATL route, as well as the chlor-alkali regeneration unique to the HCA process. Aspen Plus realistically simulated all chemical reactions, mineral dissolutions and solid-liquid separations. Both models were standardized to process the same quantity of the same saprolite feedstock, enabling a fair and consistent comparison.

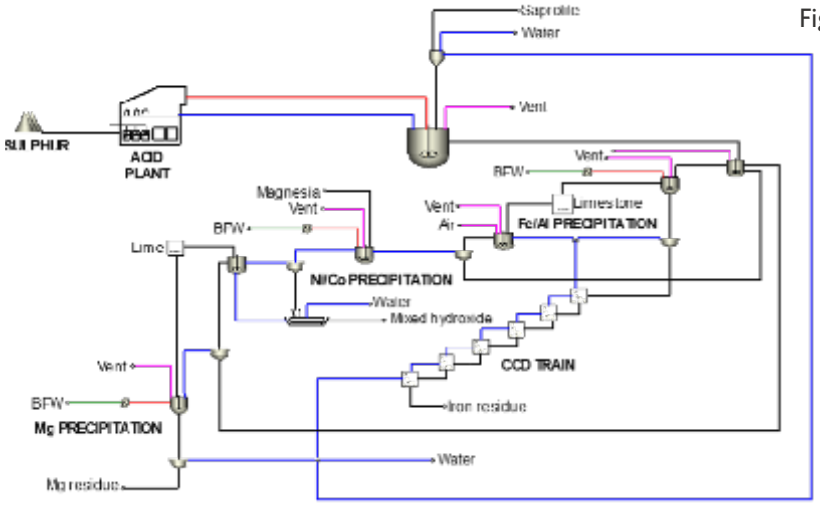



**Figure 1.** ATL circuit

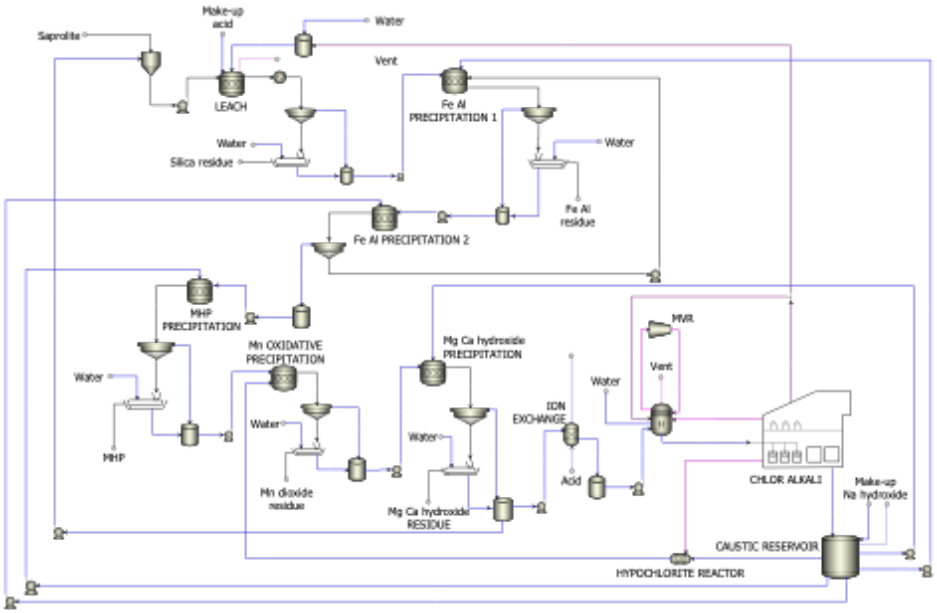



**Figure 2.** HCA circuit

With the process models completed, Arithmetek activated the integrated costing functionality by running APEA, automatically using the mass and energy balances and operating conditions and mapping unit operations to realistic equipment models and materials of construction, calculating preliminary CAPEX and OPEX estimates that were then used to evaluate and compare the two circuits.

The ATL process served as the baseline for this comparison given it is already commercially established.

The initial comparison of cash flow returns generated using the data from APEA showed that the novel HCA circuit was significantly less competitive, requiring an 80% reduction in CAPEX to match the internal rate of return (IRR) of the ATL process. Further analysis uncovered several things that could shift the economic balance:

- Carbon Pricing and Capture Potential:
  Both circuits generate calcium and magnesium hydroxides, which can absorb atmospheric $CO_2$ and form stable carbonates. The higher hydroxide yield in the HCA circuit suggested greater potential for $CO_2$ capture, but current carbon pricing would need to increase by 420% to make

the new circuit cost competitive. These insights were derived by analyzing emissions using Aspen Plus and applying multiple carbon prices.

- Renewable Electricity Pricing:
  The new HCA process is electricity-intensive, making it highly sensitive to utility pricing. Arithmetek modelled various electricity cost scenarios, helping identify a potential economic tipping point should electricity prices ultimately fall due to advancements in renewable generation.
- Sulfur Market Disruption:
  ATL relies on sulfuric acid derived from fossil fuel refining. If global fossil fuel use declines appreciably, sulfur availability and cost will be affected significantly. Arithmetek modelled how increases in sulfur pricing could negatively impact ATL's cost structure. In contrast, the novel HCA circuit is unaffected by sulfur pricing, offering a potential long-term advantage should the price of sulphur rise dramatically.

## Conclusion

The ability to perform simultaneous process modeling and economic evaluation through AspenTech solutions has been instrumental to Arithmetek's work. This use case exemplifies how the company can thoroughly assess the feasibility of an emerging process design, quickly benchmark it against established alternatives and pinpoint opportunities for improvement.

The analysis extended beyond process conditions alone—it also incorporated sensitivity to changes in utility costs, product pricing and emissions-related factors, all of which directly influence project economics and IRR. While the new circuit currently falls short of the ATL process in terms of economic performance, the agility and depth of insight provided by Aspen Plus and Aspen Process Economic Analyzer empower Arithmetek to explore future scenarios where the HCA circuit could become more viable.

## About Aspen Technology

Aspen Technology, now part of Emerson, is a global software leader helping industries at the forefront of the world's dual challenge meet the increasing demand for resources from a rapidly growing population in a profitable and sustainable manner. AspenTech solutions address complex environments where it is critical to optimize the asset design, operation and maintenance life-cycle. Through our unique combination of deep domain expertise and innovation, customers in asset-intensive industries can run their assets safer, greener, longer and faster to improve their operational excellence.

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