



PROJECT CASE STUDY – PROGRAM 1

RP1.013: Alumina refineries' next-generation transition (AlumiNEXT™) project

Project Leaders: Dr Woei Saw, University of Adelaide

HILTCRC partners: South 32, Hydro, Emirates Global Aluminium, Worley, Calix, SysCAD, Energy Exemplar, 1414 Degrees, The University of Adelaide, CSIRO, The Australian National University, Rio Tinto, MRIWA, KWA Kenwalt

Industries: Alumina and aluminium 

Commenced: 01 July 2024

Total project value: \$4.2 million (cash and in kind)

Complementary HILTCRC projects:

RP1.002: Evaluation of thermal storage and mechanical vapour recompression use to allow variable renewable input for steam in alumina production

RP1.007: Preliminary assessment of technical and economic feasibility of key options for low-carbon alumina calcination

RP2.009: Advancing the viability of high-temperature thermal energy storage for industrial applications

RP2.011: Thermal energy recovery using high-temperature heat pumps

RP2.017: Advancing the viability of high-temperature thermal energy storage for industrial applications – Phase 2

RP3.007: Unlocking investment in energy infrastructure for net-zero industrial hubs

The alumina industry plays a crucial role in the global economy but, as one of the most energy-intensive heavy industry sectors, it faces significant challenges in transitioning to low-carbon operations.

HILTCRC's AlumiNEXT™ project will address this challenge by de-risking and developing innovative low-carbon solutions for alumina refineries in two focus areas:

- steam generation and recovery in the Bayer process
- low-carbon calcination methods and designs.

THE CHALLENGE

Alumina refineries face multiple obstacles to decarbonisation:

- The steam generation required for the Bayer process and the high temperatures required for calcination are primarily derived from fossil fuels.
- Developing and implementing low-carbon technologies for high-temperature processes like calcination presents significant technical challenges.
- Transitioning to low-carbon technologies while maintaining product quality and operational efficiency is a complex undertaking.
- Low-carbon alumina production must be economically competitive.

According to Project Leader Dr Woei Saw, calcination and the Bayer process offer enormous potential for innovation but they also present major technical hurdles.

“Low-carbon steam offers significant potential benefit with less risk for implementation,” he says.

“Electrification could revolutionise alumina calcination but we need to ensure any new designs can be integrated at scale while maintaining production and performance.”



PROJECT APPROACH

AlumiNEXT™ is divided into two work packages:

1. Low-carbon steam generation and recovery:
 - Evaluate the potential for low-emission technologies – including thermal energy storage (TES), heat pumps and alternative heat transfer media – to replace or complement traditional gas-powered steam generation.
 - Optimise waste heat recovery systems to further reduce energy consumption.
 - Explore alternative heat transfer media to steam in the Bayer process.
2. Low-carbon calcination processes:
 - Investigate a two-stage calcination process that allows for greater flexibility in integrating renewable energy sources.
 - Investigate how to transition the calcination process by using low-emission heating methods, particularly electrification, such as microwave, induction and plasma heating, or hybrid systems that combine TES with hydrogen or gas.
 - Design a low-carbon calciner at lab-scale and develop an understanding of how to scale this to pilot or commercial scale.
 - Conduct kinetic studies of steam calcination to inform reactor design and performance.
 - Develop techniques for removal of alumina fines prior to the direct steam recovery system.

OUTCOMES AND INDUSTRY IMPACT

The project is designed to de-risk the transition to low-carbon emissions, providing a clear pathway for industry to adopt the new technologies.

The work aims to deliver solutions that can be applied across alumina refineries, with configurations tailored for different plants.

Cost-benefit and comparative analyses of different technologies will give refineries the data they need to make informed decisions about transitioning to low-carbon operations.

“We’re looking at a future where alumina refineries can operate with zero emissions, using advanced technologies that don’t just reduce carbon but improve efficiency across the board,” says Dr Saw. “We want to co-optimize these systems to balance efficiency, cost and sustainability.”



“OUR GOAL IS NOT JUST TO DECARBONISE, BUT TO DO SO IN A WAY THAT MAINTAINS OR EVEN ENHANCES THE ECONOMIC VIABILITY OF ALUMINA PRODUCTION.”

– Dr Woei Saw, University of Adelaide