Industry
Cement
Ceramics
Building Materials

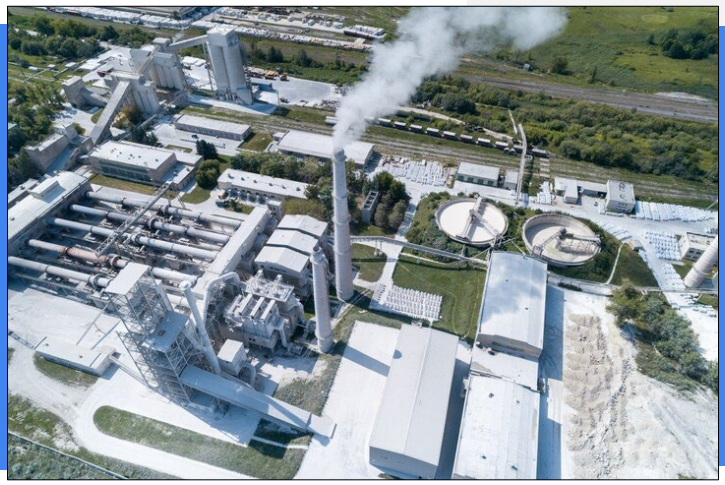
Technologies
Sensing
Machine Learning
Predictive Modeling
Advanced Control

Solutions
Manufacturing Productivity
Quality Improvement
Energy Efficiency

CESMII
THE SMART MANUFACTURING INSTITUTE

PROJECT CASE STUDY

Smart Manufacturing of Cement, Part 2



PROJECT LEAD

University of Louisville

PROJECT TEAM

Argos USA, Summit Materials

PROJECT OBJECTIVE

Develop a Smart Manufacturing control system for cement production by implementing predictive process models, data analytics, sensors and machine learning, The control algorithms will be developed in partnership with ARGOS USA Cement and result in improved energy-efficiencies and product quality.

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Smart Manufacturing Controls Reduce Greenhouse Gas Emissions at Cement Plant

BENEFITS TO OUR NATION

Cement manufacturing comprises a significant portion of the carbon footprint of construction material manufacturing. Incorporating smart monitoring, simulation and control systems will lower energy use while increasing throughput for cement manufacturers.
The Smart Manufacturing technologies developed in this project can be applied to the production of other similar products, including ceramic, brick, mortar, glass, and tile.

BENEFITS TO INDUSTRY

Concrete is the single most widely used construction material in the world and Portland Cement is a critical component of concrete. The process used to manufacture Portland Cement is energy intensive and comprises a significant portion of the energy budget of cement manufacturing. Over 90 percent of the total cement industry energy use (and CO_2 production) involves Portland cement clinker manufacturing. Reducing the energy input of Portland cement clinker production will drastically reduce production costs for cement manufacturers.

PROJECT DESCRIPTION

TECHNICAL APPROACH

Develop smart manufacturing (SM) tools by modeling rotary kiln and calciner processes to achieve a reduction in energy consumption. Extend prior physical and machine learning models developed for cement kiln processes to include calciner processes to support comprehensive energy efficiency. There is a relationship between kiln temperatures and calciner temperatures that must be accounted for in the cement process model. In addition, the degree of calcification of kiln feed and quality cement clinker must be accounted for in the models to allow the significant energy savings predicted by the previous process models to be realized.

ACCOMPLISHMENTS

- Incorporated the Calciner and Kiln Aspen model into the process model
- Expanded the predictive control (PC) model to use forward prediction methodologies
- Generated over 3,000 kiln and calciner temperature data points to combine with historic kiln and calciner data to optimize the model
- Deployed the model predictive control (MPC) at the Argos Roberta cement plant
- Developed cement kiln profiles for integration to the CESMII Smart Manufacturing Interoperability Platform (SMIP)
- Demonstrated 28% reduction in energy input while maintaining product quality *and* improving production rates

DELIVERABLES

- Delivered new cement manufacturing process numerical model
- Deployed advisory system nonlinear model predictive control (NMPC) at Argos Roberta plant, showing good agreement between predicted and measured performance
- Delivered Cement Kiln SM Profile

REUSABLE OUTCOMES / SM MARKETPLACE

- Model Predictive Control (MPC) for cement manufacturing
- Cement Kiln SM Profile

RESULTS

↓28%

Demonstrated 28% reduction in energy consumption while maintaining product quality and improving throughput at the cement plant.

↑$5.6M/yr

A 28% reduction in energy consumption will save $5.6 million in annual energy costs at the cement plant.

PROJECT DETAIL
Budget Period: BP4
Submission Date: 1/6/2025
Sub-Award (contract) Number: 45500000131044
SOPO: 2360

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