Industry
Cement

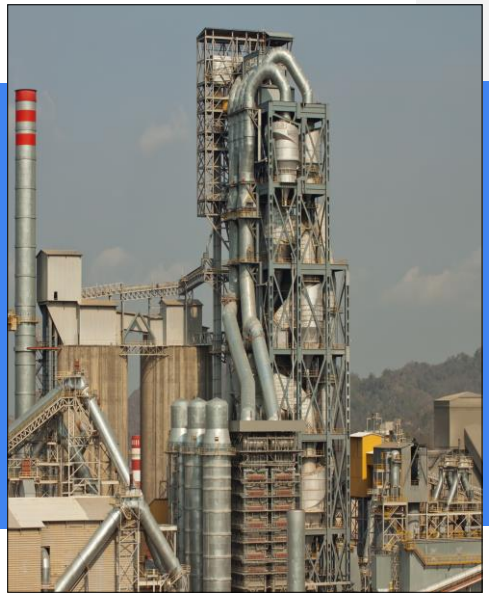
Applications
Sensing
Hybrid Modeling
Model Based Control

Solutions
Energy Savings

CESMII
THE SMART MANUFACTURING INSTITUTE

PROJECT CASE STUDY

Smart Manufacturing of Cement



PROJECT LEAD

University of Louisville

PROJECT TEAM

Argos USA

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 Result in a 20 kiloton per year Reduction in CO_2 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 in cement manufacturing will result in lower energy use and an improved environmental impact for this industry.
The Smart Manufacturing technologies developed in this project can be applied to other similar production processes, benefitting other domestic industries that utilize production kilns such as the ceramic, brick, mortar, glass, and tile industries.

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. Improvements in the efficiency of Portland cement clinker production presents the greatest opportunity for energy use reduction in the cement manufacturing sector.

PROJECT DESCRIPTION

TECHNICAL APPROACH

Lab and rotary cement kilns at the cement plant will be used as test beds to develop a sensor suite, predictive models and control system logic to characterize the product stream in the kilns. System states such as mass flow, air flow, and rotational velocity will be used to control the Kiln for optimal product quality and energy use.

ACCOMPLISHMENTS

- Completed lab kiln thermal modeling and mapping
- Completed Argos production kiln thermal modeling and mapping
- Developed model-based process control system
- Developed deep learning model for process control system
- Deep learning process control model deployed at Argos Roberta plant
- Predictive model and model predictive control tested at Argos Roberta plant

DELIVERABLES

- Designed and Fabricated Lab Scale Cement Kiln
- Developed Lab Kiln Multi-Physics Model
- Developed Argos USA Roberta Plant Kiln Multi-Physics Model
- Developed Argos USA Roberta Plant Kiln Cement Process Model
- Designed Advisory Predictive Controller System for Argos USA Roberta Plant Kiln

REUSABLE OUTCOMES

- Reduced order predictive control models for cement manufacturing
- Machine learning algorithms for kiln performance prediction
- Multi-physics based predictive control models for kilns
- Data analysis algorithms
- High temperature sensing system for thermal processes model

RESULTS

30%↑

Potential to reduce energy consumption by 30% when smart sensors and controls are implemented at the production plant.

$1M/yr

A 5% reduction in energy consumption will save $1 million in annual energy costs at the production plant.

20kt CO_2↓

A 5% reduction in energy consumption will decrease CO_2 emissions by 20 kilotons annually at the production plant.

PROJECT DETAIL
Budget Period: BP4
Submission Date: 01/31/2023
Sub-Award (contract) Number:
4550 G WA318
SOPO: 2380

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