the ENERGY lab

PROJECT FACTS

Advanced Research

Model-Based Optimal Sensor Network Design for Condition Monitoring in an IGCC Plant

Background

The U.S. Department of Energy's National Energy Technology Laboratory (NETL) develops affordable and clean energy from coal and other fossil fuels to secure a sustainable energy economy. To further this mission, NETL funds research and development of advanced sensor and control technologies that can function under the extreme operating conditions often found in advanced power systems, particularly those that are gasification-based. Reliable and robust sensors and controls are essential to the development of high-efficiency, clean energy technologies, such as low-emission power systems that use coal or other fossil fuels.

Gasification offers a viable pathway for the clean generation of power and fuels and a cost-effective option for the sequestration of carbon dioxide. Select areas of an integrated gasification combined cycle (IGCC) plant require innovative solutions to enable the system to perform as intended. One area of innovation is the use of advanced predictive controls that couple modeling, use of sensors, and model-based online estimation to enable real-time optimization of the gasifier and radiant synthesis gas cooler (RSC).

Project Description

NETL will partner with General Electric (GE) Global Research to develop an advanced model-based optimal sensor network to monitor the condition of the gasification section in an IGCC plant. The work will build on model-based controls aimed at enhancing efficiency and operational flexibility through increased automation. Within an overall strategy of employing model-based online monitoring and predictive controls, GE Global Research will extend existing models for gasifier and RSC to include the effects of degradation and fouling on the sensed variables like temperature etc., and will implement an estimation algorithm to assess the extent of gasifier refractory degradation and RSC fouling. An optimization-based solution will be employed to optimally place the hardware sensors utilized in the estimation algorithm in order to achieve the monitoring requirements at the lowest cost. The performance of the sensor placement algorithm and resulting monitoring solution will be demonstrated through simulations using representative test cases. The overall approach is one of the first to be applicable to condition monitoring of critical components in IGCC plants.

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PROJECT DURATION

Start Date
08/20/2010

End Date
12/31/2012

COST

Total Project Value
$1,195,894

DOE/Non-DOE Share
$956,714 / $239,180

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U.S. DEPARTMENT OF ENERGY

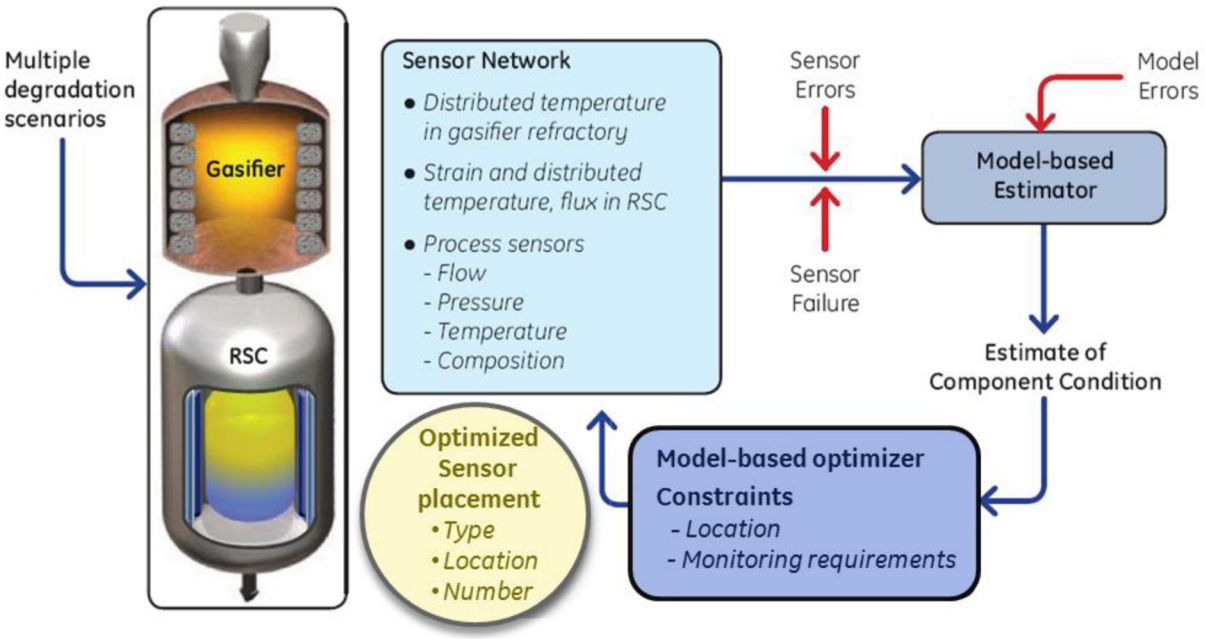
Goals and Objectives

The goal of this project is to develop a sensor network design based on models of an IGCC plant that support the development of an online condition monitoring system. To achieve this goal, the project will (1) develop a set of computational tools to address the problem of optimal sensor placement through a combination of model-based estimation and non-linear optimization; and (2) demonstrate the developed solution through extensive computer simulations, focusing on optimal sensor placement to infer and monitor the condition of the gasifier refractory and fouling of the RSC.

Benefits

The program will develop a general computational tool for solving the problem of optimal sensor placement, and demonstrate the application for condition monitoring of key equipment in the gasification section of an IGCC plant. Key benefits of the project include—

- Capability for real-time online monitoring of gasifier refractory degradation and RSC fouling.
- Improved online monitoring integrated with advanced controls to improve availability and operation efficiency.
- A general modular tool that can be applied to other process units for optimal sensor placement for online performance and condition monitoring.



Program overview and scope for model-based optimal sensor placement for component condition monitoring.