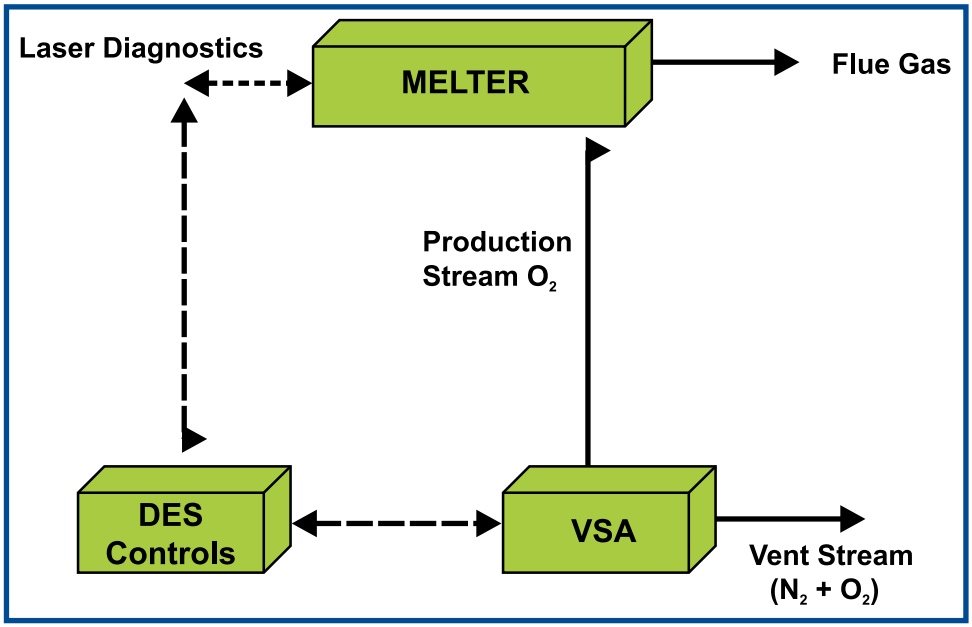
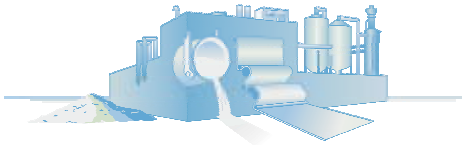
Dynamic Expert System Controls for Optimal Oxyfuel Melter Performance

Automatic Controls Would Optimize the Overall Performance of the Glass Manufacturing System

The glass industry currently controls melting processes using simple, linear systems. However, solving operational problems or switching production modes during melting often causes significant loss of production time while the linear control systems attempt to reach steady-state operation. This wasted time translates into increased operational costs for the manufacturer. The proposed system of dynamic, automatic controls would reduce that lost time, thus reducing operational costs and improving overall production efficiency by optimizing the performance of the entire melting system.



The dynamic expert system (DES) controls will be used to automatically control and optimize the entire melting process.



Benefits for Our Industry and Our Nation

- Improved production efficiency and greater product yield as a result of a consistent manufacturing process
- Reduced production costs—the coupling of DES controls with oxyfuel firing can reduce production costs by approximately 10 percent over air-fuel firing
- Reduced emissions–greater industry conversion to oxyfuel firing because of new DES controls means reduced greenhouse gas emissions industry-wide

Applications in Our Nation's Industry

By demonstrating improved production control and efficiency, this new control system would make the oxyfuel process more attractive to a larger portion of the glass industry. If all amenable glass melters converted to automatically controlled oxyfuel firing, greenhouse gas emissions nationwide would be reduced by 5.0 x 10^8 lbs/year, and annual net cost savings to the glass industry would be $50-60 MM/yr.

Project Description

Goal: Optimize the production efficiency of oxyfuel furnaces using a dynamic, automatic system to control the melting process. The system will help reduce total operational costs and enhance production, making the oxyfuel process more economically and environmentally appealing to the glass industry.

In order to meet the project goals, the partners will:

1. Develop dynamic expert system (DES) controls for the entire glass melting process
2. Incorporate nonintrusive, laser-based, diagnostic measurement methods into the system to supply the DES controls with accurate information for monitoring the furnace
3. Develop modified adsorption-based oxygen cycles that deliver a wide range of oxygen concentrations. Oxygen concentration will vary because the DES controls determine the optimal concentration for a given operational preference (e.g., maximum production mode, lowest cost operation, improved environmental compliance)
4. Investigate the development of heat recovery systems since furnace operation at lower oxygen concentrations may lead to increased flue gas volume.

Progress and Milestones

Sandia National Laboratories:

- Constructed a low-cost scanning Coherent Anti-Stokes Raman Spectroscopy (CARS) system
- Used the CARS system to acquire N_2(sub) CARS temperature measurements in glass furnaces
- Developed a spectral model for O_2(sub) CARS and verified accuracy to within 2% of temperatures measured with N_2(sub) CARS

Ohio State:

- Conducted dynamic tests on and developed models for the glass melter and forehearths
- Developed a control structure for the forehearths and melter
- Began development of a test simulator for DES

Air Products and Chemicals:

- Performed a first pass economic analysis of impact of low-purity O_2(sub) on VSA costs
- Conducted an internal review of DES

The project was terminated in 2000 due to a change in business objectives at Air Products and Chemicals.

Project Partners

Air Products and Chemicals, Inc.
Allentown, PA

Advanced Control Solutions Inc.
Toledo, OH

GE Lighting
Cleveland, OH

McDermott Technologies
Alliance, OH

Ohio State University
Columbus, OH

PPG Industries
Pittsburgh, PA

Sandia National Laboratories
Livermore, CA

Techneglas
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A Strong Energy Portfolio for a Strong America

Energy efficiency and clean, renewable energy will mean a stronger economy, a cleaner environment, and greater energy independence for America. Working with a wide array of state, community, industry, and university partners, the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy invests in a diverse portfolio of energy technologies.

U.S. Department of Energy
Energy Efficiency and Renewable Energy
Bringing you a prosperous future where energy is clean, abundant, reliable, and affordable

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