U. S. Department of Energy
Energy Savings Assessment (ESA)

Process Heating Assessment and Survey Tool (PHAST)

Introduction

Date: January 30, 2007
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Agenda

- ESA Training Web Cast Introduction – 15 minutes
- Process Heating Assessment and Survey Tool (PHAST) Software Demonstration – 45 minutes
  - Q & A – 20 minutes
- PHAST BestPractices – 30 minutes
  - Q & A – 20 minutes
- Conclusion – 10 minutes
- Reference Information
  - DOE Resources
  - Calendar for Future ESA Training Web Casts
Process Heating ESA Plant Lead Web Cast

- **Purpose:**
  Help Plant Leads selected for a Department of Energy (DOE) Energy Savings Assessment (ESA) prepare for a successful assessment.

- **Format:**
  - Introduce functionality, functions and results of the PHAST software
  - Provides an overview. (In-depth training available.)

- **Use DOE Software Tools to:**
  - Identify opportunities
  - Provide estimates of energy and cost savings
  - Not a replacement for in-depth project analysis.
What Is Process Heating?

Supplying heat to materials in

- Furnaces
- Ovens
- Heaters
- Thermal oxidizers
- Dryers
- Boilers
- Other heating equipment
Commonly Used Equipment for Process Heating

- **Fuel fired furnaces**
  - Natural draft
  - Forced draft
  - Balanced draft

- **Boilers**
  - Direct fired
  - Process heat recovery
  - Heat recovery with use of duct burners

- **Cogeneration Systems**

- **Thermal oxidizers**
Process Heating System Components

- Heat Transfer
- Heat Containment
- Emission Controls of Exhaust Gases
- Thermal Processing of Product Material
- Sensors/Process Controls
- Advanced Materials
- Design Tools/Systems Integration
- Heat Generation
- Energy Source (fuel, electricity, etc.)
- Crosscutting Enabling Technology
- Steam
- Exhaust Heat Recovery
- Material Handling
Heat Supply, Demand and Losses in a Heating System

- Furnace Heat Input
- Heat in Flue Gases
- Flue losses
  - Wall loss
  - Opening loss, Other
- Stored heat
  - Useful output (heat to load)
  - Cooling water loss and/or conveyor
- Gross fuel input
  - Net fuel input
  - Available heat
- Other heat losses
Process Heating Assessment and Survey Tool (PHAST)

A Tool Developed by Industry – Government Collaboration

Click on the Desired Button For Information

Development supported by E3M Inc.
Phone: 240.715.4333  E-Mail: athekoi@e3minc.com
Fax: 301.208.9077

This Application is developed by Oak Ridge National Laboratory in cooperation with Industrial Heating Equipment Association (IHEA) and a subcommittee consisting of members from major industries and equipment suppliers acting as advisor for the tool development.
Process Heating Assessment and Survey Tool (PHAST)

Download it from

http://www.eere.energy.gov/industry

It includes

- Installation instructions for MS Windows 2000 and XP
- User manual
- Useful calculators
- Survey forms
- PHAST program
Process Heating Assessment and Survey Tool (PHAST)

*How can PHAST help my facility?*

- Estimate annual energy use and energy cost for:
  - furnaces, heaters and boilers
- Identify furnace energy use, efficiency and losses
  - detail heat balance and energy use analysis
- Perform “what-if” analysis for potential energy reduction and efficiency improvements
  - Analyzes changes in operation, maintenance and retrofits of components/systems
- Obtain information on energy saving methods
- Identify additional resources
Energy Use and Cost Distribution Report for Heating Systems

- Estimated annual energy use and cost for heating equipment
- Lists heating equipment and % of total energy cost used for each piece of equipment
  - Ranked by annual cost of energy used.

Use this report to:

1. identify equipment with high energy use, and
2. select one or more furnaces for further analysis
Analysis of energy used in part of a furnace under a given operating condition.
Energy Use in Current vs. Modified Conditions

- Compares energy use for current operations and with potential changes (what-if analysis) in operating conditions for the furnace.

- Results calculated with furnace energy balance.
Process Heating Assessment and Survey Tool (PHAST)

Demonstration
Process Heating Best Practices:
Heat Generation

- **Best Practices for Air Flow**
  - Control burner fuel/air ratio to maintain near Stoichiometric combustion - usually less than 2% O₂ and minimum CO (<10 ppm), combustibles in flue gases
  - Avoid excess air, replace constant-air-supply burners
  - Control make-up air to minimum required for applications where it is necessary for safety reasons
  - Use forced air burners with on-ratio high turndown

- **Preheat combustion air for high temperature processes**
- **Use O₂ enrichment where economical based on energy savings, productivity gains, etc.**
- **Control flame size, shape to ensure complete combustion within the furnace.**
Benefits of Heat Generation
Best Practices

- Energy Saving Potential
  - 2% to 10%

- Typical implementation
  - 1 to 8 weeks

- Typical payback period
  - 1 to 6 months
Recall: Heat Supply, Demand and Losses

- Optimize insulation (type and thickness)
- Reduce cooling losses by insulating water or air-cooled parts in a heating system
- Reduce radiation losses by eliminating or minimizing furnace openings
- Use devices (e.g., radiation shields) to minimize radiation and convection losses
- Use draft control to eliminate or reduce furnace leakage (cold air into or hot gas out)
- Repair cracks, openings, seals in refractory, burner blocks, around doors or heater tubes.
Benefits of Heat Containment

- **Energy Saving Potential**
  - 2% to 10%

- **Typical implementation**
  - 1 to 8 weeks

- **Typical payback period**
  - 1 to 6 months
Reduce Flue Gas Heat Losses

dry stack loss = \( W \times C_p \times (T_2 - T_1) \)

- less excess air
- oxygen enrichment
- lower setpoint
- heat recovery
- more heat transfer

- Use heat of flue gases
  - Combustion air preheating
  - Charge/Load preheating
  - Steam generation
  - Water, liquid or air heating for use in other processes (e.g., plant building heat or cooling)
  - Cascade heat to lower temperature processes
  - Use absorption cooling systems where chilled water (liquid) or air (gases) are required in the plant.

- Use energy from heated products after thermal processing
  - Many of the methods suggested above
Benefits of Heat Recovery

- Energy Saving Potential
  - 10% to 30%

- Typical implementation
  - 4 to 12 weeks

- Typical payback period
  - 6 to 24 months
Process Heating Best Practices:
Heat Transfer

- Best Practices for heating equipment (e.g., furnace, heat exchanger)
  - Clean heat transfer surfaces
  - Enhance convection heat transfer (e.g., recirculation fans, jets)
  - Control temperature profile (LMTD) to maximize heat transfer.

- Avoid flame impingement on heater tubes by selecting proper burner and flame shape-size

- Use process modeling to optimize temperature profile during heating to maximize heat transfer while avoiding product overheating.
Benefits of Heat Transfer
Best Practices

- Energy Saving Potential
  - 5% to 10%

- Typical implementation
  - 1 to 12 months

- Typical payback period
  - 6 to 30 months
### Use Sensors & Controls, and Advanced Materials

- Use computer models to set furnace controls and operating conditions
- Monitor in-line process parameters (e.g., surface temperature, pressure) and couple with models
- Continuous monitoring of flue gas composition (e.g., $O_2$, combustibles) for optimum operations
- Use advanced materials (alloys, ceramics and insulation) for radiant tubes, fixtures, rails, etc.

### Energy Saving Potential
- 2% to 10%

### Typical implementation
- 1 to 8 weeks

### Typical payback period
- 1 to 24 months
Optimize Production Rate for Energy Consumption Per Unit of Production
Process Heating Best Practices: Operations and Maintenance

- Operate the systems close to design capacity
- Avoid part load operations, especially for systems using fixtures, trays, conveyors, etc.
- Schedule nearly continuous operations to avoid long delays and hold periods
- Analyze system performance to determine equipment operating mode (e.g., shut-down or maintain operating temperature or maintain at intermediate temperature).
  - There is no one answer for all situations.
- Consider using variable (or two) speed motors for fans, blowers to save power.
Questions and Answers
Use PHAST at Your Plant to Analyze Heating Systems

- Understand energy use and cost
- Analyze energy distribution and losses
- Identify potential project areas for energy savings and cost reduction
- Benchmark plants at a corporate level
- Benchmark individual systems at the plant level
- Monitor performance over time.
Download the Tool

DOE BestPractices Web site:
http://www.eere.energy.gov/industry/bestpractices/software.html
Find Additional Training

Visit the DOE BestPractices Training Web site:
www.eere.energy.gov/industry/bestpractices/training

See the Training Calendar for events in your area:
www.eere.energy.gov/industry/bestpractices/events_calendar.asp

Become a Qualified Specialist:
www.eere.energy.gov/industry/qualified_specialists.html
See the “Industrial Energy Savers” Web Site

- 20 ways to save energy now
- Tools & training you can use to identify savings opportunities
- Industry expertise available
- Assessments for your plant
- Develop an Action Plan
- Learn how others have saved
- Access the National Industrial Assessment Center (IAC) Database
EERE Information Center

On-call team of professional engineers, scientists, research librarians, energy specialists, and communication information staff.

Voice: 877-337-3463
Fax: 360-236-2023
E-mail: eereic@ee.doe.gov
Web site: www.eere.energy.gov/informationcenter
Web Site and Resources

Visit these DOE Web sites for the latest information and resources:

Industrial Technologies Program (ITP) Web site:
www.eere.energy.gov/industry/

BestPractices Web site:
www.eere.energy.gov/industry/bestpractices

Save Energy Now Web site:
www.eere.energy.gov/industry/saveenergynow

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- Data
Acknowledgments

U.S. Department of Energy’s Industrial Technologies Program