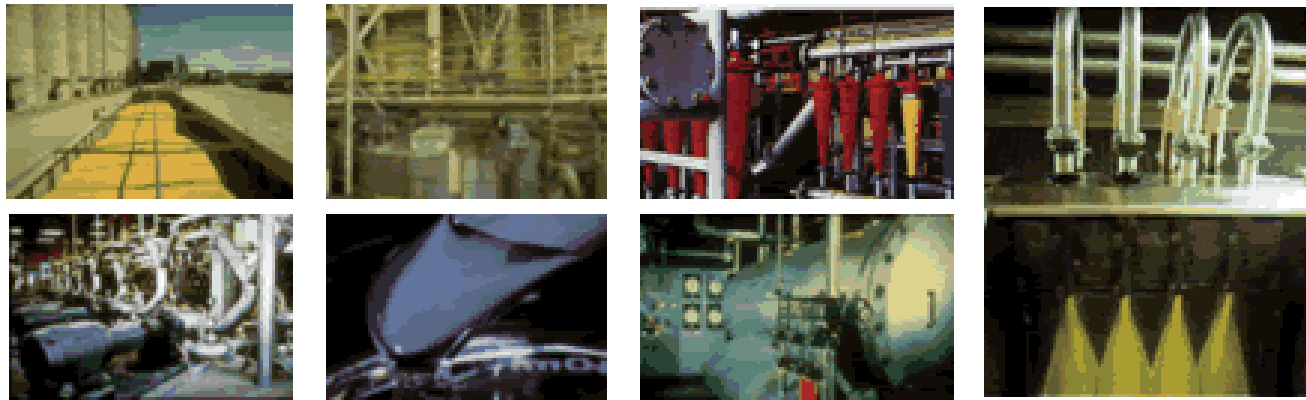




industrial technologies program

Introduction to Energy Savings in Process Heating for the Corn Refining Industry



Web-Cast Presentation By
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March 8, 2005

Arvind Thekdi – E3M, Inc.
Corn refining Industry Web Cast 0308



Energy Cost in Corn Refining Industries Operations



- Corn processing is very energy intensive
- Energy costs are the largest operating cost for the wet corn milling industry, next only to the cost of corn.
- Corn wet milling uses 15% of all energy used by the food and kindred products sector of U.S. manufacturing
- For a typical plant processing 100,000 bushels per day, energy cost is approximately 25 to 35 million dollars per year.
- This represents \$0.75 to \$1.50 cost per bushel of corn processed.
- Energy cost is projected to be the fastest rising cost element of the operating cost



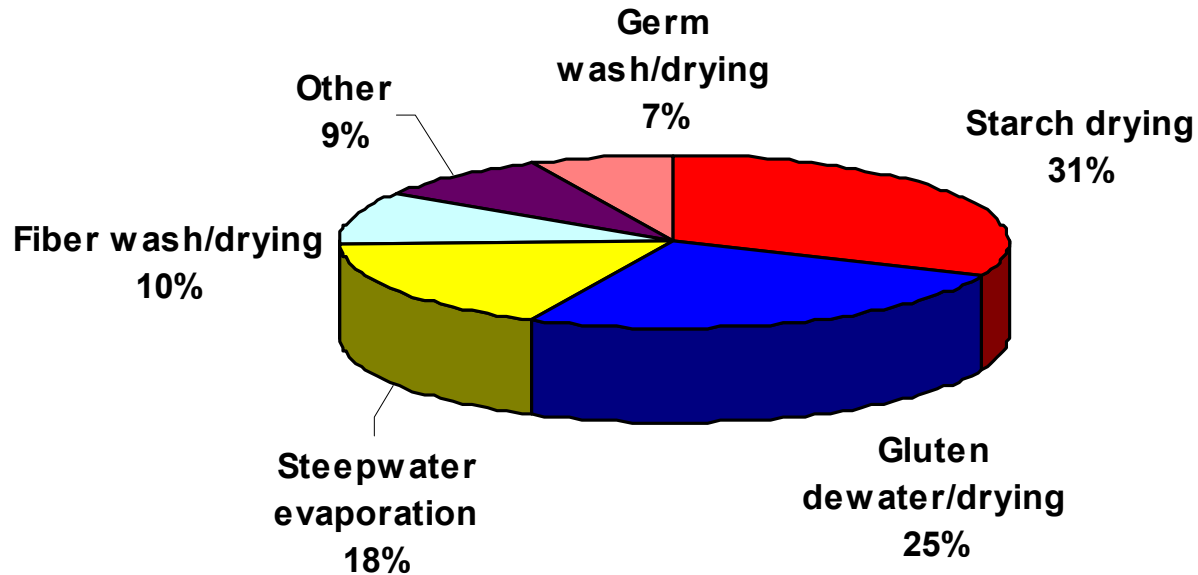
Primary Energy Use in Corn Refining Industries

- **Process/Assembly (P/A)**
 - **Process heating - Drying**
 - Steam Generation
 - Fuel firing
 - Machine drive (Pumps, Fans, Blowers, Compressors, Vacuum pumps, Other Electric Motor Driven Systems)
 - Water and other utilities
- **Building (HVAC, Lighting etc.)**



Energy Use Distribution for Typical Corn Wet Milling Operation

Portion of Primary Energy Use



•Source: Energy efficiency Improvement and cost Saving Opportunities for the Corn Wet Milling Industry, A report (LBNL 52307) prepared by LBNL for the EPA



What Is Process Heating ?

**Supplying heat
to materials using**

- **Dryers**
- **Boilers**
- **Furnaces**
- **Ovens**
- **Kilns**

**for further processing in
manufacturing operations**

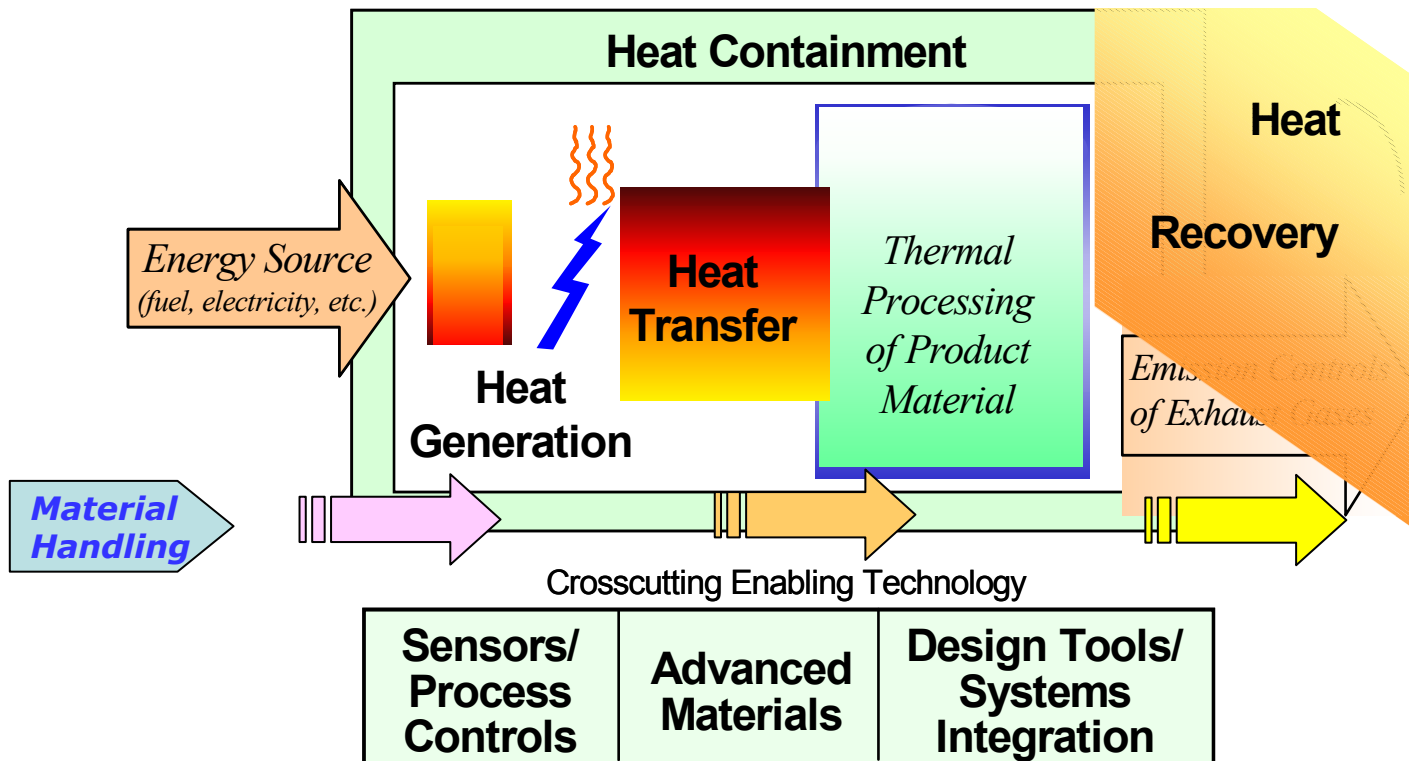


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Corn refining Industry Web Cast 030805



Process Heating System Components







All heating systems include nine basic processes/components







Process Heating Assessment and Survey Tool (PHAST)

Process Heating Assessment and Survey Tool (PHAST)

 Introduction	 Plant/Equipment Information	 Furnace Analysis - Heat Balance
 Reports	 Import Plant Information	 Export Plant Information

Click on the Desired Button For Information

[Exit Application](#)

  [Development supported by E3M Inc.](#)

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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)

What is PHAST?

A tool that can be used to:

- Estimate annual energy use and energy cost for furnaces and boilers in a plant
- Perform detail heat balance and energy use analysis that identifies areas of energy use, efficiency and energy losses for a furnace
- Perform “what-if” analysis for possible energy reduction and efficiency improvements through changes in operation, maintenance and retrofits of components/systems
- Obtain information on energy saving methods and identify additional resources

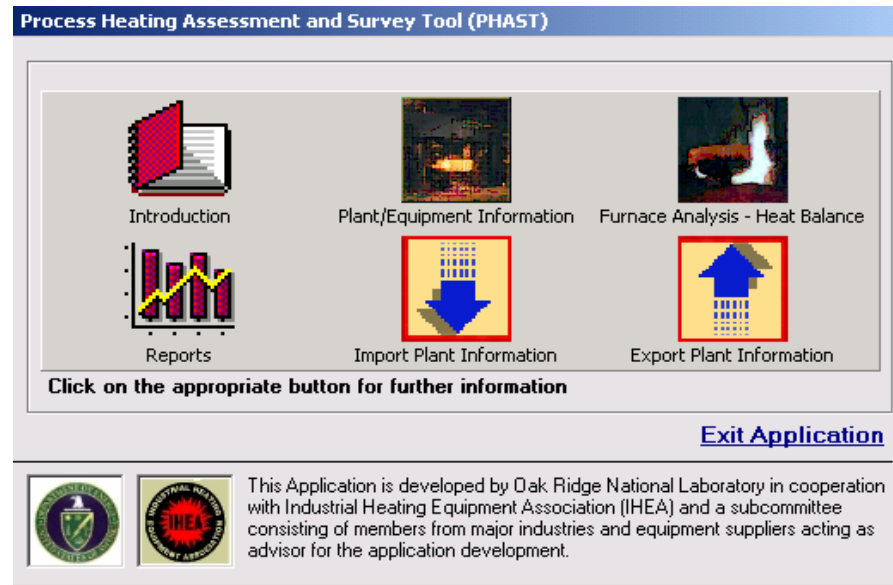


Process Heating Assessment and Survey Tool (PHAST)

- The Process Heating Assessment and Survey Tool (PHAST) was developed by Oak Ridge National Laboratory in cooperation with the Industrial Heating Equipment Association (IHEA).
- A subcommittee consisting of members from major industries (i.e., petroleum refining, chemical) and equipment suppliers acted as an advisor during the tool's development.
- Development efforts were supported by The Office of Industrial Technologies (OIT) of the US Department of Energy (DOE).



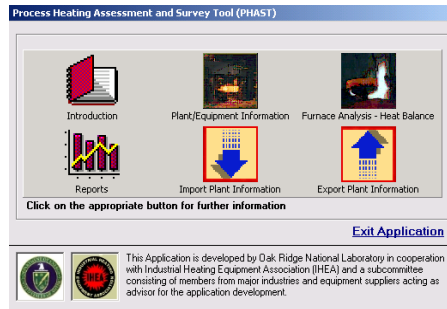
Process Heating Assessment and Survey Tool (PHAST)



Overview of features and use



Main Screen



The main screen is used to select the required section of PHAST.

There are six options

1. Introduction
2. Plant Energy Analysis
3. Furnace Heat Balance
4. Reports
5. Export Plant Information
6. Import Plant Information



Introduction

This section includes

- A number of calculators to assess effect of key furnace operating parameters on the furnace performance.
- Resources that provide additional-updated information.
 - A. Link to DOE-OIT and IHEA web sites
 - B. Glossary of terms used in process heating
 - C. Reference material related to process heating



Process Heating Calculators

Introduction

[Click here for more information on process heating](#)

Energy Equivalency	Efficiency Improvement	O2 Enrichment		Flow Calculations Energy Use
		Current	New	
Oxygen in Flue Gas (%)		8	2	
Flue Gas Temperature (Degree F.)		1600	1600	
Excess Air (%)		37.47	9.61	
Combustion Air Temp (Degree F.)		100	750	
Available Heat (% of Gross Heating Value)		43.76	66.37	
Fuel Savings (%)		Base	34.07	
Energy Input (Million Btu/Hr.)		100	65.93	

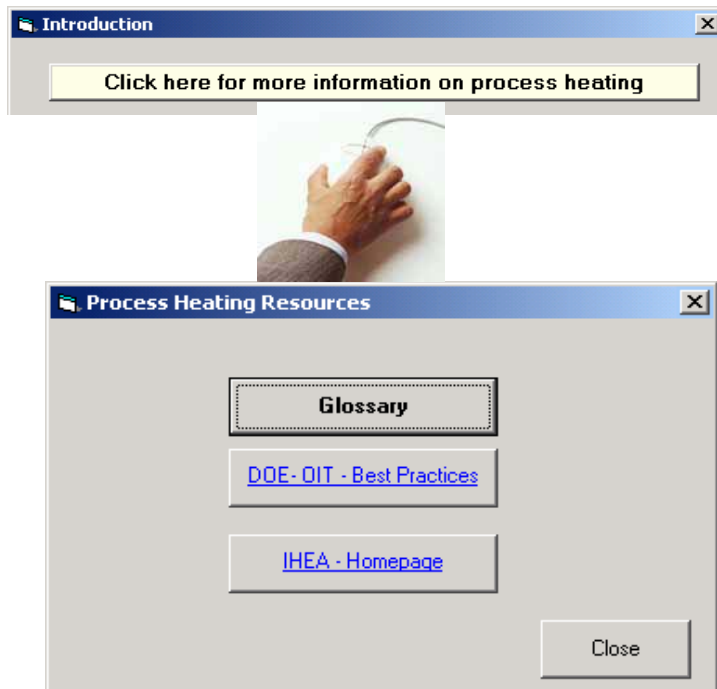
Print Save Close Previous Tab Next Tab

The calculators can be used to

1. Compare gas (fuel) vs. electrical energy for heating applications
2. Estimate energy efficiency improvements with proper air-fuel ratio control and use of air preheating
3. Calculate effect of O2 enrichment of combustion air for energy savings
4. Calculate air or gas flow with use of orifice flow meters in gas or air lines.



Information on Process Heating and web-page links



Clicking on the top bar leads to three links.

- Glossary section gives a list and brief description of commonly used terms in the process heating industry
- Link to DOE OIT Best Practices web page. The web page includes wealth of information on energy efficiency improvement
- Link to IHEA web page. This links include information on process heating equipment suppliers and links to web page of some of them.



Plant/Equipment Information

Plant Equipment Information

The “**Plant Information**” section of PHAST is used to survey the process heating (PH) equipment used in a plant, estimate their energy use and cost and compare relative energy cost for all PH equipment.



PHAST Survey Forms

Process Heating Assessment and Survey Tool (PHAST) Survey Form

Furnace - Heat Exchange Analysis

Plant Name: _____

Furnace: _____

Type of Furnace	Rectangular () / Other ()	Furnace Dimension	Is there opening in furnace in any given direction?
Inside temp - Degree F	Depth - ft		
Ambient temp - Degree F	Length - ft		
	Width - ft		

Provide appropriate information for each type of loss or current and modified condition otherwise

Current condition	Modified condition	Current condition	Modified condition
Other Loss Form extended	Other Loss Form extended	Other Loss Form extended	Other Loss Form extended

Furnace load (Net)

Type of material: _____

Charge Weights or Rate: _____

Process operation: _____

Initial temp - Degree F: _____

Final temp - Degree F: _____

% change wt: _____

Method of reaction: _____

% change in: _____

Flare, trays etc. Loss: _____

Type of material: _____

Flow or weight lbs or Rate: _____

Initial temp - Degree F: _____

Final temp - Degree F: _____

Water flow - GPM: _____

Water cooled areas: _____

Initial temp - Degree F: _____

Final temp - Degree F: _____

Opening Loss (Fixed)

Furnace well thickness - inches: _____

Length of opening - inches: _____

Di. or height of opening - inches: _____

Total opening area - sq ft: _____

Inside temp - Degree F: _____

Outside or Ambient temp - Degree F: _____

% area remained open: _____

Head Storage

Top: _____

No. of layer(s) no. of: _____

Thickness of layer 1 - inches: _____

Thickness of layer 2 - inches: _____

Bottom: _____

No. of layer(s) no. of: _____

Thickness of layer 1 - inches: _____

Thickness of layer 2 - inches: _____

Bottom: _____

Additional information: _____

Page ____ of ____ Pages

8/25/2001

Survey forms are used to collect energy use data for the furnaces, heaters etc.

1. The forms are used to collect information on process heating (PH) equipment energy supply and operating data that needs to be entered in various sections of PHAST
2. The survey forms are given as MS Excel spreadsheets.



Heating Equipment Inventory and Energy Use

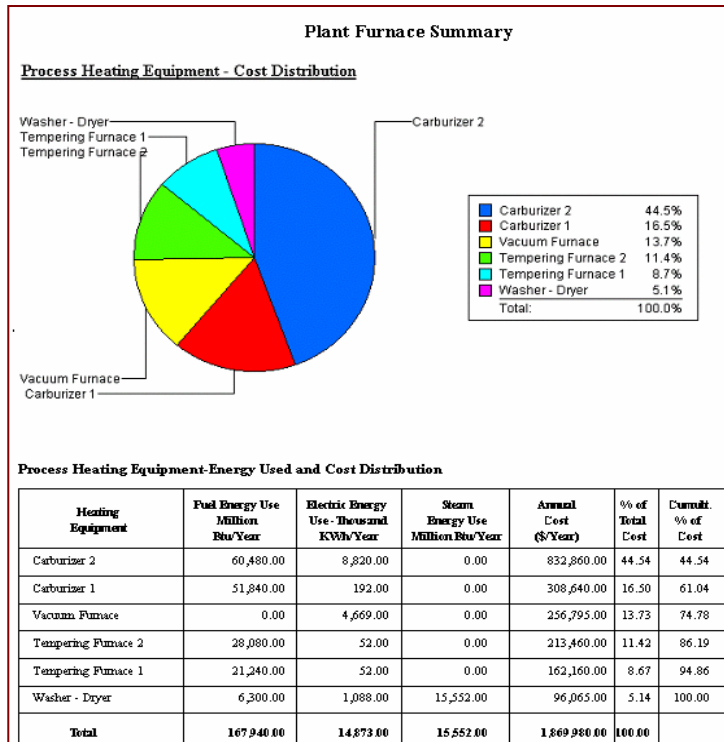
Forms in this section are used to enter equipment inventory information

- Type of fuel – energy used and unit cost
- Number of heating equipment (boiler, dryer, heater, oven etc.) and their operating information
- Information on auxiliary equipment such as motors, pumps, fans etc. associated with each heating equipment
- General information for the company, plants and general description of the plant information

Use one form for each plant.



Energy Use and Cost Distribution Report



The report shows

- Estimated annual energy use and estimate annual cost of energy for heating equipment (furnaces, ovens etc.)
- List of heating equipment and % of total energy cost used for each equipment in order of annual cost of energy used.

Use this report to identify high energy user equipment and to select one or more furnaces for further analysis



What Next?

- Review energy use and energy cost for the furnaces surveyed
- Select a furnace to analyze energy use distribution
- Collect necessary data using the survey form
- Perform detail heat balance for the furnace using section of PHAST
- Review energy use pattern and identify energy saving opportunities
- Perform “what-if” analysis to study effect of the energy saving opportunities



Heat Balance Analysis

- Analyze the energy used in various parts of a furnace under a given operating condition. The areas for energy use include charge or load, fixtures, trays etc., wall losses, water cooling losses, losses through openings and exposed hot parts, flue products (or exhaust gases) and heat storage.
- This section allows the user to identify major areas of energy use and the magnitude of losses to study the effect of changes in operating conditions and their effect on the energy used in the furnace.



Furnace Analysis - Heat Balance

Heat Balance Section

The screenshot shows a software window titled "Source of Data Information" with a menu bar (File, Help) and a title bar. The main area is divided into several sections:

- Plant Name:** Excellent Heat Treating
- Furnace Name:** Carburizer 1
- Other losses exposed hot parts:** (checkbox)
- Flue gas losses combustion conditions:** (checkbox)
- Heat Storage:** (checkbox)
- Water - cooling:** (checkbox)
- Wall losses:** (checkbox)
- Openings:** (checkbox)
- Net Load Weight:** (checkbox)
- Weight of fixtures, trays, baskets etc.:** (checkbox)
- Atmosphere:** (checkbox)

The main data entry table is as follows:

	Current	Modified
Type of Material	Carbon Steel	Carbon Steel
Moisture content (% of material charged)	1	1
Charge weight (#s/hr)	6000	6000
Initial Temp.(F)	100	100
Final Temp.(F)	1650	1650
% of Charge weight melted /vaporized	0	0
Heat of reaction (Btu/#) of material reacted	0	0
% of Charge weight reacted	0	0
	Endothermic	Endothermic
Heat Btu/hr	1,490,190	1,490,190

Source of Data / Information
Process given

Buttons: Previous Tab, Next Tab

Summary: Current Net Heat (Btu/hr) 3,099,737; Modified Net Heat (Btu/hr) 2,836,786

Buttons: Summary, Enter/Edit Modified Data, Report, Close

- A number of forms are used to enter data for various areas where heat is used in a heating equipment
- The areas include
 - Load
 - Fixtures, trays, baskets etc.
 - Wall losses
 - Opening losses
 - Radiation losses
 - Flue gas losses
 - Heat storage
- A data base includes thermal properties of commonly processed – heated used materials.
- Total heat requirement (Btu/hr) is calculated and displayed at the bottom of the data table.



Heating Performance summary

Measure flue gas temperature (deg. F.) by using "proper" temperature probe. For temperature below 1000 F use a probe with exposed thermocouple. For higher temperature a probe with "shielded" thermocouple should be used. If actual measurements are not possible then use the furnace zone temperature plus 100 F (or 200 F, for indirectly heated furnaces) as approximate flue gas temperature.

Previous Tab Next Tab

Summary

Current Net Heat (Btu/hr) 3,099,737 Enter/Edit Current Data

Modified Net Heat (Btu/hr) 2,836,786 Report Close

Furnace Summary

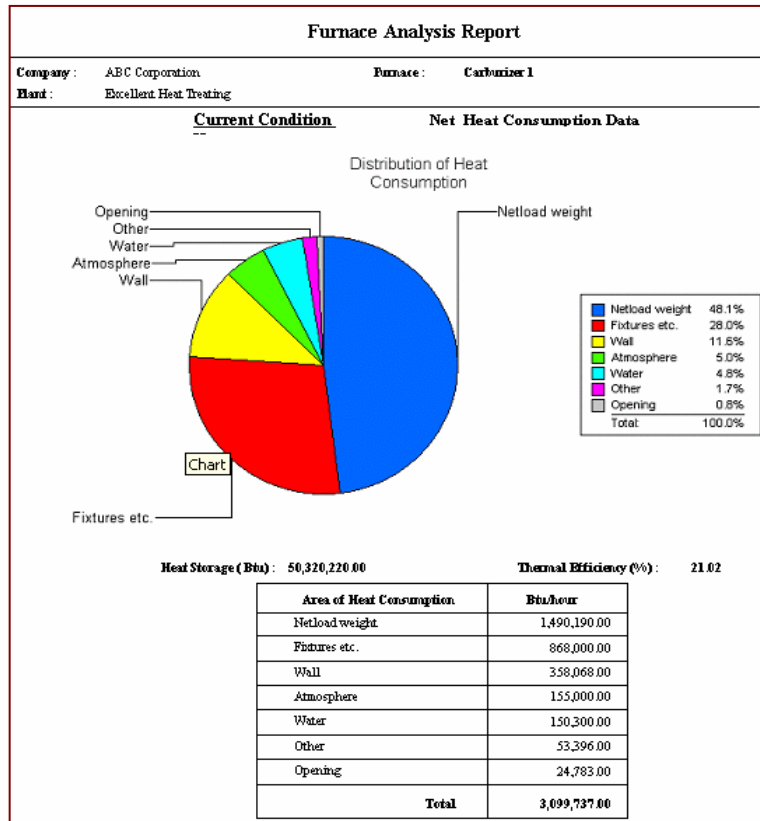
	Current	Modified
Net Heat	3,099,737	2,836,786
Gross Heat (Btu/hr)	7,089,975	5,861,128
Energy Used BTU / Pound	1,182	977
Thermal Efficiency %	21.02%	25.42%

Close

- Click on "Summary" button would open a form that shows summary of the furnace performance.
- The table shows: net heat requirement of the furnace; gross heat and energy used per unit (Lb.) of the products or material being processed.
- It also shows Thermal Efficiency of the furnace based on heat delivered to the load compared to gross heat input for the furnace.
- Thermal efficiency is NOT the same as available heat for the furnace.



Heat Balance Energy Use – Losses Distribution



- The report shows
- Analysis of energy used in various parts of a furnace under a given operating condition.



Modified Conditions Data for Performance Improvement

Source of Data Information
Plant Name: Excellent Heat Treating, Furnace Name: Carburizer 1

Other losses exposed hot parts, Elue gas losses combustion conditions, Heat Storage
Water - cooling, Wall losses, Openings

Net Load Weight, Weight of fixtures, trays, baskets etc., Atmosphere

	Current	Modified
Type of Material	Carbon Steel	Carbon Steel
Moisture content (% of material charged)	1	1
Charge weight (#s/hr)	6000	6000
Initial Temp.(F)	100	100
Final Temp.(F)	1650	1650
% of Charge weight melted /vaporized	0	0
Heat of reaction (Btu/#) of material reacted	0	0
% of Charge weight reacted	0	0
Heat Btu/hr	1,490,190	1,490,190

Source of Data / Information Process given

Current Net Heat (Btu/hr): 3,099,737
Modified Net Heat (Btu/hr): 2,836,786

Buttons: Summary, Enter/Edit Modified Data, Report, Close

Source of Data Information
Plant Name: Excellent Heat Treating, Furnace Name: Carburizer 1

Other losses exposed hot parts, Elue gas losses combustion conditions, Heat Storage
Water - cooling, Wall losses, Openings

Net Load Weight, Weight of fixtures, trays, baskets etc., Atmosphere

	Current	Modified
Type of Material	Carbon Steel	Carbon Steel
Moisture content (% of material charged)	1	1
Charge weight (#s/hr)	6000	6000
Initial Temp.(F)	100	100
Final Temp.(F)	1650	1650
% of Charge weight melted /vaporized	0	0
Heat of reaction (Btu/#) of material reacted	0	0
% of Charge weight reacted	0	0
Heat Btu/hr	1,490,190	1,490,190

Source of Data / Information Process given

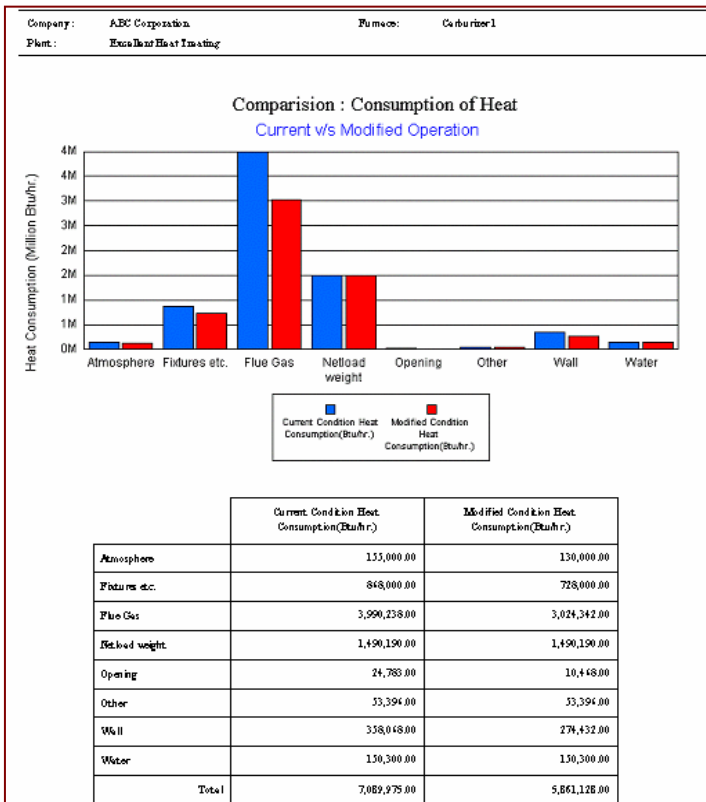
Current Net Heat (Btu/hr): 3,099,737
Modified Net Heat (Btu/hr): 2,976,786

Buttons: Summary, Enter/Edit Current Data, Report, Close

Use **Enter/Edit Modified Data** Button to switch from "Current Condition" Data to "Modified Conditions" Data



Heat Balance: Energy Use - Current vs. Modified Conditions



The report shows

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



Ten Steps to Reduce Energy Use in Heating Systems for the Corn Refining Industry

1. Air-fuel ratio (exhaust gas oxygen) control in boilers and fired dryers through proper operation - maintenance
2. Waste heat recovery from flue (exhaust gases) - Combustion air preheating, feed water or material preheating etc.
3. Heat cascading – use of high temperature steams (gases, liquids) for lower temperature processes
4. Heat recovery from thermal oxidizer gases (use of regenerative systems)
5. Use of thermal oxidizer gases for dryer (directly or indirectly)
6. Use of dryer gases with low concentration volatile materials as combustion air for boilers or other fired systems
7. Replace indirect heating (steam or fuel fired) by direct heating using new generation burners or waste heat from other processes
8. Use of direct fired – indirect fired fuel fired systems to replace steam heating where the boiler fuel costs justify it
9. Use of combined heat and power for steam generation or thermal oxidizers
10. Reduce heat losses
Insulate hot surfaces, plug openings, use pressure control, reduce steam or hot gas losses (fix leaks), maintain stem traps, return condensate etc.



Process Heating Assessment and Survey Tool (PHAST)

**Download PHAST tool
from the DOE web site**

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

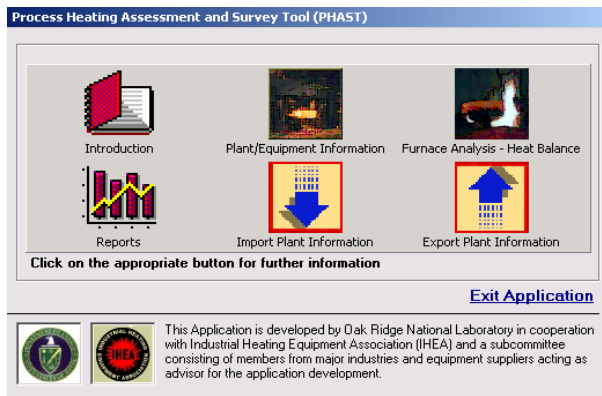
Use following steps:

- **Program Areas**
- **Best Practices**
- **Tools and Publications**
- **Software**
- **Process Heating Assessment and Survey Tool (PHAST)**



Process Heating Assessment and Survey Tool (PHAST)

The downloadable version of PHAST includes following files.



1. **Read me file** – This should be read first
2. **User manual** – This should be reviewed and printed for future reference
3. **Software for PHAST** – This is the main program for the tool
4. **Survey forms** – These are to be used for collection of data that would be used for use of PHAST



Next steps

- Attend one-day end-user PHAST training to learn capabilities of PHAST and its use
- Attend qualified specialist training to become a qualified trainer to teach others how to use PHAST. This is a 2 to 2 ½ days course offered at selected locations throughout the country
- Refer to DOE-EERE-ITP web page (www.eere.energy.gov/industry) for schedule and location in your area
- Sign-up for the end user training at the end of this meeting



Energy Savers Tips for Industries

U.S. Department of Energy
Energy Efficiency and Renewable Energy

Energy Savers *A consumer guide to energy efficiency and renewable energy*

Home Improvements | Heat & Cool | Buy Clean Electricity | **Make Clean Electricity** | Buy Vehicles | Information Resources | Home

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Develop an Action Plan

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Lower your plant energy bills**
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- [Learn more about](#)
 - How other plants have achieved big savings
 - Tools and training you can use to identify savings opportunities
 - Assessments for your facility
 - Industry expertise available
- [Develop an action plan](#) to evaluate your best opportunities and start saving on natural gas, electricity, and fuel oil in your plant

Results of Plant Assessments

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