

Aztec Engineering LLC Trainer© Heater Simulator Instructor's Training Module

The objective of the instructor module is to provide operators and engineers with a thorough understanding of how to operate a process heater in a safe and efficient manner. Where appropriate, safety issues are high lighted. Based on over thirty years experience of developing training programs and conducting training, the only way to achieve the objective is to provide an understanding of the basic combustion process, an understanding of burner design, the various burner components and burner operation, an understanding of heat transfer and heater operation and finally an understanding of how the burner and heater operate together to provide the desired result.

The instruction module that is provided with the Trainer© Heater Simulator is a PowerPoint© presentation that is linked with the heater simulator. Various topics are presented and then demonstrated with the simulator.

The instruction module is divided into four sections. They are:

1. Fundamentals of Combustion –33 Slides
2. Fundamentals of Burner Design and Operation – 20 Slides
3. Fundamentals of Heater Design and Operation – 18 Slides
4. Heater/Burner system Operation – 36 Slides

Following is a topic outline for each section. Following the topic outline is a sample of the instructor's manual that is included with the module. The Sample Manual includes only a few slides from each section. As additional features are added to Trainer©, such as forced draft operation, appropriate additional material will be added to the instructor module. These updates will be made available for your use.

- I. Combustion Fundamentals
 - a. Introduction to the Process Heater
 - b. Introduction to Excess Air Control
 - c. What is Combustion
 - d. Typical Fuels
 - e. Source of Oxygen
 - f. Combustion Products
 - g. Combustion Example
 - h. Perfect combustion
 - i. Types of Fuel/Air mixtures
 - j. Demonstration of Perfect, Rich, and Lean Mixtures
 - k. Illustration of Carbon Monoxide Formation
 - l. Definition of Excess Air
 - m. The Effect of Excess Air

- n. Why Have Excess Air
- o. Air Requirements for Various Fuels
- p. BTU Definition
- q. Fuel Higher Heating Value
- r. Fuel Lower Heating Value
- s. Examples of Heating Values
- t. Heating Values of Mixtures
- u. Maintaining Ignition
- v. Flammability Limits
- w. Minimum Ignition Temperature
- x. Flame Propagation Speed
- y. Adiabatic Flame Temperature
- z. Actual Flame Temperature
- aa. By Products of Combustion - NO_x
- bb. Factors Influencing NO_x Formation
- cc. Impact of Flame Temperature On NO_x Formation
- dd. Impact of Excess Air On NO_x Formation

II. Burner Design and Operation

- a. Definition of a Burner
- b. Types of Burners
- c. Raw Gas Burner
- d. Metering of Flows
- e. Air metering
- f. Air Control
- g. Fuel Metering and Ignition Source
- h. Fuel/Air Mixing
- i. Maintaining Ignition
- j. Flammability Limits
- k. Minimum Ignition Temperature
- l. Flame Propagation Speed
- m. Purpose of a Flame Holder
- n. Pre-Mix Burner
- o. Pre-Mix Burner Components
- p. Burner Turn Down
- q. Burner Ignition
- r. Typical Burner Light-Off
- s. Burner Styles

III. Heater Design and Operation

- a. Process Heater Description
- b. Process Heater Operation
- c. Purposes of the Heater Stack
- d. Draft
- e. Draft and Excess Air Control

- f. Heater Draft vs. Combustion Product Temperature
- g. Heat Transfer
- h. Convective Heat Transfer
- i. Radiant Heat Transfer
- j. Flue Gas Sampling and Analysis
- k. Sample Location
- l. Heater Start –Up
- m. Heater shut –Down

IV. Heater/Burner System Operation

All of the following use the heater simulator to illustrate the following

- a. Use of Stack Damper and Burner Register
- b. Damper and Register Adjustment
- c. Effect of Air Temperature on Heater Operation
- d. Effect of Humidity on Heater Operation
- e. Effect of Fuel Composition on Heater Operation
- f. Air Leakage and Heater Operation
- g. Flame Length and Heater Operation
- h. Heater Efficiency

Abnormal Operation

- i. High Draft/High O₂
- j. High Draft/Low O₂
- k. Low Draft/High O₂
- l. Low Draft/Low O₂
- m. Low Draft/Low Low O₂

Trouble Shooting

- n. Pulsating Flames
- o. Irregular Flame Patterns
- p. Flash Back
- q. Ignition Failure
- r. High Fuel Pressure
- s. High Stack temperature
- t. High Convection Section Temperature
- u. Flame Lift Off