Energy Tips – Process Heating

Process Heating Tip Sheet #2 • November 2007

Industrial Technologies Program

Factors Affecting Excess Air Level Requirements

Combustion systems operate with different amounts of excess air between high and low fire. Measurement of oxygen and combustibles such as carbon monoxide in flue gases can be used to monitor changes in excess air levels. For most systems, 2% to 3% of oxygen with a small amount of combustibles—only 10 to 50 parts per million—indicate ideal operating conditions.

Processes that evaporate moisture or solvents need large amounts of excess air to dilute flammable solvents to noncombustible levels, to ensure adequate drying rates, and to carry vapors out of the oven. Lowering excess air to minimal levels can slow down the process and create an explosion hazard.

Resources

Combustion Technology Manual. Published by Industrial Heating Equipment Association (IHEA), Arlington, Virginia 22209.

Maintenance and Adjustment Manual for Natural Gas and No. 2 Fuel Oil Burners. Technical Information Center, Department of Energy.

Handbook of Applied Thermal Design, edited by Eric C. Guyer. Published by McGraw Hill Book Company.

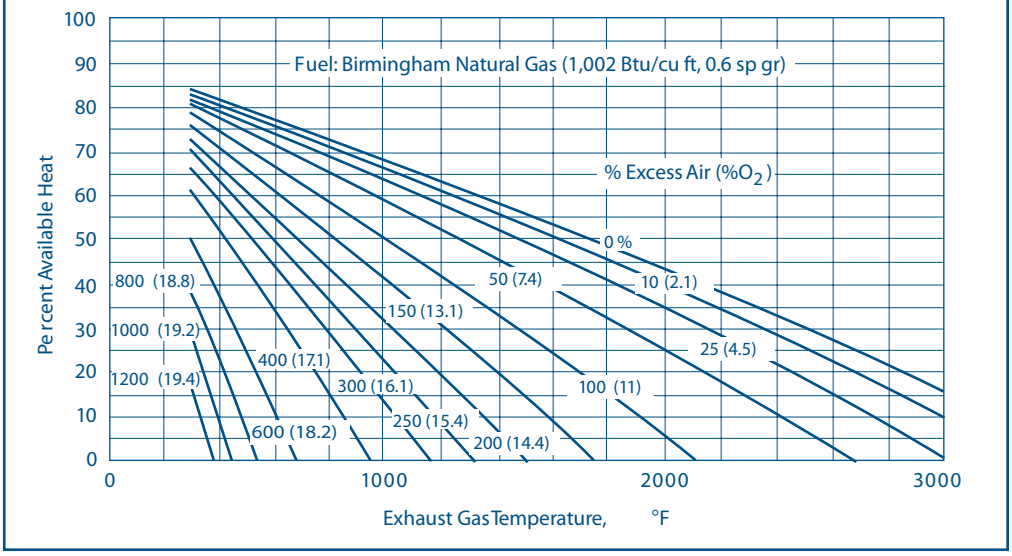
U.S. Department of Energy— For additional information on process heating system efficiency, to obtain DOE's publications and Process Heating Assessment and Survey Tool (PHAST) software, or learn more about training, visit the BestPractices Web site at www.eere.energy.gov/industry/bestpractices.

Check Burner Air to Fuel Ratios

Periodic checking and resetting of air-fuel ratios for burners is one of the simplest ways to get maximum efficiency out of fuel-fired process heating equipment such as furnaces, ovens, heaters, and boilers. Most high temperature direct-fired furnaces, radiant tubes, and boilers operate with about 10% to 20% excess combustion air at high fire to prevent the formation of dangerous carbon monoxide and soot deposits on heat transfer surfaces and inside radiant tubes. For the fuels most commonly used by U.S. industry, including natural gas, propane, and fuel oils, approximately one cubic foot of air is required to release about 100 British thermal units (Btu) in complete combustion. Exact amount of air required for complete combustion of commonly used fuels can be obtained from the information given in one of the references. Process heating efficiency is reduced considerably if the combustion air supply is significantly higher or lower than the theoretically required air.

Air-gas ratios can be determined by flow metering of air and fuel or flue gas analysis. Sometimes, a combination of the two works best. Use the Available Heat Chart below to estimate the savings obtainable by tuning burner air-gas ratios. The excess air curves are labeled with corresponding oxygen percentages in flue gases.

Available Heat Chart



Source: Calculations by Mr. Richard Bennett, published in *Process Heating* magazine, September 1997.

To figure potential savings, you need to know:

- The temperature of the products of combustion as they leave the furnace
- The percentage of excess air or oxygen in flue gases, at which the furnace now operates
- The percentage of excess air or oxygen in flue gases, at which the furnace could operate.

On the chart, determine the available heat under present and desired conditions by reading up from the flue gas temperature to the curve representing the excess air or O_2 level; then, read left to the percentage available heat (AH). Calculate the potential fuel savings:

% Fuel Savings = 100 X ((%AH Desired - %AH Actual) / %AH Desired)

Example

A furnace operates at 2,400° F flue gas temperature. The optimum ratio is 10% excess air (2.1% O_2 in flue gases), but tests show an actual ratio of 25% excess air (4.5% O_2 in flue gases). The chart shows an actual available heat of 22% compared to an ideal of 29%.

Fuel Savings = 100 X ((29 – 22) / 29) = 24%

Note: The graph on the front page is for combustion air at ambient temperature (about 60ºF) using natural gas with specific gas composition. The exact numbers may vary slightly if the natural gas composition is different from the one used for this graph. The available heat will also be different if the combustion air temperature is different. Use the Process Heating Assessment and Survey Tool (PHAST) or other methods to estimate fuel savings if your operating conditions are significantly different from the conditions stated above.

Suggested Actions

To get the most efficient performance out of fuel-fired furnaces, ovens, and boilers:

1. Determine the best level of excess air for operating your equipment.
2. Set your combustion ratio controls for that amount of excess air.
3. Check and adjust ratio settings regularly.

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BestPractices emphasizes plant systems, where significant efficiency improvements and savings can be achieved. Industry gains easy access to near-term and long-term solutions for improving the performance of motor, steam, compressed air, and process heating systems. In addition, the Industrial Assessment Centers provide comprehensive industrial energy evaluations to small- and medium-size manufacturers.

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EERE Information Center
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(1-877-337-3463)
www.eere.energy.gov

Industrial Technologies Program
Energy Efficiency
and Renewable Energy
U.S. Department of Energy
Washington, DC 20585-0121
www.eere.energy.gov/industry

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