

# Energy Tips

Tip Sheet #2 • May 2002



Process Heat



Motors



Compressed Air

## 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 percent 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.

## References

1. *Combustion Technology Manual*. Published by Industrial Heating Equipment Association (IHEA), Arlington, Virginia 22209.
2. *Maintenance and Adjustment Manual for Natural Gas and No. 2 Fuel Oil Burners*. Technical Information Center, Department of Energy.
3. *Handbook of Applied Thermal Design*, edited by Eric C. Guyer. Published by McGraw Hill Book Company.

*Process Heating Tip Sheet information adapted from material provided by the E3M, Inc. and reviewed by the DOE Best Practices Process Heating Steering Committee. For additional information on Process Heating efficiency measures, contact the OIT clearinghouse at (800) 862-2086.*

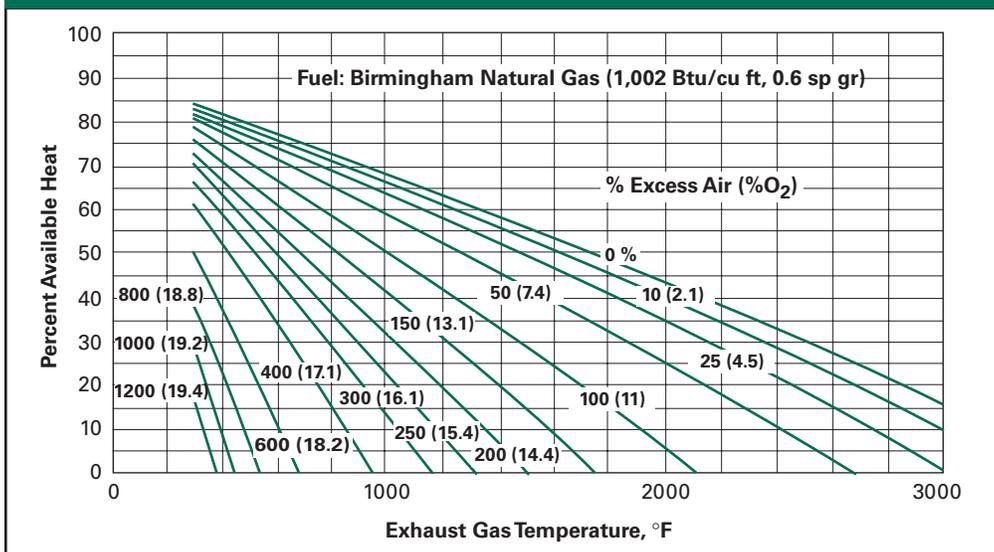


## Check Burner Air to Fuel Ratios

Periodic checking and resetting of air-fuel ratios 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 percent 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 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 air supply is significantly higher or lower than the theoretically required air.

Air-gas ratios can be determined by flow metering 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<sub>2</sub> level; then, read left to the percentage available heat (AH). Calculate the potential fuel savings:

$$\% \text{ Fuel Savings} = 100 \times ((\% \text{ AH Desired} - \% \text{ AH Actual}) / \% \text{ AH Desired})$$

## Example

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

$$\text{Fuel Savings} = 100 \times ((29 - 22) / 29) = 24 \text{ percent}$$

### ***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.



BestPractices is part of the Office of Industrial Technologies Industries of the Future strategy, which helps the country's most energy-intensive industries improve their competitiveness. BestPractices brings together the best-available and emerging technologies and practices to help companies begin improving energy efficiency, environmental performance, and productivity right now.

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.

#### **FOR ADDITIONAL INFORMATION, PLEASE CONTACT:**

Peter Salmon-Cox  
Office of Industrial Technologies  
Phone: (202) 586-2380  
Fax: (202) 586-9234  
Peter.Salmon-Cox@hq.doe.gov  
www.oit.doe.gov/bestpractices

OIT Clearinghouse  
Phone: (800) 862-2086  
Fax: (360) 586-8303  
clearinghouse@ee.doe.gov

Please send any comments,  
questions, or suggestions to  
webmaster.oit@ee.doe.gov

Visit our home page at  
www.oit.doe.gov

Office of Industrial Technologies  
Energy Efficiency  
and Renewable Energy  
U.S. Department of Energy  
Washington, DC 20585-0121

DOE/GO-102002-1552  
May 2002  
Process Heat Tip Sheet #2

## **About DOE's Office of Industrial Technologies**

The Office of Industrial Technologies (OIT), through partnerships with industry, government, and non-governmental organizations, develops and delivers advanced energy efficiency, renewable energy, and pollution prevention technologies for industrial applications. OIT is part of the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy.

OIT encourages industry-wide efforts to boost resource productivity through a strategy called Industries of the Future (IOF). IOF focuses on the following nine energy- and resource-intensive industries:

- Agriculture
- Aluminum
- Chemicals
- Forest Products
- Glass
- Metal Casting
- Mining
- Petroleum
- Steel

OIT and its BestPractices program offers a wide variety of resources to industrial partners that cover motor, steam, compressed air, and process heating systems. For example, BestPractices software can help you decide whether to replace or rewind motors (MotorMaster+), assess the efficiency of pumping systems (PSAT), compressed air systems (AirMaster+), steam systems (Steam Scoping Tool), or determine optimal insulation thickness for pipes and pressure vessels (3E Plus). Training is available to help you or your staff learn how to use these software programs and learn more about industrial systems. Workshops are held around the country on topics such as "Capturing the Value of Steam Efficiency," "Fundamentals and Advanced Management of Compressed Air Systems," and "Motor System Management." Available technical publications range from case studies and tip sheets to sourcebooks and market assessments. The *Energy Matters* newsletter, for example, provides timely articles and information on comprehensive energy systems for industry. You can access these resources and more by visiting the BestPractices Web site at [www.oit.doe.gov/bestpractices](http://www.oit.doe.gov/bestpractices) or by contacting the OIT Clearinghouse at 800-862-2086 or via email at [clearinghouse@ee.doe.gov](mailto:clearinghouse@ee.doe.gov).