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 1 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 on page 2 to estimate the savings obtainable by tuning burner air-gas ratios. The excess air curves are labeled with corresponding oxygen percentages in flue gases.

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%

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.

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.

References

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, U.S. Department of Energy (DOE).

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

Resources

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 Industrial Technologies Program Web site at *www.industry.energy.gov.*

节能措施——工艺加热

工艺加热内情报告2

检查燃烧炉的空气燃料比

从消耗燃料的工业加热设备中获得最大能效的最简单的办法之一就是对燃烧炉的空气燃料比例进行定期检查并重新复位，包括的设备有熔炉、烤箱、加热器和锅炉。绝大多数高温直接点火的熔炉、辐射管和锅炉高温燃烧时都有10%到20% 的过量空气，目的是防止形成有毒的一氧化碳，以及防止在传热表面和辐射管内部形成煤烟沉积。美国工业通常使用的燃料有天然气、丙烷和燃料油，它们在完全燃烧状态下每释放3.6克标煤（3.6 gce, 或100 Btu）的能量，需要大约0.03 平方米（即1立方英尺）的空气。常用燃料进行完全燃烧时所需要的确切的空气量可以从报告末尾给出的参考资料中得到。如果燃烧时空气供给量显著高于或低于理论空气需求量，工艺加热的效率将会大大降低。

空气–燃气比可以通过对空气和燃料进行流量计量或进行烟道气体分析得出。有时同时使用两种方法得到的效果更好。有效热量图表（见右图）可以用来估算通过调节锅炉的空气–燃气比，而获得的节能量大小。过量空气曲线以及相对应的氧气比例也在显示在下图中。

计算潜在的节能量，需要知道:

- 燃烧产物在离开锅炉时的温度
- 锅炉目前运行时烟气中过量空气或氧气的比例
- 锅炉可以运行时烟气中过量空气或氧气的比例

根据该图表，从横坐标上的烟气温度以及曲线标出的过量空气或氧气的比例，确定在目前状态下和希望状态下的有效热量。然后，从纵坐标上读出有效热量（AH）的比例。

计算潜在的燃料节省量:

燃料节省量（%）= 100 ×（希望达到的有效热量比 – 实际有效热量比）/希望达到的有效热量比

示例

一锅炉在1316 摄氏度（即2400华氏度）的烟气温度下运行。过量空气的最佳比例是10%（氧气在烟气中的比例为2.1%），但是测试表明实际的过量空气比为25%（氧气在烟气中的比例为4.5%）。根据图标显示，实际的有效热量比为22%，而理想状态下的有效热量比为29%。

燃料节省量 = 100 × ((29 – 22)/29) = 24%

影响过量空气比例的因素

燃烧系统在高火和弱火状态下对过量空气有不同的要求。对氧气和易燃物（如烟气中的一氧化碳）的测量可以用来监测过量空气比例的变化。对于大多数系统，氧气比例在2%到3%并有少量的易燃物（百万分之10到50）是最佳的运行状态。

要蒸发湿气和溶剂的工艺系统需要较多的过量空气，从而将可燃溶剂稀释到不燃的程度，确保获得满足要求的烘干率，并将水汽带出烤箱。最小化过量空气的比例将会减缓工艺过程，并且有产生爆炸的危险。

建议采取的行动

为了从燃料炉、烤箱和锅炉中获得最高的效率，建议采取以下行动:

1. 确定运行设备中过量空气的最佳比例
2. 将燃烧比例调节阀调到所需要的比例
3. 定期对比例设定进行检查和调整

参考资料

《燃烧技术指南》。由工业加热设备协会（IHEA）出版。阿灵顿，弗及利亚 2009.

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

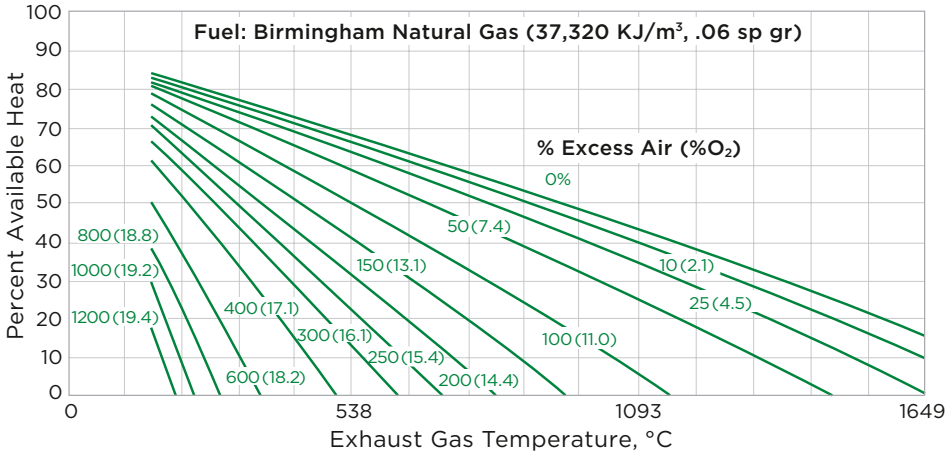
《应用热力设计手册》，Eric C. Guyer主编，McGraw Hill Book Company 出版。

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

美国能源部

如想进一步了解工艺加热系统提高能效的信息，获取美国能源部的报告以及工艺加热评估和测量工具（PHAST），或想进一步了解有关的培训，请访问美国能源部工业技术项目的网站 *www.industry.energy.gov* 。

Available Heat Chart　有效热量图表



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

注: 总坐标为有效热量百分比；横坐标为烟气温度（摄氏度）；燃料种类为: 伯明翰天然气。

来源: 发表于《工艺加热》杂志，由Richard Bennett计算得出，1997年9月。

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