Suggested Actions—Flue Gases

- Examine your flue-side heat transfer surfaces for deposits.
- Clean heat transfer surfaces periodically.
- Use a soot blower to automatically clean heat transfer surfaces.
- Use a soot burn-out practice for radiant tubes or muffles used in high temperature furnaces.
- Use continuous agitation or other methods to prevent materials from accumulating on the heat transfer surfaces.

Suggested Actions—Water Supplies

- Examine your water-side heat transfer surfaces for scale and remove the deposits.
- If scale is present, consult with your local water treatment specialist and consider modifying your chemical additives.

Resources

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 Heat Transfer Surfaces

Industrial process heating systems use various methods to transfer heat to the load. These include direct heat transfer from the flame or heated gases to the load and indirect heat transfer from radiant tubes, muffles, or heat exchangers. Indirect heating systems that use fuel firing, steam, or hot liquids to supply heat are discussed in this tip sheet. In each case, clean heat transfer surfaces can improve system efficiency. Deposits of soot, scale or oxides, sludge, and slag on the heat transfer surfaces should be avoided.

Contamination from Flue Gas and Heating Medium

Figure 1. Example of a poorly maintained heat exchanger from an aluminum melting furnace

Problem areas from flue gas include soot, scale or oxides, sludge, and slag. Soot is a black substance formed by combustion that adheres to heat transfer surfaces. Scale or oxide is formed when metals are oxidized in the presence of oxygen, water vapor, or other oxidizing gases. Sludge is residue from a liquid–solid mixture after the liquid evaporates. Slag is the residue formed by oxidation at the surface of molten metals, which can also adhere to heat transfer surfaces. These contaminants impede the efficient transfer of heat and reduce the efficiency of industrial heating systems.

Problem areas for indirectly heated systems where heating media such as air, steam, or hot liquids are used include scale, dirt, oxide film, or fouling on the heat transfer surfaces that are in contact with the heating medium.

Contamination of heat transfer surfaces is typically the result of:

- Low air:fuel ratios
- Improper fuel preparation
- Malfunctioning burners
- Oxidation of heat transfer surfaces in high temperature applications
- Corrosive gases or constituents in the heating medium
- Stagnant or low-velocity areas in contact with heat transfer surfaces for hot liquid or gas heating systems
- Special atmospheres (such as in heat treating furnaces) that can produce soot during the heating process.

As shown in Table 1, a 1/32-inch thick layer of soot can reduce heat transfer by about 2.5%.

Table 1. Efficiency Reductions Caused by Soot Deposits*

Soot Layer Thickness		
1/32 inch	**1/16 inch**	**1/8 inch**
2.5%	4.5%	8.5%

*Extracted from the Application Note – Energy Efficiency Operations and Maintenance Strategies for Industrial Gas Boilers, Pacific Gas and Electric Company, May 1997.

Contamination from flue gas can also shorten equipment life and lead to unscheduled maintenance. The extent to which dirty heat transfer surfaces affect efficiency can be estimated from an increase in stack temperature relative to a "clean operation" or baseline condition. Efficiency is reduced by approximately 1% for every 40°F increase in stack temperature.

Contamination from Water Supplies

Scale is formed from deposits of calcium, magnesium, or silica from the water supply. Problems occur when these minerals form a continuous layer of material on the water side of heat transfer surfaces; surfaces with scale deposits have much lower thermal conductivity than bare metal. Efficiency losses from scale deposits can range from 1% to 7%. Scale deposits can also lead to decreased heat transfer equipment life, especially becasue of corrosion. Most scale problems are caused by inadequate water treatment. Scale can be removed mechanically (by manual brushing) or with acid cleaning.

Reference

Improving Process Heating System Performance: A Sourcebook for Industry. U.S. Department of Energy (DOE) and the Industrial Heating Equipment Association (IHEA). This document can be obtained from www.oit.doe.gov/bestpractices/library.shtml.

BestPractices is part of the Industrial Technologies Program Industries of the Future strategy, which helps the country's most energy-intensive industries improve their competitiveness. BestPractices brings together emerging technologies and best energy-management 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:

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