

# PROCESS HEATING

A Special Supplement to *Energy Matters*

## The Big Picture on Process Heating

Consider the items we use every day—items such as decorative fixtures in our homes, the flatware we use for eating, and high-performance engine components in our cars. Although we use them in distinctly different ways, they all have a common manufacturing step that helps transform them into functional, finished goods. That step is process heating.

Process heating is vital to nearly all manufacturing processes, supplying heat needed to produce basic materials and commodities. Its use is extensive throughout industry—from the smallest manufacturers to Fortune 500 companies—to transform basic materials into the goods we use every day. Whether in the production of materials, such as steel, cement, and composites, or in the manufacture of value-added products, such as electronics, computer chips, cosmetics, and textiles, process heating plays an important part. Figure 1 captures many of the industries that use process heating as a manufacturing step.

With its wide and varied industrial use, process heating directly and indirectly affects the employment of an estimated 16 million people in the United States at more than 300,000 establishments with total annual sales and shipments of \$3.8 trillion.

It is no wonder that heating processes (not including steam generation) consume about 5.2 quads (quadrillion Btu), which is nearly 17% of all energy used by industry. Heat derived from combustion of fossil fuels accounts for 92% of this energy; electricity use accounts for the remaining 8%. Industry's heavy reliance on these processes creates a critical need to optimize their performance for improved productivity, energy efficiency, and competitiveness.

### The Components of Process Heating Systems

Process heating systems are made up of five components including:

- Heating devices that generate and supply heat
- Heat transfer devices to move heat from the source to the product
- Heat containment devices, such as furnaces, heaters, ovens, and kilns
- Heat recovery devices

The system can also include a number of other support systems, such as sensors and controls, material handling, process atmosphere supply and control, emission control, safety, and other auxiliary systems. Figure 2 (page 6) illustrates the components of a process heating system.

In most applications, heat is supplied by one or more of four heating methods: fuel-fired heating, steam heating, hot oil/air/water heating, and electric heating. The heat is transmitted either directly from the heat source, or indirectly through the

furnace walls, or through other means such as jets and recirculating fans.

For many industrial applications, 15%-85% of the energy supplied is used for heating the materials. Many factors, such as process temperature, equipment design and operation, and the type of heat recovery systems used, determine the energy efficiency of a process heating system. Hence, industrial process heating systems offer opportunities to save significant amounts of energy.

### Process Heating Energy Consumption

Process heating equipment is operated over a broad temperature range, from 300°F to as high as 3000°F. Consequently, these processes consume large amounts of energy. In fact, energy costs for process heating represent 2%–15% of a product's total cost.

In U.S. industry, process heating accounts for more direct energy use than any other processes that consume energy during manufacturing. Other energy-consuming operations, such as steam

#### Materials

- Steel
- Glass
- Basic Chemicals
- Ores and Minerals
- Copper and Brass
- Ceramic
- Petroleum
- Paper
- Aluminum
- Composite Materials
- Cement
- Precious Metal

#### Value-Added Product Areas

- Automotive Parts
- Appliances
- Speciality Steels
- Food
- Ship Building
- Textile
- Pipe & Tube
- Fasteners
- Machinery
- Plastics
- Tools
- Powdered Metals
- Weapons & Armaments
- Farm & Heavy Equipment
- Paper Products
- Gypsum
- Foundry
- Paint
- Computer Chip
- Jewelry
- Defense Equipment
- Beverage
- Carbon & Graphite
- Asphalt Paving
- Forging
- Cosmetic
- Electronics
- Construction Materials
- Aerospace Components
- Can & Container
- Wire
- Medical Products
- Rubber

Figure 1. Businesses and industries served by process heating equipment.

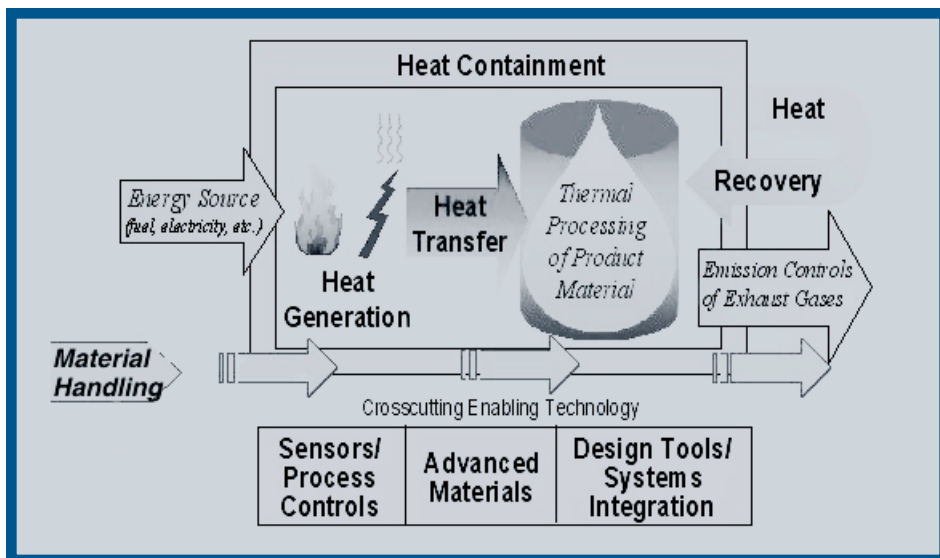


Figure 2. The components of process heating systems.

generation and cogeneration, include essentially the same components, as shown in Figure 2, and often supply steam or hot water used for process heating.

Over the last two decades, U.S. industry has made significant improvements in process heating efficiency, which has resulted in a reduction of energy per unit of production. However, U.S. industry's total energy use for process heating is expected to increase. Process heating R&D activities and application of process heating best practices can contribute to significant reductions.

Across industries, process heating is used for nine generic industrial operations: fluid heating, calcining, drying, heat treating, metal heating, metal and nonmetal melting, smelting/agglomeration, curing and forming, and other heating. Factors such as cost, availability, process, and emission requirements determine which energy source is used. Figure 3 shows the most commonly used energy sources for each operation.

Combustion-related emissions, such as nitrogen oxide (NO<sub>x</sub>), volatile organic compounds (VOCs), and particulates, are closely related to energy use in process heating. In the last 20 years, the combined effects of advancements in processes, improvements to equipment design, and gains in thermal efficiency have helped to re-

duce environmental impacts from these emissions. As these advancements continue and efficiency levels improve, so will emission reductions.

#### Potential for Savings

Today, overall thermal efficiency of process equipment varies from 15% to 80%, compared to the thermal efficiency of steam generation, which varies from 65% to 85%. Lower efficiency levels for process heating opens the door for significant energy savings. The greatest potential is in the higher temperature range processes, as the

margin for improvement is large and the returns are greater. With the use of advanced technologies and operating practices, process heating energy consumption could be reduced by an additional 5%-25% within the next decade.

Together, OIT and the process heating community will continue to develop and carry out R&D programs to guide industry and help achieve major improvements in heat processes over the next 20 years. However, manufacturing companies can embark on heat process efficiency measures—right now—in their own operations. Take a look at page 3 of this supplement for examples of activities that offer good results with limited effort. In addition, OIT's BestPractices Web site offers many resources and tools to help you assess and improve systems throughout the operation—systems like motors, steam, and compressed air, which may all be connected to heat processes in the plant.. Explore the Web site at [www.oit.doe.gov/bestpractices](http://www.oit.doe.gov/bestpractices). ●

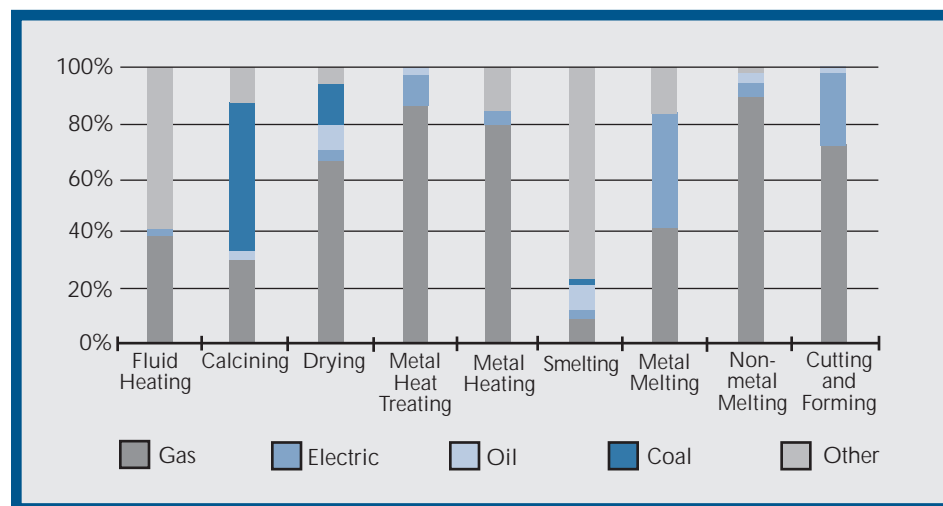


Figure 3. Energy sources for common industrial processes that require process heating.