A BestPractices PUBLICATION ON IMPROVING INDUSTRIAL ENERGY EFFICIENCY

ENERGY MATTERS

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Implementing Technology

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Darby Electric—A Model Allied Partner

Steve Darby, president of Darby Electric, and Doug Pittman, of Rockwell Automation Power Systems Division, conduct customer training.

The BestPractices initiative works closely with Allied Partners that provide equipment and services to industry. Allied Partners are private companies, organizations, or government agencies that help assess plant efficiencies and demonstrate efficiency improvements. Not only do the plant owners benefit, but so do the Allied Partners—who become valuable to clients by helping them achieve plant efficiencies. One excellent example of an Allied Partner is Darby Electric, of Anderson, South Carolina.

The company signed on as an Allied Partner under the Motor Challenge program about 5 years ago. This year, the Motor Challenge program was incorporated under the umbrella of the BestPractices initiative as the Motor Systems program.

As an Allied Partner, Darby Electric has taken advantage of OIT's BestPractices training modules, software, publications, and technical assistance to help customers upgrade motor systems and save energy and money. In fact, according to Steve Darby, president of Darby Electric, "Gaining knowledge and being up-to-date on the latest technology are the biggest advantages of being an Allied Partner."

Those advantages helped Darby win the "Joint Cost Reduction" award from Milliken Textile Company in 1997. This award is Milliken's highest level of supplier recognition. It was achieved, in part, through Darby's work with OIT's Motor Systems program.

Steve Darby says that convincing customers to replace old motors with energy-efficient versions can be a challenge. "It's a hard sell, because companies often just look at the short-term bottom line, and they want to buy less expensive motors. But we've stuck to our guns," partly because of certain Energy Policy Act requirements, and partly "because I know we can serve customers better by providing them with better technology that gives them better efficiency and cost savings. Every motor should be evaluated prior to repair or replacement. If efficiency can't be improved by replacement, it should be rewound to original specifications with the utmost attention to detail, using the best techniques and insulating materials."

To make the selling job easier, Darby Electric has had to educate customers. It has sponsored and cosponsored motor system workshops, sent representatives to tradeshows, and in the process, has distributed many OIT fact sheets and software programs. Account managers for Darby Electric are trained in the use of Motor Master+ software and the Repair/Replace training module to help customers determine cost savings on purchasing replacement energy-efficient motors. In addition to Milliken, Darby Electric has served Monsanto, Morton International, NutraSweet, FujiFilm, and DuPont.

"Steve Darby had a vision to educate customers about energy efficiency. He successfully used OIT materials in his efforts, and it has paid off handsomely. I've really enjoyed working with him," says Chris Cockrill, project manager for the BestPractices Motor Systems program.

One advantage, according to Steve Darby, has been improved business. "Participating in this program has enabled Darby Electric to increase business volume in both new motor sales and in motor rebuilding," he says.

Darby Electric's experience demonstrates that through the Allied Partners program, vendors add value to their services and customers gain more efficient operations. ●

COMMENTS?

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Assessment Helps Aluminum Casting Plant Key In to Potential Improvements

One year ago, OIT's BestPractices initiative launched its Plant-Wide Energy Efficiency Opportunity Assessments program. The idea was to encourage industrial facilities to investigate the possibilities throughout the plant and identify potential energy savings, process improvements, and opportunities for new technologies. With cost-shared funding and technical assistance from OIT, such assessments could facilitate the process for industrial plants.

AMCAST found that the most potential for improvement is in its manufacturing process.

Since the program began in September 1999, OIT has opened three rounds of solicitations and has made awards to 13 companies to conduct plant-wide assessments. These companies represent industries, such as aluminum, chemicals, glass, forest products, and petroleum refining—all within the scope of OIT's Industries of the Future initiative.

Among the recipients of the plant-wide assessment awards is aluminum casting manufacturer AMCAST of Wapakoneta, Ohio. One of the original seven companies to receive the cost-shared funding from OIT, AMCAST recently completed its assessment and moved quickly to implement improvements that could yield impressive savings of $3.6 million annually.

AMCAST's primary products are aluminum permanent mold castings for the automotive industry, but the company also serves the construction and other industrial sectors. The company employs 300 people at this plant and processes 15–20 million pounds of aluminum annually at the Wapakoneta site.

To make its products, AMCAST begins with aluminum ingots, which are melted in natural-gas-fired reverb furnaces. Melted aluminum is transferred to the hold furnaces adjacent to each low-pressure permanent mold machine via electrically heated ladles. After casting, flash and scrap parts are sent back to a Jet-melt furnace. Cast products are trimmed, inspected, heat treated, and aged in ovens. Primary waste streams include aluminum dross, recyclable aluminum flash, deburring material, metal shavings, and cooling wastes.

AMCAST is the first to use the low-pressure, permanent mold casting process to produce high-volume, aluminum suspension components for the auto industry. The company set out to identify ways to cost-effectively reduce waste, energy, and operating costs, and the plant-wide assessment award supported this effort. The company teamed with the University of Dayton Energy Efficiency Office and the Edison Materials Technology Center, of Dayton, Ohio; Midwest Building Diagnostics (formerly Miami Valley Diagnostics), of Xenia, Ohio; and CSGI of Rockville, Maryland. The team identified areas of improvement in AMCAST's operation, and generated ideas that could help other casting-related industries.

Path to Improved Efficiency

The assessment team's first step was to gain an understanding of the total cost of energy in the AMCAST facility. Utility costs as well as ongoing maintenance, capital investments, material, and labor associated with energy systems were also considered. By monitoring the operation's energy use, from the transformer and switches to production lines, the team identified opportunities to improve reliability, increase efficiency, and reduce total cost of energy.

Initially, the focus was on identifying and minimizing end-use loads. Next, the distribution system was examined for savings opportunities, then the primary driver. In most cases, the end-use and distribution system savings directly influence the recommendation for modifying the energy source.

Sources of Savings

Based on previous assessments of metal casting facilities and the information provided by AMCAST, the team noted potential savings and improvements throughout the plant in electrical, lighting, motor drive, compressed air, and process heating systems. By implementing these efficiency measures, the company expects to save $600,000 annually.

The assessment confirmed that the most significant improvements are in the manufacturing process. Approximately 90%, or about $3 million, of the total projected savings are process-related. As a result of material modifications to process equipment (riser tubes, glow bars, and others),

(continued on page 3) ►

continued from page 2

AMCAST has realized reductions in maintenance, scrap, downtime, and has improved product quality.

The prospect of saving $3.6 million annually has led AMCAST to act immediately on the process improvements and other efficiency measures identified in the assessment. Of the 13 programs identified, four are underway and one is complete. For its $1 million investment on these improvements, AMCAST anticipates a simple payback of just 3 months. In addition, the company stands to reduce carbon dioxide (CO_2) emissions by 11 million pounds per year.

Opportunity Captured

For AMCAST, this plant-wide assessment highlights the synergy of process performance and its impact on overall energy and cost savings. It also demonstrates the need to consider all other factors that affect performance and costs.

AMCAST has taken the opportunity to explore potential improvements, and is now implementing programs to capture substantial savings. In turn, other casting companies have the opportunity to share in the findings at AMCAST and perhaps capture similar results.

"The opportunity, guidance, and encouragement from OIT to help foster teamwork has helped overcome the 'not-invented-here' syndrome and has made the assessment a glowing success." explains James R. Van Wert, Jr., AMCAST's vice president of technology. ●

OIT Financial Assistance Programs Facilitate New Technologies

By Lisa Barnett, OIT Financial Assistance Programs, Washington, DC

OIT, through its Industries of the Future (IOF) initiative, plays a unique role as a catalyst and facilitator for industry. By working in partnership with companies and others, OIT helps to develop and deliver advanced energy efficiency, renewable energy, and pollution prevention technologies that can significantly improve resource efficiency and industrial competitiveness.

An important way OIT facilitates new technology implementation is through financial assistance to accelerate commercialization. This assistance can pave the way for industries, and even individual inventors, to define concepts, build prototypes, and develop and demonstrate energy-efficient, environmentally beneficial technologies. Two key financial assistance programs that support IOF efforts are National Industrial Competitiveness through Energy, Environment, and Economics ($NICE^3$) and Inventions and Innovation.

$NICE^3$ Advances New Technologies

The $NICE^3$ grant program allows state agencies, in partnership with industry, to apply for up to 50% of costs (up to $525,000) through a competitive solicitation process to demonstrate innovative energy-saving and pollution-reducing industrial technologies ready for first-time commercial demonstration. The $NICE^3$ program reduces the risk for industry introducing new technologies into the commercial market.

In total, $NICE^3$ has sponsored 91 projects, with more than half the sponsorship going to small businesses. Since 1991, $NICE^3$ has leveraged $26.3 million in federal funds—$81.8 million in state and industry funds. Some commercially successful $NICE^3$ projects include:

- **TELSONIC Ultrasonics**, of New Jersey, demonstrated ultrasonic technology for the pharmaceutical industry, which cleans storage tanks, replacing solvent cleaning.
- **Whyco Technologies**, in Connecticut, developed a perforated barrel design that increases the flow rate in metal plating.
- **Quad/Graphics, Inc.**, in Wisconsin, pioneered a closed-loop ink jet supply and printer solvent recovery system that eliminates hazardous emissions without energy-intensive exhaust systems.

Inventions and Innovation Targets Promising Developments

The Inventions and Innovation program provides financial assistance (up to $200,000) and technical assistance to help individual inventors and small businesses develop and demonstrate promising energy-saving technologies having significant future commercial market potential. The program is designed for independent inventors and small businesses with less than 500 employees. These inventors and companies are important sources of novel ideas for energy-saving and energy production technologies. Through Inventions and Innovation, OIT can help support the development and deployment of new, innovative energy-related technologies.

To date, more than 500 inventions have received financial support through this program. Nearly 25% of them have reached the marketplace, achieving cumulative sales of nearly $710 million. Combined, these inventions have saved enough energy to light 6 million homes for 1 year (in excess of 0.6 quad).

Benefits Beyond Financial

OIT's financial assistance programs provide millions of dollars in funding annually for concepts, prototypes, and commercial demonstrations. These dollars mitigate industry's financial risk in developing new technologies. In addition, the programs offer many other benefits to grant recipients. For example, they:

- Provide demonstration data to industry on the operating parameters of new technologies.
- Help researchers and technology providers find technical partners, commercial sponsors, business plan resources, and follow-on funding sources.
- Provide access to technical and commercialization assistance.
- Provide access to regional and local services and user facilities.
- Provide Internet sites and information relevant to energy-related innovations.
- Conduct forums for financial investors interested in energy-related businesses.

The programs also benefit U.S. industry by providing technology solutions to major industry challenges, reducing the risk of implementing new technologies, and providing information for technology investment decisions.

Eligibility and Criteria

If you are an inventor or part of a small business, the Inventions and Innovation program could be your avenue to financial assistance from OIT. Industries of all sizes and individual inventors can apply for $NICE^3$ grants, provided your proposed project is in partnership with a state agency. Learn how these OIT programs might help you demonstrate your industrial efficiency technology by visiting the Financial Assistance Web sites at **www.oit.doe.gov/nice3** or **www.oit.doe.gov/inventions.** ●

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Emissivity: The Unknown Factor

Understanding Thermal Calculations to Save Money and Energy

By Gary J. Bases, BRIL, inc., Copley, OH

Recently, a client, who is a plant manager for a major oil refinery, asked for help to understand how the amount of refractory and insulation lining system recommended for his flues and waste heat boiler by his supplier/contractor was calculated and what questions he should ask. I asked him what he knew about emissivity. He knew only that it was a measure of reflection or something to that effect.

I explained that emissivity is a key factor to understanding heat flow calculations and saving energy and money. The other important factors are wind velocity, ambient air temperature, surface temperature, thermal conductivity, or "K" value, and operating temperature. Proper calculation of the insulation and refractory (thicknesses and material types) will save money at the initial installation because he will only be paying for what he needs. As a long-term investment, this client will save energy and money by minimizing the amount of heat loss that radiates from the outer casings. By understanding emissivity, he will use less fuel to reach and maintain the waste heat boiler's operating conditions.

The following discussion, while not the whole story on emissivity, might simply shed some light on its value in determining the right insulation and refractory requirements for maximum savings.

Emissivity Defined

Emissivity is a measure of the ability of a material to radiate energy. It is expressed as a ratio (decimal) of the radiating ability of a given material to that of a black body.[1] A black body emits radiation at the maximum possible rate at any given temperature, and has an emissivity of 1.0. The values of emittance for various metals are published and so are undisputed. I suggest that the emissivity value used for the calculation be based on the current conditions of the materials being installed (i.e. reusing existing outer casing or lagging or installing new lagging or casing).

More than just knowing the definition of emissivity, however, it is important to understand where and how this value can be used or misused in the calculation of insulation thickness.

Calculating Insulation Thickness

A good way to understand the role of emissivity in calculating insulation and refractory material thickness is to use good old-fashioned hand calculations. The formula below can be used for flat surfaces:

$$thickness = \left[\frac{(operating \text{ deg } F - surface \text{ deg } F)}{(heatloss\ Btu)} \right] \text{ x } (K\ value)$$

To find the elusive emissivity factor, the formula must be broken down further:

$$thickness = \left[\frac{(operating \text{ deg } F - surface \text{ deg } F)}{(1 + 225 \text{ x } velocity\ (fps)) \text{ x } (surface \text{ deg } F) + (0.1714 \text{ x } EMISSIVITY) \text{ x } \left[\frac{(surface \text{ deg } F + 460)^4}{(100)^4} - \frac{(ambient \text{ deg } F + 460)^4}{(100)^4} \right]} \right] \text{ x } (K\ value)$$

This gives the two basic components of Btu or heat loss portion, which are convection (in this case natural convection) and radiant values. In the radiant component of the Btu value we find emissivity.

This thermal calculation seems quite complicated, and with all the calculation software on the market today,[2] we should be glad that we no longer have to hand calculate. However, these computer programs require the same input to calculate heat flow. They all ask for *velocity, ambient air temperature, surface temperature, and operating temperature*. Most have built-in K values for the types of insulation and refractory to be used, or these values can be easily entered.

Variables of Calibration

So, what affects the insulation thickness calibration? The most obvious factor is the K value. A higher K value causes the calculation to have a greater insulation thickness. By using the mean value of the insulating material, we get a lower K value, and therefore, a lower insulation thickness. To find the K value:

1. Find the mean temperature:

$$\frac{\text{(operating temp. + surface temp.)}}{2}$$

2. Identify value of K on published charts

The K value of insulation has not changed dramatically over the years. As R.L. Schneider, a pioneer in heat transfer calculations, wrote "...since it is harder to keep improving insulation by decreasing the K value, let's increase the thickness when necessary."[3] If this is still true, then the only other variable that can affect the outcome of the insulation thickness calculation is emissivity.

Factoring Economic and Energy Savings

By understanding the emissivity factor, you can compare labor and material costs at various insulation thicknesses. That is the easy part of determining economic savings. The more difficult part is to relate that to energy savings, but this is the key. Think of insulation and refractory as an investment in energy savings down the road. "The greater the cost of insulation, the smaller the cost of heat loss," explained J.F Malloy,[4] in *Thermal Insulation.* That is, savings on heat loss occur when insulation thickness is increased; however initially, there is a greater installation cost for that increase of insulation thickness.

A Little Knowledge Pays Off

With a better understanding of emissivity, my client felt that he could evaluate the insulation and refractory design with confidence. The next time he talked with his supplier/contractor, he could ask informed questions, such as:

- Was the K value based on mean temperature?
- What external wind velocity was used?
- What emittance was used to calculate the insulation and refractory thickness?

Knowledge is everything! Knowing more about the calculations helped my client obtain the proper material type at the right thickness. He found that the design was insufficient due to incorrect emissivity and wind velocity factors. As a result, he kept the initial installation costs down by paying only for what he needed (short-term cost savings). In addition, heat loss in the plant has been minimized, which keeps fuel costs down (long-term energy savings). The end result is a thermally efficient and cost-effective installation of a refractory and insulation lining system for his flues and waste heat boiler. Thus proving what Mr. Malloy also wrote: "Thermal insulation installed to save energy also saves money at the rate that is essential for efficient plant operation." ●

Gary Bases is president of BRIL inc., an independent consulting firm specializing in brick, refractory, insulation, and lagging. Contact him at (330) 665-2931 or e-mail inquiry@bril-inc.com.

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[1] ASTM C-680-89, page 13, Appendix A.
[2] Download DOE/NAIMA's 3E Plus insulation thickness software at **www.oit.doe.gov/bespractices/software_ databases/software.shtml**.
[3] *Fundamental Heat Transfer*, R. L. Schneider, 1961.
[4] *Thermal Insulation*, J.F. Malloy, 1969.

Mark Your Calendar for Expo 4

"Global Competition: Challenges and Solutions" is the title of the 4th Biennial Industrial Energy Efficiency Symposium and Exposition (Expo 4) coming up in February. With an expanded program, a renowned keynote speaker, and up to 200 booths, Expo 4 promises to thoroughly explore the major trends and opportunities facing the country's essential, energy-intensive industries.

Expo 4 attendees can attend workshop and speaker sessions to learn what issues, trends, and challenges face industry and where the opportunities lie.

Speaker Tracks

Expo 4 will be held February 19-22 at the Washington Hilton and Towers in Washington, DC. Sponsored by OIT and several of the nation's leading manufacturing and materials companies, Expo 4 will feature an expanded program with four speaker tracks:

- **Manufacturing Megatrends**—Topics will include lean manufacturing, supply chain management, Internet trading, and contract manufacturing.
- **Technology and the Environment**—New applications of traditional materials and long-term technology changes and their potential impact on industry and global climate change are among the topics that will be covered.
- **Global Markets and Investment Potential**—The market outlook for basic-materials industries, including the perspectives of securities analysts and investors will be explored.
- **Human Resources**—This track will cover issues related to workforce development and meeting the needs of engineers of the future.

Honors and awards presented at OIT's Expo recognize visionary industrial leaders.

Keynote Address

Eamonn Fingleton, author and former editor of *Forbes* and *The Financial Times,* will be the keynote speaker at Expo 4. Fingleton's most current book, *In Praise of Hard Industries: Why Manufacturing, Not the Information Economy, is the Key to Future Prosperity,* takes a look at the economic resurgence of U.S. manufacturing. Fingleton will speak on this topic.

Exhibit Hall

Meanwhile, in the exhibit hall, booths will tout the newest in cutting edge processes to increase industrial energy and cost efficiencies. Companies from the Industries of the Future (the nine most energy-intensive industries and those that work most closely with OIT to reduce energy use) will be exhibiting alongside national laboratories, federal research and development agencies, universities, industry associations, and others. Industrial technology executives will be offered a one-stop-shop for potential government research and development partnership opportunities.

Young Engineers

Furthering the spirit of partnership, Expo 4 organizers are partnering with the Junior Engineering Technical Society, a nonprofit organization that works to involve high school students in engineering, science, and mathematics programs. The organization administers a rigorous annual exam, and this year's topic focuses on the Industries of the Future. Winning teams from across the country will be invited to participate in an awards ceremony at Expo.

In addition, Expo's timing coincides with National Engineering Week, and many industry trade organizations will be sponsoring events with OIT. ●

*For more information on Expo 4, call toll free (877) OIT-SYMP, or visit **www.oitexpo4.com.***

Don't Delay! Register now to attend Expo 4. See page 6 for registration form.

Hotel Reservations

The special room rate at the Washington Hilton and Towers Hotel for OIT's Expo 4 is $164, single or double occupancy, plus applicable tax. A limited number of rooms are available at the government rate. To reserve your room, call the hotel directly at (202) 483-3000 or (800) 445-8667. Mention you are attending the OIT Exposition to obtain the special rate.

The hotel will require a credit card number or a deposit to hold your reservation. The credit card will not be charged at that time. If you must cancel, please do so at least 72 hours prior to scheduled arrival to avoid being charged for one night's stay. The cut-off date for hotel reservations is January 19th, 2001. Rooms are subject to availability.

OIT EXPO Registration Form

Online registration is also available at www.oit.expo4.com.

Detach and send to:

Meeting Management Services, OIT Expo Office
1201 New Jersey Ave. NW
Washington, DC 20001

If paying by credit card, you may fax your registration to (202) 624-1766.

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Track you plan to attend:

- ☐ Track A: Manufacturing Megatrends
- ☐ Track B: Technology Trends, Environmental Issues
- ☐ Track C: Human Resources
- ☐ Track D: Global Markets & Investment Potential

Your primary area(s) of interest (check all that apply):

- ☐ Agriculture
- ☐ Aluminum
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- ☐ Mining
- ☐ Petroleum
- ☐ Steel
- ☐ Combustion
- ☐ NICE^3
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- ☐ Industrial Assessment Centers
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- ☐ Combined Heat and Power
- ☐ Inventions & Innovation

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- ☐ Early Registration—$425 (before January 1, 2001)
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Special Needs

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For more information, please call (202) 624-1790.

New Feature! OIT Emerging Technologies and Research

In this new column, *Energy Matters* highlights emerging technologies to illustrate their important role in helping industry achieve energy savings and emission reductions. OIT considers technologies to be "emerging" when:

- They are ready for use in industrial settings.
- They have been demonstrated under real-use conditions to achieve a minimum of 25% baseline or potential improvement in energy efficiency and emissions generation.

These technologies are developed with support from OIT's Industries of the Future partnerships. After a successful demonstration, the technologies could be brought into industrial use through OIT's BestPractices initiative.

One such technology, developed by Argonne National Laboratory (ANL) recycles usable plastics products from automotive scrap when vehicles are shredded to recover metal for reuse. About 3–5 million tons of residue are produced annually in the United States and have been destined for landfills without an economical or effective means for material recovery. This patented ANL process, which separates the residue into streams of polyurethane foam, mixed plastics, and iron oxides, has the potential to recover 250,000 tons of polyurethane foam and 750,000 tons of heat-formed plastics when applied to the annual production of shredder residue in the United States. It would thus minimize landfill disposal operations by recovering 20%–30% of the shredder residue.

An ANL pilot plant built to demonstrate its 6-step process for recovering polyurethane foam from the shredder residue produced more than 3 tons of foam that met industry specifications for new material carpet padding and for reuse in automobile applications. At a cost of less than $.30 per pound, the recycled foam has a substantial cost advantage over the $1 per pound cost for virgin foam. Because of these significant results, the polyurethane foam recovery process has received a 2000 R&D 100 Award from *R&D* magazine.

Photo: Argonne National Laboratory

Recovered polyurethane foam is cleaned and prepared for recycling at Argonne's demonstration plant.

In addition, ANL has developed a froth-flotation process, which, when combined with mechanical/physical separation, can be used to recover high-value plastics, such as acrylonitrile-butadiene-styrene (ABS) and high-impact polystyrene (HIPS) from the shredder residue stream of mixed plastics. A pilot-plant demonstration at Appliance Recycling Centers of America, in Minneapolis, Minnesota, suceedeed in producing high-purity (>90% pure) ABS and HIPS. The recovered polymers can be mixed with new materials to make automobile, appliance, and electronic parts, piping, and furniture. When applied to recovery operations of automobile shredder residue and obsolete appliances, more than 300 million pounds of high-value plastics could be reclaimed for reuse. That would save 87 trillion Btu in energy costs and avoid disposal costs of $10–$40 per ton of waste.

The process for recovering polyurethane foam has been licensed to Salyp Recycling Center, of Belgium, where it will be applied to achieve a 40% reduction of the waste from end-of-life vehicles by 2005, as required under European Union directives. Negotiations are ongoing for licensing the froth flotation process to private companies.

Learn more about these processes online at **www.oit.doe.gov/factsheets/chemicals/pdfs/froth.pdf** and **www.techtransfer.anl.gov:80/techtour/autoshredder.html.** ●

Letters to the Editor

Energy Matters welcomes your typewritten letters and e-mails. Please include your full name, address, organization, and phone number, and limit comments to 200 words. Address correspondence to:

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We publish letters of interest to our readers on related topics, comments, or criticisms/corrections of a technical nature. Preference is given to letters relating to articles that appeared in the previous two issues. Letters may be edited for clarity, length, and style. ●

Energy Matters EXTRA

Don't miss the story about Ispat Inland, Inc.'s efforts to increase production, reduce maintenance, improve product quality, and reduce emissions in its steel production facility. Look to Energy Matters Extra to learn how Ispat Inland has implemented heat recovery and an improved burner design in its heat treating process, and find out the results achieved.

Also, connect to complete details about OIT's 4th Industrial Energy Efficiency Symposium and Exposition, which is set for February 19-22, 2001 in Washington, DC. Pages 5 and 6 of this issue highlight the conference, and Energy Matters Extra links you to even more information.

Check out two BestPractices Steam resources now online. Download *Clean Boiler Fireside Heat Transfer Surfaces*, a steam tip sheet, which explains how soot buildup on fireside heat transfer surfaces can reduce boiler efficiency. It offers suggestions for avoiding such deposits. And, take a look at *Steam Digest 2000*, a compendium of articles on steam system management and resources.

Find Energy Matters Extra at **www.doe.oit.gov.exlopre_library/emextra**. ●

Coming Events

OIT Expo 4—Global Competition: Challenges and Solutions

- February 19-22, 2001 in Washington, DC

For more information please call (877) OIT-SYMP or visit **www.oitexpo4.com.** See also pages 5 and 6 of this issue for details and a registration form.

Send Us Your Maintenance Lessons Learned

When it comes to energy systems maintenance, there are plenty of valuable lessons to be learned. Although they can be hard to admit, we invite you to submit an example of a maintenance mishap—with our ***assurance*** *that we will maintain your individual and company anonymity. We'll publish these anecdotes in the January/February 2001 edition of* Energy Matters*, which will focus on the importance of developing maintenance methods and equipment right-sizing plans. The examples you submit will help us emphasize the need for a reliable maintenance plan by showing what happens when no such plan is in place. Send* Energy Matters*, your lessons learned from a lack of or improper industrial energy system maintenance. In your description, please tell us:*

- *What occurred and why you think it resulted from improper maintenance?*
- *What were the consequences to the plant? Did a lack of maintenance affect equipment, productivity, efficiency, and personnel well being?*
- *What steps were taken to improve maintenance and what benefits have been gained?*

Mail or e-mail (see page 2 masthead for contact information) your examples to the Energy Matters *Editor: Lessons Learned. Please include your name and phone number (to verify information only), and send by December 22, 2000.*

To keep up-to-date on OIT training and other events, check the calendar regularly on Energy Matters Extra at ***www.oit.doe.gov/bestpractices/explore_library/emextra.***

BestPractices

The Office of Industrial Technologies (OIT) BestPractices initiative and its *Energy Matters* newsletter introduces industrial end users to emerging technologies and well-proven, cost-saving opportunities in motor, steam, compressed air, and other plant-wide systems. For overview information and to keep current on what is happening office wide, check out the newsletter—The OIT Times—at **www.oit.doe.gov/oit-times.**

Information Clearinghouse

Do you have questions about using energy-efficient process and utility systems in your industrial facility? Call the OIT Information Clearinghouse for answers, Monday through Friday 9:00 a.m. to 8:00 p.m. (EST).

HOTLINE: (800) 862-2086

Fax: (360) 586-8303, or access our homepage at www.oit.doe.gov/clearinghouse.

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PROCESS HEATING

A Special Supplement to *Energy Matters*

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Process Heating Roadmap to Help U.S. Industries Be Competitive

Process heating is vital to improving industrial productivity, energy efficiency, and global competitiveness. Competitive pressures demand use of process heating technologies with improved performance, lower environmental impact, and greater flexibility. However, few companies have the resources to do the necessary research and development (R&D) to meet these goals. In response to industry's need, the process heating community, led by the Industrial Heating Equipment Association (IHEA) and DOE's Office of Industrial Technologies (OIT), has begun to develop a comprehensive plan for meeting industrial process heating needs. This plan is entitled "Roadmap for Process Heating Technology" and is intended as an industry guide on how to best implement process heating technology.

In November of 1999, thirty-five experts representing equipment manufacturers, end users, energy suppliers, and researchers met to address the issues facing industrial process heating. First, the participants defined key performance parameters and specific targets that are necessary to maintain their competitive position. Second, a list of barriers was identified, and third, specific goals were developed to address the barriers and achieve the set performance targets.

The highly diverse nature of industrial heating applications presented a significant challenge to the participants. In the end, the group agreed on the goals needed to ensure the competitiveness of U.S. industries in process heating over the next two decades.

The top priority R&D goals were:

- Advanced sensors that measure multiple emissions.
- Improved performance of high-temperature materials, including alloy composites.
- Predictive models of the process heating system.
- Improved methods for stabilizing low-emission flames.
- Heating technologies that simultaneously reduce emissions, increase efficiency, and increase heat transfer.
- Low-cost, low- and high-temperature heat recovery.

The top non-R&D goals were:

- Establish R&D and nonresearch priorities based on end-user input.
- Promote rational and consistent policies.
- Develop voluntary conventions and practices for equipment manufacturers.
- Develop incentives for purchase capital equipment utilizing new technologies.
- Expand the number of process heating applications using advanced technology.

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Process Heating Roadmap
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- Foster the use of advanced enabling technologies in new process equipment.
- Develop the workforce by providing technical education starting at the elementary school level up through the post secondary level.
- Educate end users about information sources and equipment suppliers.
- Educate the public about industry and environmental issues via public relations activities and the media.

In October of 2000, a process heating steering committee was formed that consists of representatives from major industries and equipment suppliers. The committee created a plan that will help U.S. industries implement and demonstrate the best practices in process heating and to meet the near-term non-R&D goals. These activities will be carried out under OIT's BestPractices program. The R&D goals will be met through appropriate industries' R&D plans.

According to Dr. Arvind Thekdi of CSGI, Inc., who is also secretary of the process heating steering committee, "This cooperative effort will help U.S. industry remain competitive in the face of increasing pressure from the global marketplace."

Watch for process heating information in future issues of Energy Matters and learn about OIT's BestPractices activities in process heating. Because process heating savings can be reaped in locations throughout most industrial plants, it's likely that this information could improve your plant's bottom line. Look through this supplement for new ideas on process heating. ●

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;

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.

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.

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Seven Ways to Optimize Your Process Heat System

By Arvind Thekdi, Executive Vice President, CSGI, Inc., Rockville, MD

For most industries, process heating accounts for a high percentage of energy use, which means most plants can benefit from efforts to optimize their process heating systems. As natural gas prices continue to escalate, efficiency measures provide a means to save energy and curb energy costs. Beyond improving the bottom line, efficient process heating systems go a long way toward reducing emissions, such as nitrogen oxide (NO_x) and carbon dioxide (CO_2).

When it comes to optimizing heat process systems, an industrial facility has plenty of incentive to take action. So the question might not be "Should we make improvements?" but "Which improvements should we make?" One answer is to begin with the tried and true—the activities that have been done before with excellent energy-saving and pollution-reducing results. Consider those that can be easily accomplished using existing hardware and components and yield the best paybacks.

Efficiency measures such as these do exist. The table below is a guide to some process heating activities industrial companies can begin to implement in the near term. By addressing these changes to key process heating components today, your plant could be on its way to better system performance, and the plant-wide benefits will be apparent in the not-too-distant future. ●

Process Heating: Best Bets for System Savings and Improvements

Process Heating Component	Energy Saving Method	Energy Savings Potential (% of current use)	Typical Implementation Period	Typical Payback	Example Activities
1. Heat Generation	Efficient combustion (burners) and operation of other heat generating equipment	5%–25%	1 week to 2 months	1 to 6 months	Maintain minimum required free oxygen (typically 1%–3%) in combustion products from burners for fuel-fired process heating equipment. Control air-fuel ration to eliminate formation of excess carbon monoxide (CO), typically more than 30–50 ppm, or unburned hydrocarbons. Eliminate or minimize air leakage into the direct-fired furnaces or ovens.
2. Heat Transfer	Design, operation, and maintenance of furnaces and heating systems to increase heat transfer from heat source to process or load	5%–15%	3 months to 1 year	6 months to 1 year	Select burners and design furnaces that allow use of high convection or radiation in processes and loads. Clean heat transfer surfaces frequently in indirectly heated systems, such as stream coils, radiant tubes, and electrical elements. Replace indirectly heated systems, such as radiant tubes, and enclosed electrical heating elements, where possible.
3. Heat Containment	Reduction of heat losses	2%–15%	4 weeks to 3 months	3 months to 1 year	Use adequate and optimum insulation for the equipment. Conduct regular repair and maintenance of insulation.
4. Heat Recovery	Flue gas heat recovery	10%–25%	3 to 6 months	6 months to 2 years	Preheat combustion air. Preheat and/or dry the charge load. Cascade heat from exhaust gases to the lower temperature process heating equipment.
5. Sensors and Controls	Improved process measurements, controls, and process management	5%–10%	1 to 10 weeks	1 to 6 months	Develop procedures for regular operation, calibration, and maintenance of process sensors (i.e. pressure, temperature, and flow) and controllers.
6. Process Models and Tools	Process models and design simulation to optimize equipment design and operations	5%–10%	2 weeks to 6 months	1 month to 2 years	Set appropriate operating temperatures for part load operations to avoid long "soak" or overheating.
7. Advanced Materials	Reduction of nonproductive loads	10%–25%	2 weeks to 3 months	3 months to 2 years	Use improved materials, design, and applications of load support (fixtures, trays, baskets, etc.) and other material systems.

Indirect-Fired Kiln Conserves Scrap Aluminum and Cuts Costs

One successful example of a waste heat recovery application is at Wabash Alloys (formerly Roth Bros.), an aluminum recycler and provider of aluminum alloy in East Syracuse, New York. A demonstration project conducted at this plant by Energy Research Company (ERCo), of Staten Island, New York, involves a new energy-efficient kiln that heats scrap aluminum for reuse. This kiln has enabled Wabash to reduce metal loss and emissions of volatile organic compounds (VOCs) and, in addition, has reduced kiln energy use by more than half.

Aluminum scrap can be reused if it is decoated of oils and solid organics, such as rubber and plastics. ERCo's process uses an indirect-fired controlled atmosphere (IDEX™) kiln, which is better than traditional kilns at processing unwanted substances and reducing VOC emissions, product loss, and energy requirements. Thus, operational costs are also reduced. Figure 1 shows the IDEX kiln installed at Wabash Alloys.

In the kiln, gases heated to 1500°F enter a center tube (Figure 2) and flow parallel to the scrap aluminum in a rotary drum while the center tube indirectly heats the scrap. The heat from the gases vaporizes the organics, but because the oxygen concentration is kept below the organics' flammability limits, no combustion occurs.

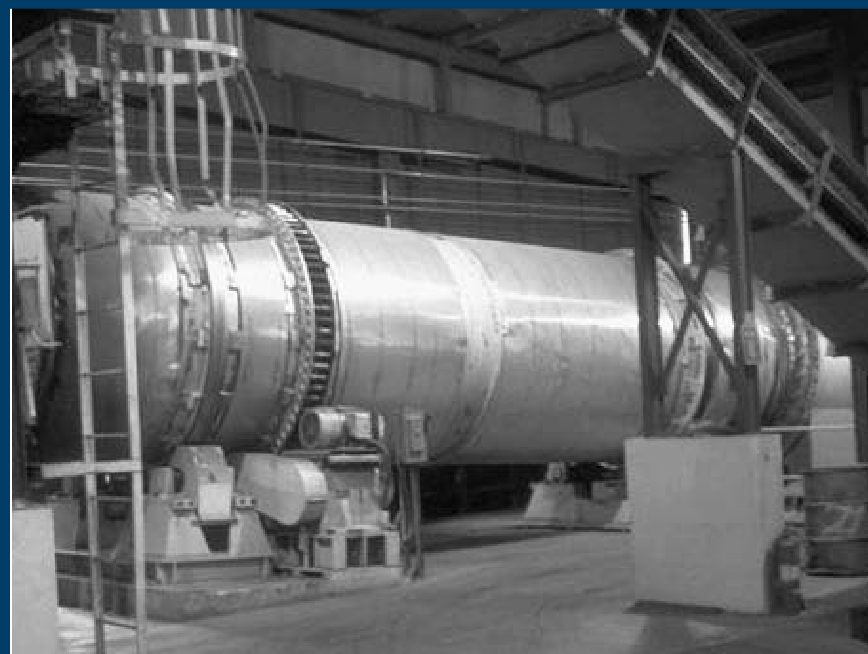

Figure 1. IDEX kiln at Wabash Alloys.

The gases are then passed to an incinerator that elevates their temperature to 1500°F. The organic vapors combust, which releases heat and destroys the VOCs. Part of the gases are vented and part are recirculated back to the kiln via a fan. The hot recirculated gases perpetuate the kiln heating and vaporization process.

Upon exiting the IDEX, the cleaned aluminum scrap is fed into a furnace where it is melted to produce specification ingots for die casters.

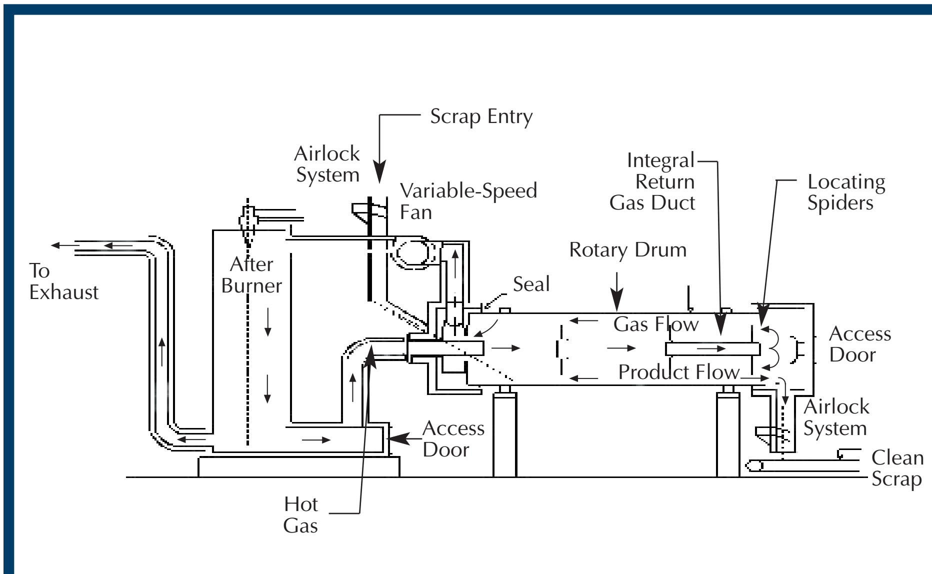

Figure 2. Schematic of IDEX kiln.

Energy Savings

Figure 3 shows the measured specific energy use of the IDEX at Wabash Alloys, which is an energy savings of 55% over conventional equipment. Furthermore, the scrap is at 628°F after being processed by the IDEX; if this hot scrap is fed into the furnace, an additional energy savings of 370 Btu per pound of mass (Btu/lbm) is possible, for a total savings of 820 Btu/lbm.[1]

If air leaks are eliminated and preheated scrap is utilized, this technology could save 3 trillion Btu per year in the secondary aluminum market alone.

Loss Reduction

Furnace measurements were also taken. With the IDEX making up only 20% of the furnace feedstock, metal loss was reduced from 8.2% to 7.5% on one set of furnace data runs. Using this data, it is estimated

[1] Due to scheduling problems, Wabash Alloys does not feed the scrap immediately into the furnace, and so does not take advantage of the preheating.

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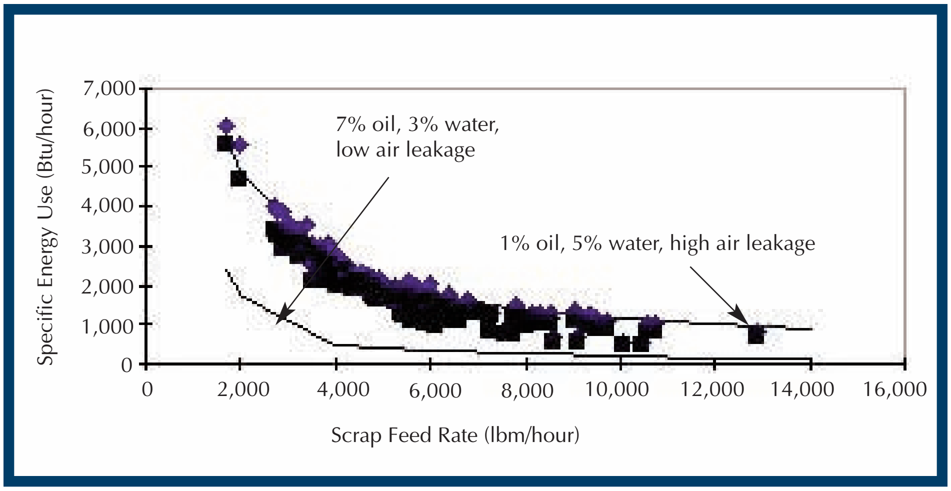

Figure 3. IDEX specific energy use.

that loss could be reduced by 2.8% for a metal yield gain of 2.35 million pounds per year per unit.

In Figure 4, scrap metal that has been processed using a conventional dryer is being charged into the furnace. Flames are clearly visible, indicating the presence of organics that are burning and oxidizing the metal. In Figure 5, the scrap charge has been processed in the IDEX. The only flames visible are those left over from the previous charge.

Neal Schwartz, who was general manager of Roth Bros. at the time of the installation, said, “The quality of the scrap that comes out of the IDEX is much much better…[when] we were using the older technology, scrap would burn and smoke... now we get a better product and there is no smoke at all, and we are really very happy with it.”

Emissions Reduction

Emission measurements were taken from the IDEX by Galston Measurement of Syracuse, New York. Nitrogen oxide (NO_X), sulfur dioxide (SO_2), VOCs, and particulates were measured to be at 19%, 2%, 2%, and 6%, respectively, compared to New York State’s Department of Environmental Conservation standards.

The EPA has proposed emissions regulations for scrap dryers.[2] The IDEX meets and betters these EPA-proposed standards in all measured categories.

Project Participants

This project was funded by DOE’s National Industrial Competitiveness through Energy, Economics, and Environment (NICE^3) program and the New York State Energy Research and Development Authority. Other participants in the project included O'Brien & Gere, of Syracuse, who built and installed the equipment, and two technology marketers—Gillespie & Powers of St. Louis, Missouri, and Stein Atkinson Stordy, of Wolverhampton, United Kingdom.

By saving energy, reducing emissions, improving product quality, reducing solid waste, and decreasing operating cost, the IDEX kiln clearly has a bright future in the aluminum industry.

For more information on this project, contact Bob DeSaro at (718) 442-2725 or rdesaro@er-co.com. ●

[2]EPA CFR Part 63 [IL-64-5807;FRL].

To read a similar article about a heat recovery application involving high-temperature annealing in the steel industry, see the Energy Matters Extra Web site at www.oit.doe.gov/bestpractices/explore_library/emextra/.

Figure 4. Conventionally processed scrap being fed to the charging well.

Figure 5. Scrap that has been processed by the IDEX kiln sitting in charging well.

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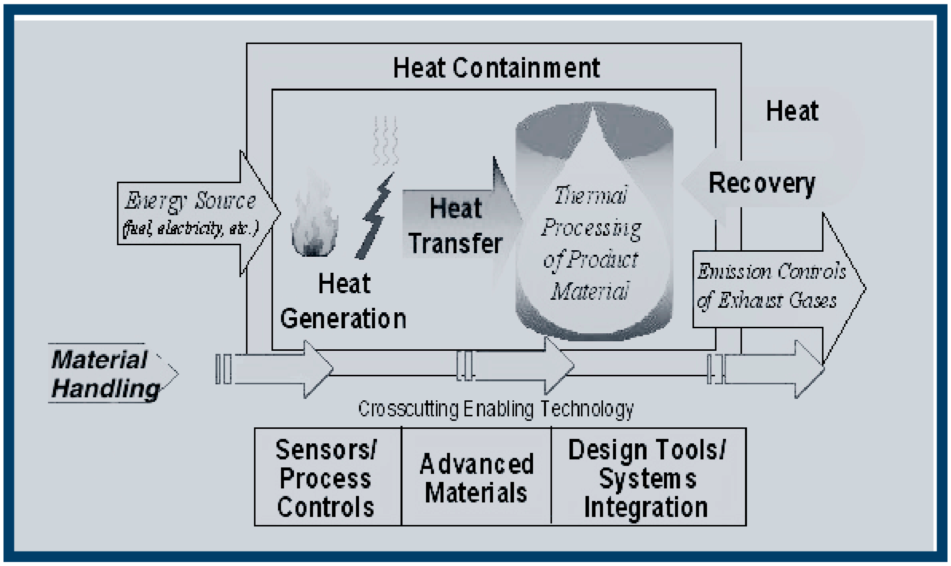

Figure 2. The components of process heating systems.

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 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_X), 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 reduce 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.** ●

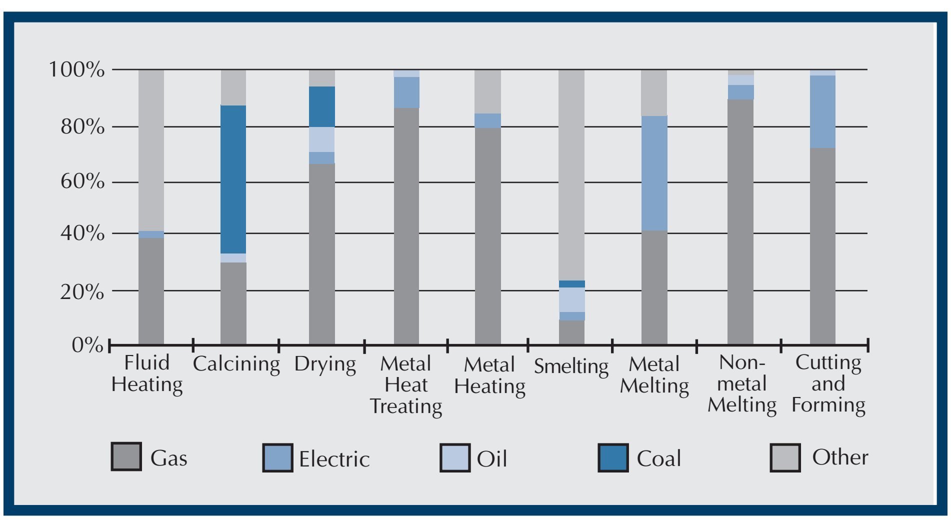

Figure 3. Energy sources for common industrial processes that require process heating.