



# Energy Conservation in Heat Treating

**H**eat treating consumes a lot of energy. When we look around our heat treat shops, we are likely to find areas where energy conservation can save us time, money, and improve overall productivity. With rising fuel costs and the competitive nature of the industry today, we can no longer afford to ignore potential energy savings. Let's learn more.

## Gathering energy information

An essential component of any successful energy management program is a comprehensive detailing of energy use and its cost. Company energy bills should be treated as though the money was coming out of our own pocket. This requires keeping up-to-date records of monthly energy consumption and all related costs. Recording the information on a spreadsheet or similar record allows easy comparison and analysis. Data for each type of energy (gas, electricity, water, oil, etc.) shown as a separate record should be distributed to all functional departments. Also, a single energy unit, such as MMBtu, should be used to express the heating value of the various fuel sources to allow a meaningful comparison of fuel types and conservation.

## Conducting an energy audit

An energy audit requires performing both efficiency tests and energy balances. Traditional focus areas with large potential for energy saving are heat treating equipment design and construction, burner combustion efficiency, power distribution of electrical systems and electric motors (power factor). Nontraditional areas that offer good potential for energy saving include cooling towers and pumping systems, oil

skimmers, fans and ventilation systems, compressed gas storage and transmission, and steam systems.

## Resources available

Many small and medium size heat treat shops often do not have the time or lack the tools to look into energy conservation issues. Production issues and time constraints associated with energy-audit activities often limit their ability to implement energy conservation ideas. Thus, the DOE's Office of Industrial Technology established several programs and developed software packages to assist in this effort.

One of these tools is the DOE-funded Industrial Assessment Center program ([www.oit.doe.gov/iac](http://www.oit.doe.gov/iac)) that enables eligible small and medium-sized manufacturers to have comprehensive industrial assessments performed at no cost. Teams of engineering faculty and students from these Centers, located at 26 universities around the country, conduct focused or generalized energy audits and help manufacturers identify opportunities to improve productivity, reduce waste, and save energy. The IAC team conducts an on-site visit, performs an assessment and sends a report detailing the analysis, its findings and recommendations to the client within 60 days, and schedules follow-ups.

Company eligibility for IAC assessment is based on meeting these criteria:

- A Standard Industrial Code (SIC) of 20-39
- Less than \$100M gross annual sales
- Less than 500 employees at the plant site
- Annual energy cost between \$100-2,000K
- No professional in-house staff to perform the assessment

Assessments are provided at no direct cost to participating companies, and the plant incurs no obligation to act on any recommendation. In addition, client proprietary information is protected. DOE statistics show the average (potential) cost savings for an IAC audited company is \$55,000 per year. The average payback time for the cost of recommended renovations or payback on new equipment is 18 months.

For example the IAC at University of Michigan has performed 252 assessments in Michigan and northern Ohio, including 13 specific to heat treating. The most common areas in the heat-treating industry where energy savings are possible according to UM IAC assistant director David Everest are:

## Gas-fired furnaces

- Recovery of hot exhaust gases through recuperators (Fig. 1)
- Proper adjustment of the air-to-fuel ratio and control of specialty gases to the furnace (more easily accomplished than heat recovery)
- Installation of variable frequency drives and controls on motors (especially combustion blowers)



Fig 1 Modern combustion system with recuperation (Eclipse Inc. ThermThief TFB burners and Bayonet-Ultra Recuperators) installed on a continuous furnace [3]



- Control of important parameters including air and gas flow rates; furnace temperature, operating hours and mode (continuous vs. intermittent); exhaust gas composition and temperature blower sizes; and measured current (amperage) draw

### Electrically heated furnaces

- Control of furnace operating hours can dramatically reduce demand charges (these charges often can be reduced by changing the energy provider)
- Install energy monitoring/control equipment (Fig. 2) based on time-of-day metering (if automated control system is unaffordable, stagger equipment startups to minimize energy use)
- Control important parameters including furnace operating schedule and mode (continuous vs. intermittent)

### All furnaces

- Upgrade furnace thermal insulation and cover heat tanks where possible
- Heat treat parts only to required specifications or standards
- Reduce fixturing and other nonessential material in the heat treatment process
- Calibrate furnace instrumentation
- Control important parameters including wall temperatures and furnace operating schedule and mode (continuous vs. intermittent)



**Fig 2** Plant-wide energy monitoring device [4]. The number on the left is the KW that the shop is currently running at. The number on the right is the peak already attained for the month. As you approach the peak, alarms are sounded. Ramping rates can immediately be cut back (or put on hold if possible) and auxiliary items (blowers, etc.) can be turned off. Cost of the monitor is about \$3,000, and has a typical payback of 1 to 6 months.

Another tool is the Process Heating Assessment and Survey Tool (PHAST), available from DOE ([www.oit.doe.gov/bestpractices/software/phast\\_cert.shtml](http://www.oit.doe.gov/bestpractices/software/phast_cert.shtml)), which focuses on all process heating applications with the aim of improving thermal efficiency of heating equipment. The tool helps survey process heating equipment that uses fuel, steam or electricity, and identifies the most energy-intensive equipment. You can also perform an energy (heat) balance on selected equipment to identify and reduce nonproductive energy use, as well as compare performance of the equipment under various operating conditions and test “what-if” scenarios.

Energy Solutions Center ([www.energy.solutionscenter.org/heatreat/index.htm](http://www.energy.solutionscenter.org/heatreat/index.htm)) is developing a more heat-treat specific tool called Furnace Energy Analysis Tool (FEAT) that allows the heat treater to compare energy components of heat treat processes (consumption, cost, labor, depreciation) on a per hour, per pound or per year basis for batch and continuous furnaces, and to quantify upgrades and improvements (from simply tuning a burner to updating to the latest recuperative burner designs).

### Where to look

Today, the cost of operating energy consuming equipment is under intense scrutiny. Although individual devices can reduce energy, a systematic approach is best if cost savings are to be sustained. A number of obvious and not so obvious areas to find savings in heat treat allow us to quickly ascertain where we should expend our limited resources. These include:

- Scheduling workload and production runs so equipment is full, and being run when energy costs are most attractive
- Monitoring energy use and idling practices
- Adjusting combustion systems and electrical power devices (saturable core reactors, silicon controlled rectifiers, variable reactant transformers)
- Reviewing cycle information and process parameters

**Table 1** Energy equivalents

Energy unit	Energy equivalent (Btu)
1 Kilowatt-hour (1 kWh)	3,412
1 cubic foot natural gas	1,000-1,050(a)
1 Therm	100,000
1 gallon propane	92,000(a)
1 gallon fuel oil (No. 2, diesel)	140,000(a)
1 gallon fuel oil (No. 6, bunker C)	150,000(a)
1 gallon gasoline	130,000(a)
1 horsepower, or hp (electric)	2,515
1 horsepower (boiler)	33,500

(a)Varies with source

- Surveying furnace operation (heating and cooling rates, temperature and atmosphere uniformity)
- Inspecting temperature systems (controls, temperature sensing devices, etc.)
- Measuring furnace efficiency (e.g. shell temperature measurements to determine insulation efficiency)
- Negotiating long term contracts to reduce rates
- Analyzing electrical system efficiency

### Where do we go from here?

Energy management is for everyone. Begin today by identifying areas of high energy consumption, understanding your energy costs and performing an energy audit. Our industry needs to take the lead in energy conservation to offer the most price-competitive technology to the marketplace. **IH**

### References

1. R. Kratowicz, Energy Conservation and Thermal Processing, *Plant Services Magazine*, Jan. 2001
2. D.A. Everest, Industrial Assessment Center (IAC), U. of Mich., (tel: 734-763-7471; [deverest@umich.edu](mailto:deverest@umich.edu))
3. C. Allen, Eclipse Inc., Rockford, Ill. (tel: 800-676-3254; [www.eclipse.com](http://www.eclipse.com)); R. Hill, Solar Atmospheres, Hermitage, Pa. (tel: 866-982-0660; [www.solaratm.com](http://www.solaratm.com)); D. Welling, Dominion East Ohio, Cleveland, Ohio; tel: 216-736-5392
4. D.H. Herring, Energy Saving Tips, *HOT TOPICS in Heat Treatment and Metallurgy*, Vol. 1, No. 2, Dec. 2003