"TURNING INFORMATION INTO ENERGY SOLUTIONS FOR INDUSTRY"

Energy Matters

INDUSTRIAL TECHNOLOGIES PROGRAM

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ISSUE FOCUS:
Reducing Waste Heat

IN THIS ISSUE

Reducing waste heat losses can lower the energy component of product costs. See opposite.

U.S. Department of Energy
Energy Efficiency and Renewable Energy
Bringing you a prosperous future where energy is clean, abundant, reliable, and affordable

Identifying Opportunities for Waste Heat Reduction

By Arvind Thekdi – E3M, Inc. and Energy Matters Editorial Advisory Board member, and Richard Bennett – Janus Technology Group

Waste gas heat losses are an unavoidable part of operating any fuel-fired furnace, kiln, boiler, oven, or dryer. Air and fuel are mixed and burned to generate heat, and a portion of the heat is transferred to the heating device and its load. When the energy or heat transfer reaches its practical limit, the spent combustion gases are removed from the furnace via a flue or stack to make room for a fresh charge of hotter combustion gases.

The flue gases still hold considerable thermal energy, often more than what was left behind in the process. In most fuel-fired heating systems, this waste heat is the biggest single loss in the process, often greater than all the other losses combined. These losses depend on factors associated with the design and operation of the heating equipment.

This article is a guide to reducing waste heat losses associated with heating equipment as they affect associated exhaust gas losses. A second article, to be published in the online Fall 2005 issue of *Energy Matters*, will address waste heat recovery techniques.

This article also supports material related to the Process Heating Assessment and Survey Tool (PHAST), developed jointly by Industrial Heating Equipment Association (IHEA), and Office of Energy Efficiency and Renewable Energy (EERE) Industrial Technologies Program. For more information on process heating, visit the ITP Web site at www.oit.doe.gov/bestpractices/process_heat/.

Heat Losses

Thermal efficiency of process heating equipment such as furnaces, ovens, melters, heaters, and kilns is defined as the ratio of heat delivered to the material being heated to the heat supplied to the heating equipment.

The first step in reducing waste heat in flue gases requires close attention and proper measures to reduce all other heat losses associated with the furnace. Any reduction in furnace heat losses will be multiplied by the overall available heat factor, which could result in much higher energy savings. Available heat is defined as the ratio of heat retained in the furnace to heat lost in flue gases. Note that the heat retained in the furnace is used for heating the load and to compensate for furnace heat losses. Furnace losses include:

- Heat storage in the furnace structure
- Losses from the furnace outside walls or structure
- Heat transported out of the furnace by the load conveyors, fixtures, trays, and so on
- Radiation losses from openings, hot exposed parts, and so on
- Heat carried away by the cold air infiltration into the furnace
- Heat carried away by the excess air used in the burners.

All of these losses can be estimated by using the Process Heating Assessment and Survey Tool (PHAST) or the Process Heating Tip Sheets available through ITP at www.oit.doe.gov/bestpractices under the BestPractices Process Heating section.

Reducing waste heat losses brings additional benefits, including:

- Lowering the energy component of product costs
- Improving furnace productivity
- Lowering emissions of carbon monoxide (CO), nitrogen oxides (NOx) and unburned hydrocarbons (UHCs).
- Reductions may also contribute to more consistent product quality and better equipment reliability.

Determining Waste Gas Losses

To properly determine waste gas losses, it is first necessary to understand the flow of heat in a furnace or oven. The objective of a heating process is to put a certain amount of thermal energy into the product, raising it to a certain temperature to prepare it for additional processing, to change its properties, or for some other purpose. To carry this out, the product is heated in a furnace or oven.

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Identifying Opportunities for Waste Heat Reduction *(continued from page1)*

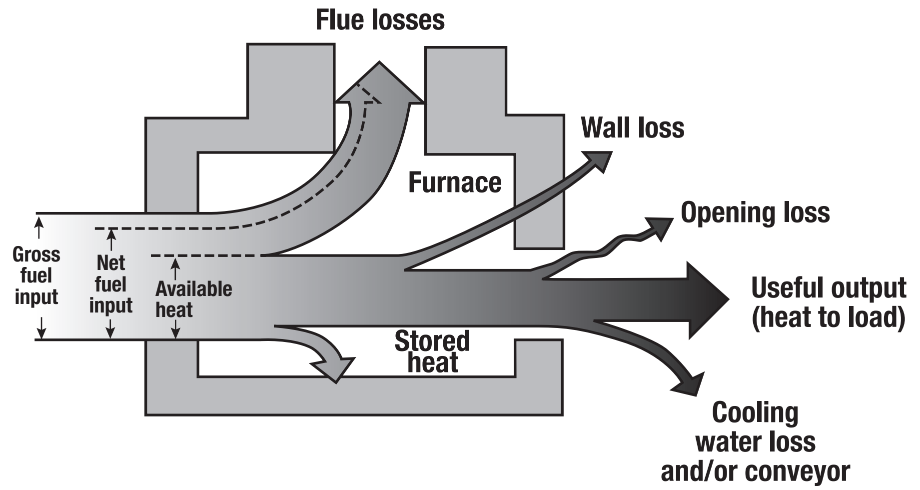

Figure 1. Heat Losses in Industrial Heating Processes

This entails some energy losses as shown in Figure 1. First, the metal structure and insulation of the furnace must be heated so their interior surfaces are about the same temperature as the product they contain. This stored heat is held in the structure until the furnace is shut down. Then it will leak out into the surrounding area. The more the furnace is cycled from cold to hot and back again, the more times this stored heat will have to be replaced. In addition, because the furnace can't run production until it has reached the proper operating temperature, the process of storing heat in it entails lost production time—fuel is being consumed with no useful output. Additional heat losses occur while the furnace is in production.

Wall, or transmission, losses occur through the conduction of heat through the walls, roof, and floor of the heating device. Once the heat reaches the outer skin of the furnace and radiates to the surrounding area or is carried away by air currents, it must be replaced by an equal amount taken from the combustion gases. This process continues as long as the furnace is at an elevated temperature.

Anywhere or anytime an opening exists in the furnace enclosure, heat is being lost, often at a rapid rate. These openings include the furnace flues and stacks as well as doors left partly open to accommodate oversize work.

Many furnaces have material handling equipment to convey work into and out of the heating chamber. These pieces of equipment can lead to heat losses, too. Conveyor belts or product hangers that enter the heating chamber cold and leave it at higher temperatures drain energy from the combustion gases. In car bottom furnaces, the hot car structure gives off heat each time it's rolled out of the furnace and into the room to load or remove work. This lost energy must be replaced when the car is returned to the furnace.

Water-cooling protects rolls, bearings, and doors in hot furnace environments, but at the cost of lost energy. These cooling media components and their cooling water become the conduit for additional heat losses. Maintaining an adequate flow of cooling media is essential, but it may be possible to insulate the furnace and load from some of these losses.

Furnaces and ovens operating at temperatures above 1,000° Fahrenheit (F) may have significant radiation losses. Hot surfaces radiate energy to colder surfaces in their line of sight, and the rate of heat transfer increases with the fourth power of the surface's absolute temperature. Anyone who has ever stood in front of the open door of a high-temperature furnace can vouch for the amount of thermal energy radiated into the room.

All these losses—heat storage, wall transmission, conveyor, and radiation—compete with the workload for energy released by the burning fuel-air mixture. Unfortunately, they may be dwarfed by the biggest loss of all – waste gas loss.

Stack Loss

Waste gas loss, also known as flue gas or stack loss, is made up of the heat that can't be removed from the combustion gases inside the furnace. There's a reason for this—heat, like water, flows downhill, and once there is no temperature difference between the heat source and the load, all heat transfer stops.

In effect, the heat stream has hit bottom. If, for example, a furnace is heating products to 1,500°F, the combustion gases cannot be cooled below this temperature. Once they reach the same temperature as the furnace and load, they can't give up any more energy to them, and so must be discarded. At this temperature, they still contain about half the thermal energy put into them, so the waste gas loss is close to 50% (Figure 2). The other half, which stayed in the furnace, is called available heat. Once heat storage and wall, conveyor, cooling media, and radiation losses take what they need, the load absorbs anything remaining.

From this, it's clear that a process's temperature (or, more correctly, the temperature of its exhaust gases) is a major factor in energy efficiency. The higher the temperature, the lower the efficiency.

Another factor with a powerful effect is the burner system's fuel-air ratio. For every fuel, a chemically correct, or stoichiometric, amount of air is required to burn it. One cubic foot of natural gas, for example, requires about approximately 10 cubic feet of combustion air. Stoichiometric, or on-ratio, combustion will produce the highest flame temperatures and thermal efficiencies.

Combustion systems can be operated at other ratios, however. Sometimes this is done deliberately to obtain certain operating benefits. Often it happens simply because the burner system is out of adjustment. The ratio can either become rich (excessive fuel or insufficient air) or lean (excessive air). Either way, the result is wasted fuel. Because there's not enough air for complete combustion, operating in a rich manner wastes fuel by allowing it to be discarded with some of its energy unused. It also generates large amounts of CO and UHCs.

At first glance, operating lean might seem to be a better idea because all the fuel is consumed. Indeed, lean operation doesn't produce the flammable, toxic by-products of rich combustion, but it does waste energy. That's because excess air has two effects on the combustion process.

First, it lowers the flame temperature by diluting the combustion gases, in much the same way cold water added to hot will produce warm water. This lowers the temperature differential between the hot combustion gases and the furnace, and load they're heating. This makes heat transfer less efficient. More damaging, however, is the increased volume of gases that need to be exhausted from the process – the products of stoichiometric combustion, plus the excess air that all are at the same temperature. The excess air becomes one more competitor for energy released in the process. Because it's part of the combustion process, excess air goes to the head of the line, taking its share of heat before the furnace and its contents get theirs.

The results can be dramatic—in a process operating at 2,000°F, available heat at stoichiometric ratio is about 45% (55% goes out the stack). Allowing 20% excess air into the process (roughly a 12-to-1 ratio for natural gas) will knock the available heat down to 38%. Now, 62% of the total heat input goes out the stack, the difference carried away by a relatively small amount of excess air. To maintain the same temperatures and production rates in the furnace, 16% more fuel will have to be burned.

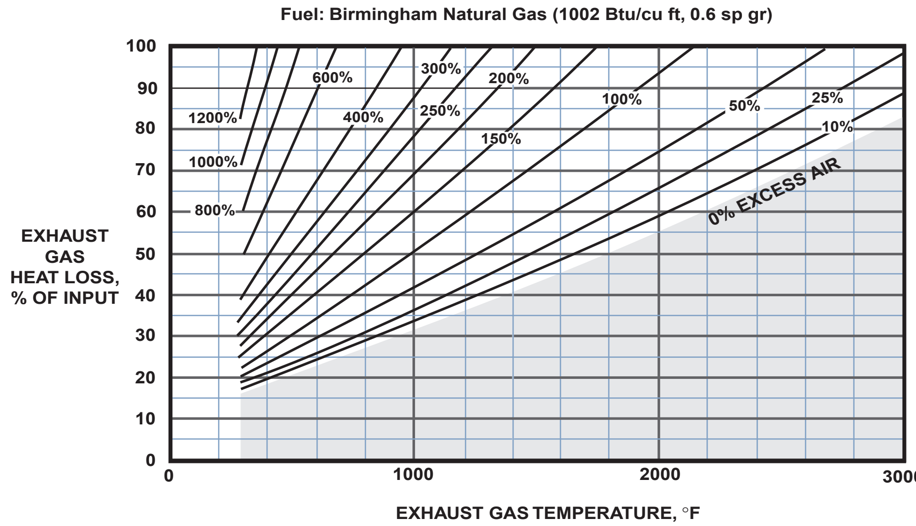

Figure 2. Exhaust Gas Heat Losses vs. Exhaust Gas Temperature and Air-gas Ratio

Air Infiltration

Excess air doesn't necessarily have to enter the furnace as part of the combustion air supply—it can also infiltrate from the surrounding room if there's a negative pressure in the furnace, as shown in Figure 3. Because of the draft effect of hot furnace stacks, negative pressures are fairly common, and cold air will slip past leaky door seals and other openings in the furnace.

Once this air gets in the furnace, precious heat from the combustion system is absorbed and carried out of the stack, lowering the furnace efficiency. A furnace pressure control system may be an effective way to deal with this. The bottom line is that to get the best possible energy efficiency from furnaces and ovens, reduce the amount of energy carried out by the exhaust and lost to heat storage, wall conduction, conveying and cooling systems, and radiation.

Furnace Scheduling and Loading

A commonly overlooked factor in energy efficiency is furnace scheduling and loading.

"Loading" refers to the amount of material processed through the furnace or oven in a given period of time. It can have significant effect on the furnace's energy consumption when measured as energy used per unit of production (British thermal units per pound—Btu/lb—for example). Certain furnace losses (wall, storage, conveyor, and radiation) are essentially constant regardless of production volume, so at reduced throughputs, each unit of production must carry a higher burden of these fixed losses. Flue gas losses, on the other hand, are variable and tend to increase gradually with production volume. If the furnace is pushed past its design rating,

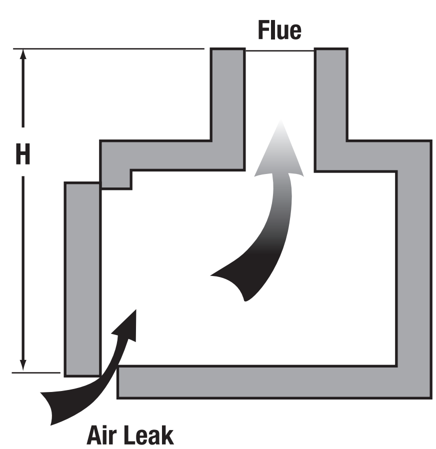

Figure 3. Air Infiltration from Furnace Opening

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flue gas losses begin to increase more rapidly. This is because the furnace has to be operated at a higher-than-normal temperature to keep up with production.

Total energy consumption per unit of production will follow the curve in Figure 4—lowest at 100% of furnace capacity and progressively higher as throughputs increasingly deviate from 100%. Furnace efficiency varies inversely with the total energy consumption. The lesson here is that furnace operating schedules and load sizes should be chosen to keep the furnace operating as near to 100% capacity as much as possible. Idle and partially loaded furnaces are less efficient.

Improving Energy Efficiency

The exhaust gas heat losses can be calculated by the equation:

Furnace exhaust heat losses = W * Cp * (T exhaust – T ambient)
Where
W = Mass of the exhaust gases
Cp = Specific heat of the exhaust gases
T exhaust = Flue gas temperature entering the furnace exhaust system (stack)
T ambient = Ambient temperature (usually assumed 60˚F)

The highest priority is to minimize exhaust gas temperature and mass or volume of exhaust gases.

- The furnace exhaust gas temperature depends on many factors associated with the furnace operation and heat losses discussed above. It can be measured directly or can be assumed to be at 100˚F to 200˚F above the control temperature from the furnace zone where the flue gases are exhausted.
- The exhaust mass flow depends on the combustion airflow, fuel flow and the air leakage into the furnace. Measurement of fuel flow together with the oxygen (or carbon dioxide [CO2]) percentage in the flue gases can be used to estimate mass or volume of exhaust gases.
- The flue gas specific heat (Cp) for most gaseous fuel-fired furnaces can be assumed to be 0.25 Btu/(lb per ˚F) or 0.02 Btu/(standard cubic foot per ˚F) for a reasonably accurate estimate of flue gas heat losses.

Excessive exhaust gas temperatures can be the result of poor heat transfer in the furnace. If the combustion gases are unable to transfer the maximum possible heat to the furnace and its contents, they will leave the furnace at higher temperatures than necessary.

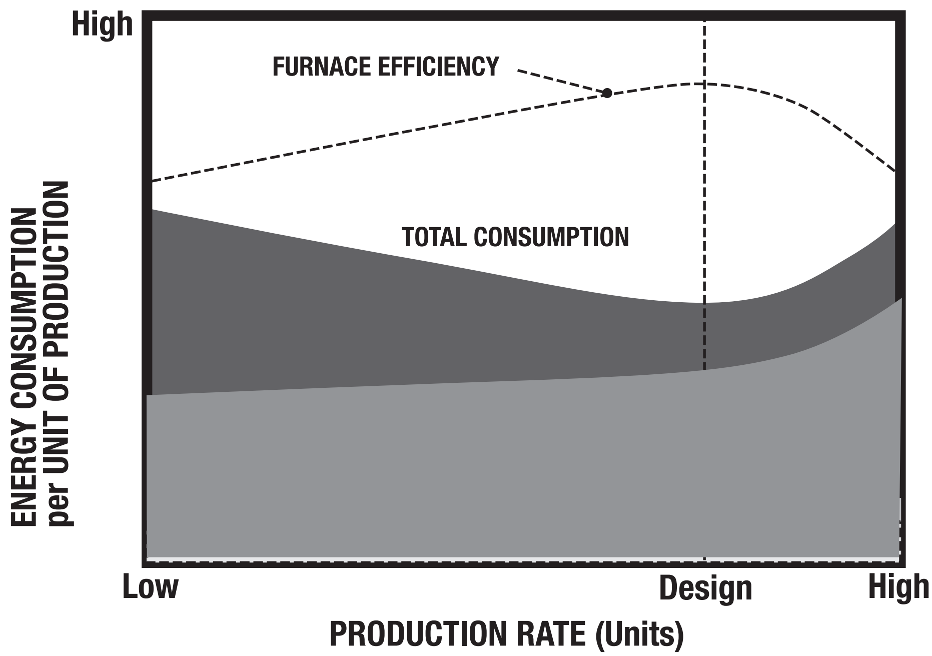

Figure 4. Impact of Production Rate on Energy Consumption per Unit of Production

Optimizing heat transfer within the furnace requires different methods for different situations.

Overloading a furnace can also lead to excessive stack temperatures. To get the proper rate of heat transfer, combustion gases must spend a certain amount of time in the heating chamber. The natural tendency of an overloaded furnace is to run colder than it should—unless the temperature is set artificially high. This causes the burners to operate at higher-than-normal rates, with an accompanying increase in combustion gas volumes. The higher the gas flow rates, the shorter their residence times in the furnace, and the poorer the heat transfer.

Avoiding overloading while at the same time optimizing heat transfer are two ways to lower waste gas flows, but there are others. The most potent one is exercising close control of fuel-air ratios. By operating the furnace close to the optimum ratio for the process, fuel consumption is closely controlled. The best part of this is that it can usually be done with the existing control equipment—all that's required is a little maintenance attention.

Reducing exhaust losses should always be the first step in a well-planned energy conservation program. Once that goal has been met, it's time to consider moving to the next level—waste heat recovery. The next issue of *Energy Matters – available online only* – considers this topic in detail.

Metal Forging Plant-Wide Assessment Finds Opportunities for Significant Cost Savings

Metaldyne, Inc., recently completed a plant-wide energy assessment at its forging facility in Royal Oak, Michigan. The assessment team addressed opportunities to increase energy efficiency, reduce waste and pollutants, and increase productivity by evaluating demand-side energy management, lean manufacturing techniques, best practices, the use of emerging technologies, and potential supply-side improvements.

Although the assessment focused on the plant's large energy-using systems and equipment, the assessment team also evaluated product inventory, and the potential for reducing or even eliminating defects, all of which could increase the plant's energy efficiency. If all the projects identified during the Royal Oak plant-wide study were implemented, the assessment team estimated that total annual energy savings for electricity would be more than 11 million kilowatt-hours (kWh). Total annual cost savings were estimated at $12.6 million.

Public-Private Partnership

DOE's Industrial Technologies Program (ITP) cosponsored the assessment through a competitive process. DOE promotes plant-wide energy-efficiency assessments that will lead to improvements in industrial energy efficiency, productivity, and global competitiveness, while reducing waste and environmental emissions. In this case, DOE contributed $100,000 of the total $200,000 assessment cost.

Assessment Approach

Metaldyne and its team conducted a plant-wide energy assessment at Royal Oak to address opportunities to increase energy efficiency, reduce waste and pollutants, and increase productivity. Electricity is the plant's main process-related energy source. Natural gas is used primarily for water heating and for space heating, ventilation, and air-conditioning (HVAC) systems, and has a negligible role in process heating.

The annual cost of electricity at the Royal Oak plant is about $6 million. The plant spends another $40,000 for natural gas, and $500,000 for water and sewer utilities. It operates eight Hatebur hot-forging machines, 14 cold-forging presses, a Kurimoto hot-forging press, a warm-forging press, three Wagner hot ring rolling machines, and several high-tonnage presses. High-power, high-pressure sodium lights provide the plant's primary illumination. Currently, six 150-horsepower (hp) air compressors and two 330-hp air compressors are in use.

The assessment team evaluated demand-side energy management, best practices, opportunities for implementing emerging technologies, and potential supply-side changes. The assessment concentrated on the plant's large energy-using systems and equipment. These included solid-state induction heaters for the Hatebur hot-forging machines; the warm-forging press; the hot-forging vertical press; the Wagner hot ring rollers; electric motors; material handling equipment; HVAC, and lighting.

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Performance Spotlight

Optimizing the Pumping System Saves Energy and Reduces Demand Charges at a Chemical Plant

Project Summary

Staff at Kodak's plant in Rochester, New York, significantly improved the energy efficiency of its two lake-water pumping stations in December 2003. To identify areas for efficiency improvements, Dr. Barry Erickson of Flowserve Corporation, a U.S. Department of Energy (DOE) Allied Partner, used the DOE Pumping System Assessment Tool (PSAT) to conduct a pumping system assessment at the plant. Flowserve then proposed a system-level project to increase the pumps' energy efficiency.

The project team established a baseline for the performance and energy consumption of both stations' pumps. The evaluation indicated the most energy-efficient pump combinations, as well as other non-capital-intensive energy efficiency measures, that would save energy while pumping the required volume of water. Plant personnel then implemented several energy efficiency measures that improved system performance and yielded important energy savings at the Rochester plant.

Plant/Project Background

The Rochester plant is home to Kodak's corporate headquarters; it is also the company's largest U.S. manufacturing operation, its corporate services office, and a research and development facility. Several years ago, the plant's management realized that many motor and process systems installed in the 1950s were not operating efficiently. This was occurring because the motor and process systems were being used to support newer production equipment, and the new equipment is less energy-intensive (i.e., it needs less energy to operate) than the 1950s-era production equipment.

The plant's lake-water pumping system includes two pumping stations served by 12 pumps with an aggregate horsepower (hp) of 7,450 hp. Flowserve found that many of the pumps had a low ratio of flow rate to input power, expressed as gallons per minute per kilowatt (gpm/kW). There were also some unnecessary flow restrictions, and some pumps were operating during peak hours that could operate more economically off peak. The improvement project included trimming impellers, replacing valves, and reconfiguring piping. Plant staff then selected and combined pumps that could achieve the highest gpm/kW ratio.

In addition to improving the pumping systems, Kodak is also using DOE's MotorMaster+ software tool in its recommissioning program to evaluate the performance of motors and processes throughout the Rochester plant. Since the program's inception, the plant has retrofitted more than 600 motors (with a total of 11,000 hp) with energy-efficient motors. These actions are yielding annual energy savings of more than 7 million kWh and energy cost savings of approximately $500,000 per year.

Results

Modifications made to the plant's lake-water pumping system improved its efficiency and performance, yielding significant energy savings. The improvements allow the pumps to maintain their combined flow rate even though fewer units are operating at any one time. As a result, energy consumption and maintenance needs have declined. This improved efficiency has yielded annual energy savings of 1,092,000 kWh and energy cost savings of $52,000. Because the pumps are being used more optimally and during off-peak hours, the plant has reduced annual demand charges by an additional $48,000.

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Performance Spotlight

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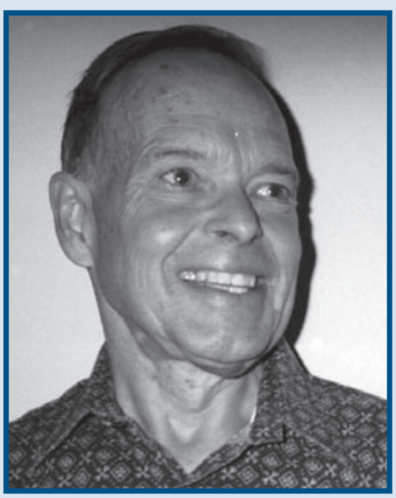
With total project costs of $25,000, the project had a 3-month simple payback.

Lessons Learned

Using aging and improperly configured industrial pumping systems can waste energy and increase maintenance and operating costs. Over time, industrial plants acquire more efficient manufacturing processes and equipment, and these can reduce the loads on supporting systems. Recognizing these evolutions and reconfiguring industrial motor systems in response to changing demand patterns can save energy and improve productivity. In the case of Kodak's Rochester plant, selecting efficient pump combinations and reconfiguring some of the pumps greatly improved the efficiency of two pumping stations. Optimizing the lake-water pumping system in this manner resulted in significant energy and cost savings; therefore, Kodak is now evaluating pumping systems at other plants for similar opportunities. Projects such as this one can be implemented in virtually all industrial facilities that require lake or river water to meet production and process cooling needs.

Project Partners:

Eastman Kodak Company, Rochester, NY
Flowserve Corporation, Kalamazoo, MI



Partner Profile

Dr. Barry Erickson is a mechanical engineer serving as a Key Account Manager for Flowserve Corporation, a DOE Allied Partner. He has more than 33 years of experience with industrial pumping systems. He has presented papers at technical conferences in the United States and Europe, written articles for numerous journals, and holds two patents. Currently, he is based at Eastman Kodak's plant in Rochester, NY.

Allied Partners

DOE's Industrial Technologies Program (ITP) offers many opportunities for partnering, such as BestPractices Allied Partnerships (www.oit.doe.gov/bestpractices/ap_whatis.shtml). Allied Partners are manufacturers, trade associations, industrial service and equipment providers, utilities, and other organizations that agree to help promote increased energy efficiency and productivity for industries that participate in ITP's Industries of the Future strategy. DOE also provides helpful tools for industry to use in achieving greater efficiency. One is the Pumping System Assessment Tool (PSAT), which uses data on pump and motor performance to calculate potential energy and cost savings.

For information, visit www.oit.doe.gov/bestpractices/software_ tools.shtml.

Applications

Lake-water pumping systems that provide process-cooling water for industrial plants can consume a significant amount of energy. Optimizing inefficient pumping systems can save energy, reduce water consumption, and minimize the need for chemical treatment of the lake water.

Benefits

- Saves $100,000 annually
- Reduces annual energy consumption by nearly 1.1 million kWh
- Improves performance
- Achieves a 3-month simple payback

(Metal Forging continued from page 5)

Product inventory and the potential for reducing or eliminating defects were also examined. Manufacturing processes were examined for potential lean manufacturing/best practices improvements. The assessment team also looked at emerging technologies that could improve manufacturing efficiency.

Results and Projects Identified

A team of energy and manufacturing process experts identified 21 assessment recommendations. The recommendations are listed in the accompanying table. More detailed discussions of certain proposed projects follow.

• Install air saver nozzles on press machine blow-off lines—Several of the presses use a continuous stream of compressed air blown through two 3/8-inch open pipes to detach parts from the dies. The assessment team recommended installing air-saver, high-thrust nozzles on the air lines to reduce compressed air usage. Air-saver nozzles entrain ambient air into the compressed air flow.

• Install radiation shields and improve insulation to reduce heat losses from induction heaters—Eight multistage induction heaters preheat the bar stock before forging. The air gaps between stages permit access for maintenance and temperature measurement, but also allow excessive heat losses. The team recommended installing an insulated, removable radiation shield to reduce heat losses through the air gaps. A quartz window could also be installed to allow the bar stock to be inspected visually.

• Install a controlled cooling system for parts whose heat-treating is currently outsourced—The assessment team recommended that the plant consider options for in-house controlled cooling of forged parts that are currently being outsourced for heat-treating. The options were (1) to use a batch-type cooling system, in which parts are put in bins and cooled under controlled temperature and time conditions immediately after being forged, and (2) to use a batch-type system to control the cooling of parts produced from the ring rolling machines, and two continuous (spiral) systems to handle single parts produced directly from the Hatebur presses. If cooling bins are used, the batch-type systems should feature high-convection recirculating air flow to ensure uniform cooling of all the parts.

• Reduce change-over time for press retooling—Current press change-over times for die replacement are longer than necessary; this results in increased machine downtime and wasted electricity because the induction

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(Metal Forging continued from page 6)

heaters remain hot while the machine is idle. The assessment team recommended a list of actions to reduce change-over time, including improving personnel training and procedures, upgrading the tool kit, and using automatic locators for dies.

• Reduce product inventory—The current average stored inventory is one month's production of finished product, which the assessment team considered to be excessive.

• Establish a "pull scheduling" system—The goal of lean manufacturing is to minimize or eliminate non-value-added steps in the process across the entire product supply, production, and customer delivery cycle. The "pull scheduling" approach ensures that upstream manufacturing activities are linked and controlled by the activities of the next downstream operation. This approach is essentially process-driven.

• Improve product quality and reduce rework—Product inventory was found to be excessive and parts were being stored longer than necessary. The assessment team recommended reducing product inventory and improving material flow through the plant. These measures would reduce storage time and associated rework on degraded material.

• Increase machine tool durability—A new technology that can increase the life of stamping tools and improve the finish of stamped parts involves applying hard coatings made of thin-film nitride or carbide-based ceramics. The assessment team recommended that Metaldyne consider using hard coatings on inserts, drills, bits, and other parts to increase the speed of machining operations as well as the life of tools. These measures would also reduce press downtime and costs associated with punch and die manufacturing.

• Increase punch and die life by applying lubricating coatings —The team recommended increasing the life of the forging tools (punches and dies) by maintaining cooler tool surfaces. This could be done by reducing the cooling water temperature and by applying a lubricating coating to the tool surface. Longer tool life would increase the productivity of the forging presses, reduce press downtime, increase throughput, and reduce overall production costs.

These recommendations and others represent more than 20 opportunities for Metaldyne to save energy and money at its Royal Oak plant.

To learn more about the plant-wide assessment program, visit the plant-wide assessment Web page at www.oit.doe.gov/bestpractices/assessments.shtml or contact the EERE Information Center at 1-877-EERE-INF (1-877-337-3463).

Metaldyne Plant-Wide Assessment Recommendations

Assessment Recommendation	Annual Electricity Savings (kWh)	Annual Cost Savings	Capital Cost
Eliminate excess lighting in warehouse areas (AR1)	115,000	$8,000	$500
Replace 400 W metal halide lamps with 360 W lamps at failure (AR2)	76,000	$5,000	$6,000
Replace standard V-belts with notched V-belts on belt-driven equipment (AR3)	32,000	$2,000	$0
Enhance motor management program by using MotorMaster+ software for repair/replace analysis (AR4)	40,000	$3,000	$14,000
Install air-saver nozzles on press machine blowoff lines (AR5)	953,000	$64,000	$400
Reconnect compressed air system supply via automation valves in primary presses to reduce compressed air use (AR6)	103,000	$7,000	$1,700
Implement maintenance program to identify and repair compressed air system leaks (AR7)	347,000	$23,000	$900
Upgrade compressed air system controls (AR8)	576,000	$39,000	$17,800
Install radiation shields and improve insulation to reduce heat losses from induction heaters (AR9)	2,678,000	$79,000	$117,000
Install a controlled cooling system for parts whose heat treating is currently outsourced (AR10)	NA	$6,598,000	$4,750,000
Provide additional baskets or use larger scale basket strainers in scale pits to improve mill scale trapping and reduce pit cleaning frequency (AR11)	NA	$99,000	$85,500
Install water meters on blowdown lines from cooling towers to document water loss from evaporation and apply for sewer charge exemption for water not sent to sewer (AR12)	NA	$116,000	$6,500
Install new groundwater supply system to reduce consumption of city water (AR13)	NA	$272,000	$180,000
Reduce change-over time for press retooling (AR14)	862,000	$43,000	$10,000
Reduce product inventory (AR15)	NA	$1,800,000*	$25,000
Establish a "pull scheduling" system (AR16)	NA	$720,000	$10,000
Improve product quality and reduce rework (AR17)	NA	$180,000	$20,000
Increase machine tool durability (AR18)	NA	$710,000	$60,000
Increase punch and die life by applying lubricating coatings (AR19)	4,478,000	$3,500,000	$1,200,000
Implement a "closed loop" procurement/disposal system to reduce cost of tool steel material (AR20)	NA	$27,000	$10,000
Employ alternative forging tool design and selection (AR21)	1,260,000	$84,000	$20,000
Totals	11,520,000	$12,579,000	$6,535,300

*One-time savings only; not included in total savings.

Coming Events

The following list contains only 6 of the 42 training opportunities that are currently scheduled and available to you and other plant personnel. For a complete listing, registration information, and updates, visit the ITP training and events Web site at www.eere.energy.gov/industry/events/.

Steam System Assessment, Bridgeport, New Jersey, September 7, 2005
For more information, contact Mike Sanders at mpsanders@sunocoinc.com or 215-339-7111

Process Heating Assessment, Shoreview, Minnesota Process Heating Assessment September 7, 2005
For more information, contact Barb Krech at barb.krech@state.mn.us or 651-284-3262

Pumping System Specialist Qualification, Dallas, Texas, September 7-8, 2005
For more information, contact Allison Kupfrian at akupfrian@pumps.org or 973-267-9700, ext. 16

Fundamentals of Compressed Air Systems (Level 1), Auburn, Maine, September 8, 2005
For more information, contact Joy Adamson at joy.adamson@main.gov or 207-287-8350

Process Heating Assessment, Madison, Wisconsin, September 8, 2005
For more information, contact Nancy Giere at ngiere@wi.rr.com or 262-376-2988

Steam System Assessment, McKeesport, Pennsylvania, September 13, 2005
For more information, contact Maggie Hall at mahall@state.pa.us or 412-442-4137

BestPractices

The Industrial Technologies Program's BestPractices initiative and its *Energy Matters* newsletter introduce industrial end users to emerging technologies and well-proven, cost-saving opportunities in motor, steam, compressed air, and other plant-wide systems.

A Strong Energy Portfolio for a Strong America

Energy efficiency and clean, renewable energy will mean a stronger economy, a cleaner environment, and greater energy independence for America. Working with a wide array of state, community, industry, and university partners, the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy invests in a diverse portfolio of energy technologies.

EERE Information Center

Do you have questions about using energy-efficient process and utility systems in your industrial facility? Call the Energy Efficiency and Renewable Energy (EERE) Information Center for answers, Monday through Friday 9:00 a.m. to 7:00 p.m. (EST).

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U.S. Department of Energy
Energy Efficiency and Renewable Energy
Bringing you a prosperous future where energy is clean, abundant, reliable, and affordable

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