August 2001

OFFICE OF INDUSTRIAL TECHNOLOGIES

ENERGY EFFICIENCY AND RENEWABLE ENERGY, U.S. DEPARTMENT OF ENERGY

Alcoa North American Extrusions Implements Energy Use Assessments at Multiple Facilities

Compressed Air System Assessment at Elizabethton Extrusion Plant

BENEFITS

- Assesses core systems commonly found in many industrial operations
- Saves time and money by sharing lessons learned across numerous facilities
- Helps companies discover multiple ways to manage energy costs across facilities

APPLICATIONS

Combining energy use assessments across a company's facilities helps energy-intensive industries reduce corporate energy consumption, improve profitability, and reduce the environmental impact of production.

Summary

In May 2001, Air Management of Powder Springs, Georgia, assessed the compressed air system at the Alcoa North American Extrusions (NAE) facility in Elizabethton, Tennessee. The result of the assessment was a proposal to optimize the compressed air system to meet current and future production requirements and reduce operating costs by 45 percent. The proposed system will use new and upgraded technologies designed to provide tighter pressure control on the demand side, plus greater efficiency and reliability on the supply side. The estimated cost savings for the modified system is approximately $71,000/year. With an initial cost of about $115,000, the proposed system will pay for itself in just over 19 months.

Plant Overview

The NAE facility in Elizabethton is an aluminum extrusion plant. Compressed air is used to operate equipment necessary for various production processes, for agitation of water in quench tanks, in saw chip removal, and for metal cooling.

Project Overview

The purpose of Air Management's assessment was to provide NAE with a plan for improving the compressed air system at the Elizabethton plant. The project goals were to lower operating costs, improve efficiency, and optimize energy conservation while not adversely affecting the manufacturing output.

The existing compressed air system at the Elizabethton plant consists of four electric rotary screw compressors plus one reciprocating compressor. The compressors are located at three different sites within the plant and use an extensive piping system to distribute air to end users. Only two of the electric rotary screw compressors, both of which are 250 hp, are normally used. The pressure in the system ranges from 111 to 120 psig during normal production. This can be controlled unless the total plant demand exceeds the supply available from the two 250-hp compressors.

The compressed air is processed through refrigerated air dryers before it is distributed to the users. However, Air Management discovered that the dryer piping is incorrectly routed and that the dryers are not properly removing the condensed water from the compressed air system. Water is being carried into the compressed air distribution system where it can cause problems for the end users.

Benefits

- 45 percent cost reduction in compressed air system
- Tighter pressure control on demand side
- Greater efficiency and reliablity on supply side
- Payback in 19.3 months

Applications

The generation of compressed air requires a huge amount of energy and can be a relatively large source of costs. Compressed air is vital to the operation of nearly every industrial plant. An efficient compressed air system can increase productivity and ensure better product quality.

Project Partners

Air Management
Powder Springs, GA

Alcoa North American Extrusions
Elizabethton, TN

The assessment determined that the normal system operating pressure of 111 to 120 psig is substantially higher than what is necessary to support the needs of the plant and is creating artificial demand in the system. The base load leaks in the plant are at a rate of 449 scfm, which does not include the additional leaks that occur as production equipment is brought on line. The compressors are not centrally controlled, and there is a significant partial loading of the on-line compressors, causing lower output efficiency than they are capable of delivering. The compressors discharge directly to the system, with no separation of supply from demand. Response to changing system demand must be accomplished with raw compressor power.

Project Implementation

Air Management's proposed plan to upgrade the compressed air system includes optimizing the supply side of the system, adding controlled storage, and eliminating artificial demand. The supply will be separated from the demand at the main compressor area by a central compressor automation system. The new protocol will use one 250-hp compressor operating in the load/unload mode behind a demand controller, with the second 250-hp compressor in standby mode. All other remote compressors will operate at the system distribution pressure, and low-pressure blowers will be used for air agitation in the quench tank.

The operating compressor will discharge through the correctly configured dryers to a new 5,000-gallon control storage receiver. Adding 5,000 gallons of control storage upstream of the demand controller will allow for the efficient loading and controlling of the compressors. From there, the compressed air will pass through a new 2,400-scfm mist eliminator that will remove all lubricants and other contaminants from the compressed air stream before it enters the distribution piping.

Separating supply from demand with a demand controller will ensure stable system pressure control. The system distribution pressure can be safely reduced to 85 psig with the demand controller, keeping system pressure ±1.0 psig from the set point. The ability to compensate for a surge demand using control storage will eliminate low-pressure conditions that now occur during momentary surge loading of the system. Leak reduction and management will become easier once the distribution pressure is stabilized. Air Management recommends that a leak repair and benchmarking program (at 301 scfm) be implemented after the demand controller is installed.

Results

When the recommended modifications are implemented, the annual compressed air system operating costs will be reduced from $159,000 to approximately $88,000. With an initial implementation cost of slightly less than $115,000, the payback period is estimated at 19 months.

Benefits

- Costs and energy savings
- Reduced energy consumption
- Increased furnace efficiency
- Reduced waste heat loss
- Increased productivity
- Longer furnace life

Applications

A process heating assessment can discover numerous ways to cut energy use, improve production, and improve the performance of the many industrial thermal processes found throughout the manufacturing sector.

Project Partners

CSGI, Inc.,
Rockville, MD

Alcoa North American Extrusions
Plant City, FL

Process Heating Assessment at Plant City Extrusion Plant

Summary

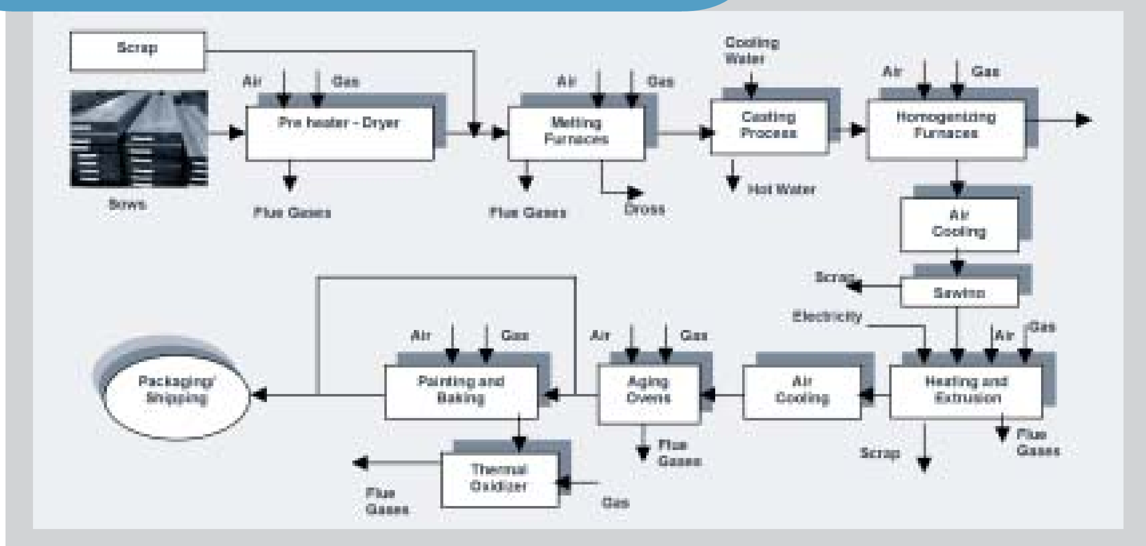
In January 2001, CSGI, Inc., of Rockville, Maryland, conducted a collaborative technology assessment at the NAE facility at Plant City, Florida. The focus of the assessment was the plant's process heating systems. The review identified several opportunities for energy savings and production improvements through improved combustion, waste heat recovery, heat loss minimization, and process modifications. A preliminary estimate indicated that the plant could save up to $450,000 annually in natural gas costs by implementing several of the opportunities identified in the assessment.

Plant Overview

The NAE facility in Plant City produces aluminum extrusions and sections used by the building industry. Aluminum ingots and in-house scrap are melted and processed in a number of different furnaces and ovens at the plant.

A simplified flow diagram for the production processes and major process heating equipment is shown in Figure 1.

Figure 1. Plant City Manufacturing Operations



Project Overview

The plant uses natural gas and electricity for its heating operations. All but one of the furnaces are fired by natural gas. One billet reheating furnace uses electrical induction heating.

Table 1 shows the annual energy consumed by each of the burners and furnaces. The equipment was analyzed to identify both the largest energy consumers and those that use more than 80 percent of the total process heating energy used.

Table 1. Equipment Analysis for Plant City Process Heating

Process Heating Equipment	Operating Temperature (°F)	Total Annual Energy Consumed (MMBtu)	Percent of Total	Accumulated Total Percent
Melter–South	1350	100,800	18.7	18.7
Melter–North	1350	100,800	18.7	37.5
Homogenizer 1	1060	45,360	8.4	45.9
Homogenizer 2	1060	45,360	8.4	54.3
1650 Billet Heater	800	30,240	5.6	60.0
2200 Billet Heater	800	30,240	5.6	65.6
3000 Log Heater	800	30,240	5.6	71.2
Preheat Oven–vertical paint	360	30,888	5.7	76.9
Preheat Oven–horizontal paint	360	30,888	5.7	82.7
3000 Age Oven	400	14,414	2.7	85.4
3000 North Age Oven	400	14.414	2.7	88.0
2200 Age Oven	400	14,414	2.7	90.7
Preheat–vertical line	360	14,274	2.7	93.4
1250 Age Oven	400	10,296	1.9	95.3
Preheat–horizontal line	360	10,296	1.9	97.2
Bake Oven–vertical	400	6,864	1.3	98.5
Bake Oven–horizontal	400	6,864	1.3	99.7
Sow Dryer	400	1,373	0.3	100.0
Reoxidizer	1600	0	0.0	100.0
Total		**538,026**	**100.0**	

Project Implementation

CSGI, Inc., identified several opportunities for energy savings and increased productivity at the Plant City facility. Table 2 summarizes these opportunities.

Results

Several energy savings measures can be applied to the process heating equipment at the NAE facility. Figure 2 provides an example of the potential savings that could be realized through a 50 percent recovery of waste heat from the flue gases of the major energy-consuming equipment. Similar calculations can be performed for all of the energy savings measures listed in Table 2.

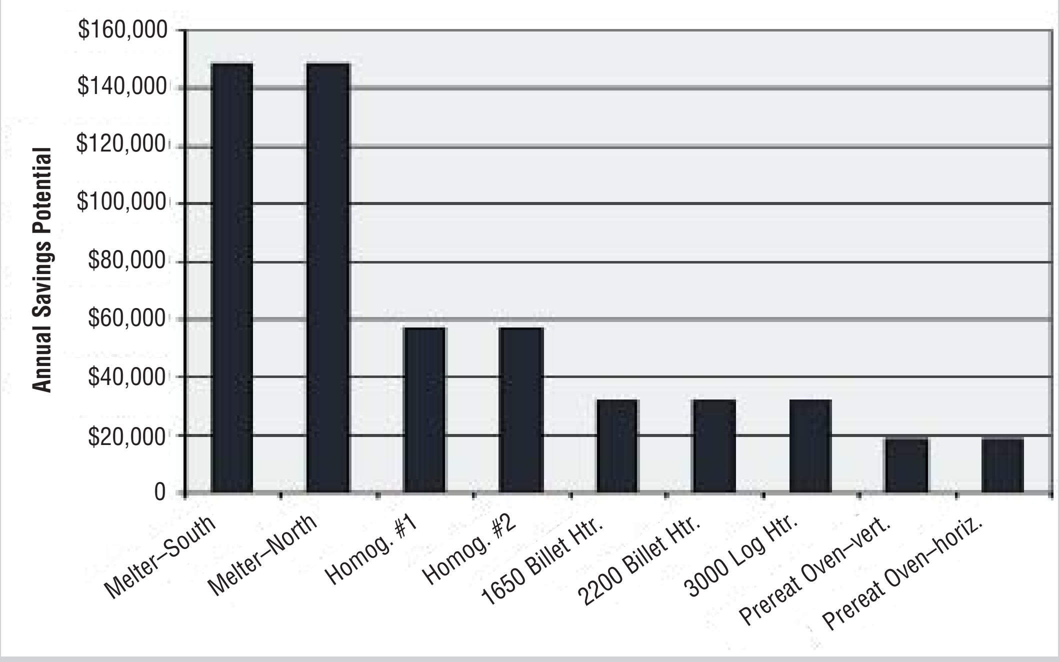
Table 2. Summary of Plant City Energy Saving Opportunities

Process Step	Energy Saving Measures	Energy Savings Potential	Typical Implementation Period	Typical Payback Period	Examples of Specific Activities
Heat generation	Use of efficient combustion (burners) and operation of other heat-generating equipment	2 to 10 percent	1 to 4 weeks	1 to 6 months	▶ Maintain minimum required free oxygen (typically 1 to 3 percent) in combustion products from burners for fuel-fired process heating equipment ▶ Eliminate formation of excessive amount (typically more than 30 to 50 ppm) of carbon monoxide or unburned hydro-carbons through control of air-to-fuel ratio ▶ Use of oxygen injection in combustion air to increase furnace heat input and production if melter productivity is a bottleneck ▶ Evaluate economics of induction heating or possibilities of using gas turbine power generation with heat recovery in other processes
Heat recovery	Flue gas heat recovery	5 to 25 percent	3 to 6 months	6 to 24 months	▶ Peheating of combustion air; use of preheated air or recuperative burners ▶ Preheating and/or drying of the charge–load ▶ Use of water/air (fogging) nozzles for accelerated cooling of logs after homogenizing ▶ Evaluate use of absorption cooling system that uses low-grade heat from clean exhaust gases ▶ Cascade heat of the exhaust gases to the lower-temperature process heating equipment
Heat containment	Reduction of heat losses	1 to 5 percent	1 to 10 weeks	3 to 12 months	▶ Use of adequate and optimum insulation for the equipment. Regular repairs and maintenance of insulation ▶ Furnace pressure control to avoid cold air entering the furnace or hot gases escaping the furnace
Heat transfer	Design and operation of furnaces and heating systems to increase heat transfer from heat sources to the process or load	5 to 10 percent	1 to 12 months	6 to 24 months	▶ Use of high convection or radiation from burners and furnace surfaces to the process and load through selection of proper burners and furnace design ▶ Frequent cleaning of heat transfer surfaces for indirectly heated systems (i.e. steam coils, radiant tubes, electrical elements) ▶ Replacement of indirectly heated systems (steam, radiant tubes, enclosed electrical heating elements) by direct-heated systems where possible

Table 2. Summary of Plant City Energy Saving Opportunities (continued)

Process Step	Energy Saving Measures	Energy Savings Potential	Typical Implementation Period	Typical Payback Period	Examples of Specific Activities
Sensors and controls	Improved scheduling, load management, and controls	2 to 5 percent	1 to 4 weeks	3 to 18 months	▶ Operations with full load with minimum idle time or shutdown and start-up cycles ▶ Programmed heating (high head) for homogenizing furnaces to reduce heating time and increase productivity. Check available heat input ▶ Maintain proper turn-down for burners by adjusting and maintaining control motor drive-valve linkages at correct position
Advanced materials	Use of improved or advanced materials (insulation, refractories, alloy parts, etc.) in equipment design	2 to 5 percent	Weeks to months	3 to 24 months	▶ Use of improved materials, design, and application of heat exchangers to recover heat from contaminated gases.

Figure 2. Potential Savings through Waste Heat Recovery from Flue Gases



Benefits

- Cost and energy savings

Applications

Pumping systems are one of the core unit operations found in almost every manufacturing and industrial setting. An assessment is a desirable way to determine ways to cut costs and energy use in these systems.

Project Partners

Oak Ridge
National Laboratory
Oak Ridge, TN

Diagnostic Solutions, LLC
Knoxville, TN

Alcoa North American
Extrusions
Cressona, PA

Pumping System Assessment at Cressona Extrusion Plant

Summary

In May 2001, representatives from Oak Ridge National Laboratory (ORNL) and Diagnostic Solutions, LLC, conducted an assessment of several pumping systems at Alcoa's NAE aluminum extrusion facility in Cressona, Pennsylvania. The purpose of the assessment was to identify potential cost and energy savings opportunities that could be achieved by more efficient use of process pumping equipment. Potential annual cost savings for each system ranged from $26,000 to $55,000.

Plant Overview

The NAE plant in Cressona produces aluminum extrusions used in the transportation, service center, automotive, and original equipment manufacturer (OEM) markets.

Project Overview

Although the plant has many pumping systems, the assessment focused on three main cooling water systems. Table 3 identifies systems that were evaluated during the assessment. The initial reason for selecting these systems was that they all involved the continuous operation of a fixed number of parallel pumps. As the evaluation progressed, however, it became obvious that the consistent use of valve throttling was another common factor affecting system operation.

Table 3. Pumping Systems Initially Chosen for Evaluation at Cressona

System Number	Process Description	Number of Pumps Operating	Pump Rated HP	Pump Style
1	Ingot casting unit 5–recirculating pumps	2	75	Vertical turbine (3-stage)
	Ingot casting unit 5–cooling tower pumps	1	50	Vertical turbine (1-stage)
2	Ingot casting units 1 and 4 –recirculation pumps	2	125	Double-suction, horizontal split-case
	Ingot casting units 1 and 4–cooling tower pumps	1	100	Double-suction, horizontal split-case
3	Extrusion cooling recirculation pumps	2	125	Vertical turbine (6-stage)

Project Implementation

Pressure, elevation, flow rate, and motor power were recorded for each pump. The Pumping System Assessment Tool (PSAT), which was developed by ORNL for the U.S. Department of Energy, was used to analyze system performance based on the measured data. Using this tool, both an optimization rating for each pump and potential annual savings were estimated. Based on the analysis, several measures to enhance pump performance were identified. These measures included:

- Trimming pump impellers
- Installing adjustable speed drives
- Checking the lift setting
- Determining if a single pump will suffice where two are currently being used

Results

Table 4 shows potential savings that could be achieved for each system if optimization measures were implemented.

TABLE 4. ENERGY AND COST SAVINGS POTENTIAL AT CRESSONA

System Number	Process Description	Potential Reduction In Energy (Percent of Present)	Potential Annual Cost Savings ($K)
1	Ingot casting unit 5–recirculating pumps	75	20
	Ingot casting unit 5–cooling tower pumps	42	6
2	Ingot casting units 1 and 4–recirculation pumps	77	44
	Ingot casting units 1 and 4–cooling tower pumps	55	11
3	Extrusion cooling recirculation pumps	>50	29

INDUSTRY OF THE FUTURE—ALUMINUM

Through OIT's Industries of the Future initiative, the Aluminum Association, Inc., on behalf of the aluminum industry, has partnered with the U.S. Department of Energy (DOE) to spur technological innovations that will reduce energy consumption, pollution, and production costs. In March 1996, the industry outlined its vision for maintaining and building its competitive position in the world market in the document, ***Aluminum Industry: Industry/Government Partnerships for the Future****.*

OIT Aluminum Team Leader: Sara Dillich (202) 586-7925.

BestPractices is part of the Office of Industrial Technologies' (OIT's) Industries of the Future strategy, which helps the country's most energy-intensive industries improve their competitiveness. BestPractices brings together the best-available and emerging technologies and practices to help companies begin improving energy efficiency, environmental performance, and productivity right now.

BestPractices focuses on plant systems, where significant efficiency improvements and savings can be achieved. Industry gains easy access to near-term and long-term solutions for improving the performance of motor, steam, compressed air, and process heating systems. In addition, the Industrial Assessment Centers provide comprehensive industrial energy evaluations to small- and medium-size manufacturers.

FOR ADDITIONAL INFORMATION, PLEASE CONTACT:

OIT Clearinghouse
Phone: (800) 862-2086
Fax: (360) 586-8303
clearinghouse@ee.doe.gov

Visit our home page at
www.oit.doe.gov

Please send any comments, questions, or suggestions to
webmaster.oit@ee.doe.gov

Office of Industrial Technologies
Energy Efficiency
and Renewable Energy
U.S. Department of Energy
Washington, DC 20585-0121

DOE/GO-102001-1437
August 2001