Weirton Steel: Mill Identifies $1.4 Million in Annual Savings Following Plant-Wide Energy-Efficiency Assessment

Benefits

- Identified savings of about 108,000 MMBtu of fossil fuel energy annually
- Identified savings of about $1.4 million annually by reducing energy consumption
- Identified paybacks ranging from 3 to 23 months, depending on the project

Application

The Weirton Steel Corporation plant-wide energy assessment focused on the technical and economic potentials for using alternative energy sources, such as "waste heat," in various energy-intensive processes. The assessment team evaluated 1) the continuous steel strip drying operations, 2) fossil fuel consumption in furnaces, 3) personnel comfort heating costs, and 4) reduction of water booster pump operating costs. The projects identified in these systems could be replicated in other steel plants and in certain other energy-intensive industries.

Summary

The Weirton Steel Corporation began a plant-wide energy assessment of its steel mill plant in Weirton, West Virginia, in the fall of 2001 and continued assessment studies through most of 2002. The main objectives were to identify energy saving projects that would reduce the large expenses for fossil fuel and electricity. (In this case study, "fossil fuel" refers to a variable combination of blast furnace gas, natural gas, and fuel oil.) These resources are used in many applications to heat or dry steel, in producing steam, and in pumping water. Weirton Steel recently pursued other efficiency enhancement programs in response to intense global competition; this plant-wide energy assessment continued the company's on-going pursuit of energy efficiency. Based on the assessment results, the company found strong economic justification for six projects that would reduce the use of fossil fuel, electrical energy, and water.

The continuous annealing (CA) lines have steel strip washers and strip dryers that consume large amounts of heated water and steam-heated air, respectively. Four of the six projects proposed alternatives for conserving these resources. Other projects seek to optimize furnace operation and reduce the cost of comfort heating for workers in the tin mill. All of the proposed projects would reduce fossil fuel requirements for heating steam or firing the furnace. This savings totals 108,000 million British thermal units (MMBtu) annually or nearly $1.3 million. Other yearly savings include 119 million gallons of water ($87,100) and 84,000 kilowatt-hours (kWh) ($3,360) of electrical energy. All of the projects could be applied to other steel mills and possibly other industries using steam processes and furnaces.

Public-Private Partnership

The U.S. Department of Energy's (DOE) Industrial Technologies Program (ITP) cosponsors plant-wide assessments 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.

Company Background

Headquartered in Weirton, West Virginia, Weirton Steel has been in existence since 1910. It is the largest industrial employer in the state of West Virginia and is the eighth largest steel producer in the United States. Weirton Steel provides an extensive array of tin mill and sheet steel products as well as steel products for the building and construction market to customers worldwide. The company also sells high-quality galvanized steel to manufacturers of steel framing for residential and commercial applications. Because of intense global competition, the company is under great pressure to produce its product more efficiently. This pressure led to Weirton's decision to upgrade its facilities and streamline its production processes to significantly reduce energy usage.

Assessment Approach

Weirton Steel began efficiency improvement studies and implementation programs on its compressed air system and control system modernization in the late 1990s. Because of tremendous pressure to remain competitive in the global market, even as these programs were being implemented, the company began the much broader plant-wide energy efficiency audit process in 2001. The audit goals were to identify cost-effective, energy saving projects relating to 1) the strip drying operations adjacent to the annealing furnace in the tin mill, 2) reducing fossil fuel use in the annealing furnaces, 3) reducing comfort heating costs in the tin mill, 4) reducing Weirton River water booster pump operating costs, and 5) steel preheating (warm charging) in the reheat furnace.

In performing the plant-wide energy efficiency assessment, Weirton Steel hired the technical analysis services of White Hat Engineering and Diagnostic Solutions, LLC. Weirton directed these project partners to look at numerous potential projects and identify those that 1) provide a high return on investment with a short payback, 2) require only modest capital investment, and 3) can be implemented with minimal disruption to production. This last requirement meant that the projects can be phased in, one at a time, on individual lines of the continuous annealing process, and the modifications would not require extensive alterations to the furnace structure.

The Weirton Steel assessment team helped provide the other teams with access to processes and the necessary information to support analyses. The team members, who had extensive knowledge of the processes, equipment, and batch runs at the Weirton plant, also carefully evaluated all of the studies.

Results

Weirton steel operates three CA lines in one section of the Tin Mill. Each process line feeds steel strip through various operations to create a properly sized, high-quality, uniform product with the desired material properties. The assessment team successfully explored options for reducing the consumption of steam, electricity, fossil fuel, and water in the CA lines. The team also identified ways of reducing the cost of comfort heating in the tin mill. For several other processes, the team will continue to investigate new or emerging opportunities.

Table 1 lists projects that show the greatest promise based on the assessment team's analyses. It also lists the primary savings whether they are energy or utility (such as water), the project cost, the estimated savings, and simple payback shown in months. Since line 1 operates only 700 hours per year compared to 7,500 hours for lines 2 and 3, most line-specific projects are based on the two more active lines. The first project, which recycles most of the heated water that is sprayed on the strip, provides the greatest cost savings by far. The savings are primarily thermal in each case, translating into reduced usage of fossil fuel and less plant byproduct gas emissions. All of the projects have a simple payback of less than 2 years.

Projects Identified

The following discussion details the selected energy-efficiency projects developed during the plant-wide assessment. Because of the similar basic processes used in steel plants, all of the projects are highly applicable throughout the steel industry. The projects may also be replicable in other industrial plants that use energy-intensive thermal processes.

Project 1 – Recycling final wash and rinse water

The strip washers at the infeed end of the annealing furnaces use large amounts of filtered river water that must be heated to 180°F. The back section, consisting of the No. 2 scrubber and final rinse, loses all of the sprayed water to a drain. This represents a loss of 200 to 500 gallons of heated water per minute for the three lines. White Hat Engineering recommends installing a new system that would capture and recycle the water at the wash line. The system would include a low-pressure pump, a

Table 1. Estimated Project Cost, Savings, and Payback for Projects at Weirton Steel

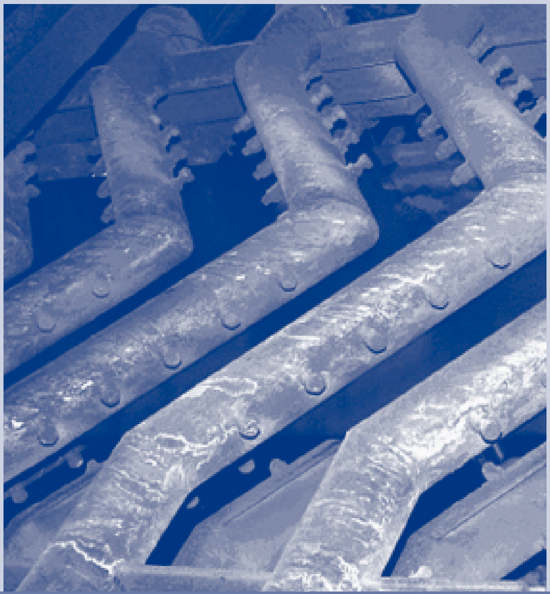
Project	Primary Resource Conserved	Project Cost ($)	Annual Savings ($)	Payback (months)
Recycle final wash and rinse water	Thermal/ water	225,000 (3 lines)	780,000 (3 lines)	3 (Lines 2 & 3) 20 (Line 1)
Reduce strip dryer air flow and improve instrumentation	Thermal/ electric	58,000 (2 lines)	55,000 (2 lines)	13
Use furnace stack gases to dry strip	Thermal	130,000 (2 lines)	120,000 (2 lines)	13
Use annealer slow-cooling air to dry strip	Thermal	180,000 (2 lines)	120,000 (2 lines)	18
Repair and adjust annealing furnace	Thermal	260,000[1]	180,000	17
Modify comfort heating system in the tin mill	Thermal/ (steam)[2]	81,000	100,000	10
	Total	**934,000**	**1,355,000**	

[1] A rough estimate that may vary from $180,000 to $340,000.
[2] Replaces steam heat with electric heat in order to attain this cost savings.

hydrocyclone to clean the water, a high-pressure pump to create a pressure of 150 pounds per square inch (psi), and a booster heater to return the water to 180°F. Assuming that the new system saves 80% of the water that would have been lost to the drain, the net thermal energy savings would be 66,244 MMBtu annually for the three lines combined. The system would also save 113 million gallons of water annually.

Project 2 – Reduce strip dryer air flow and improve instrumentation

The CA process in lines 2 and 3 feeds steel strip through a wash before it enters the annealing furnace and the strip is quenched in water as it exits the furnace. However, immediately before the furnace and also after the quenching, the strips must be dried to prevent rust and discoloration in the final coiled steel product. Both of these drying operations use two hot-air strip dryers that obtain hot air from steam coils. The entire steam heat transfer and hot-air blowing operation is manual and runs at maximum continuously. The 75-horsepower blowers produce 4,400 standard cubic feet per minute per dryer and the air temperature is about 135°F. The assessment team concluded that this non-regulated operation is oversized by a factor of about two and needs maintenance. The team's primary recommendations are to clean the heating coils and begin experiments to regulate operation of selected dryers. The team estimates that, by following their recommendations, Weirton could save at least 15% in total cost, with much higher savings likely. Most of the savings would be thermal, with annual savings of at least 3,950 MMBtu in steam and at least 84,000 kWh savings in electricity, for the combined lines 2 and 3.



Hot-Air Strip Dryers for a Continuous Annealing Line (Project 2)

Project 3 – Use furnace stack gases to dry strip

This project builds upon Project 2 by using waste heat (annealing furnace stack gases) instead of steam heat to dry the strip before it enters the annealing furnace. To protect the two blower fans in each line from excessive temperatures, the stack gases would first be mixed with ambient air. The project would save 13,180 MMBtu annually for the combined lines 2 and 3.

Project 4 – Use annealer slow-cooling air to dry strip

This project, like Project 3, builds upon Project 2 by using waste heat (from the annealer slow-cooling air supply) to dry the strip. In this case, the drying would take place immediately after the furnace and quenching stages. The project cost is somewhat higher than for Project 3 because the cooler air temperature (roughly 220°F) necessitates larger ductwork. The mixing equipment and controls are included in the estimate but may not be necessary. (A longer-term temperature profile is needed to determine this.) The project would save 13,180 MMBtu annually for the combined lines 2 and 3.

Project 5 – Repair and adjust annealing furnace

Based on numerous observations, the assessment team concluded that the annealing furnaces for lines 1 and 2 were in disrepair and significant amounts of excess, unheated air were leaking in. The team recommended burner repair, damper repairs, and balancing the combustion system based on rough but conservative cost estimates. In this limited assessment, no thermal savings estimate was calculated.

Project 6 – Modify comfort heating system in the tin mill

The heating system in the tin mill keeps workers comfortable by dispersing steam-heated air. However, much of the heat rises to the roof, doing little good for the workers at floor level. The White Hat Engineering team proposed replacing area heating with localized electric radiant heating at 150 work zones. Timers or motion detectors will control each of the radiant heaters. Although electric energy will replace the fuel-heated steam energy, the thermal energy reduction (11,780 MMBtu annually) and cost savings justify the project.

Steam Heater for the Tin Mill (Project 6)

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