

## Mid-South Metallurgical Makes Electrical and Natural Gas System Upgrades to Reduce Energy Use and Achieve Cost Savings

After receiving an energy assessment from the U.S. Department of Energy’s (DOE’s) Industrial Assessment Center (IAC) at Tennessee Technological University, Mid-South Metallurgical implemented several resulting recommendations, which included installing new furnace insulation, implementing an electrical demand system, installing energy efficient equipment on its natural gas furnace burner tubes, and upgrading its lighting. Through these upgrades, the commercial heat treating business cut its overall energy use by 22%, reduced its peak demand by 21%, and decreased its total energy costs by 18%.

### Company Background

Founded in 1985, Mid-South Metallurgical is a niche commercial heat treating company based in Murfreesboro, Tennessee. The company does not produce or manufacture any products, but instead provides precision and specialty heat treating services on parts that are made by other manufacturers. Mid-South Metallurgical has specific expertise in the heat treatment of high-speed tool steels—generally created to perform processes on other materials—and provides stress relieving, annealing, induction, and straightening services to a number of different industries, including construction, military, aviation, molding, and precision gauges, among others.

In 2007, Mid-South Metallurgical, under new ownership, was looking for ways to cut costs and increase profits, including energy efficiency projects.

### Plant and Project Overview

Mid-South Metallurgical is comprised of three facilities that occupy 21,000-square-feet of space. The facilities operate 24 hours a day, 5-1/2 days a week, 52 weeks a year. The plant has several industrial systems, including 25 horsepower air compressors, vacuum and electric furnaces, two barium chloride salt bath furnaces, and several atmospheric furnaces that rely on



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Efficiency Improvement Projects	Results
Furnace Insulation: Covered and insulated two barium chloride salt baths while not in use to reduce heat losses.	Produced annual electricity cost savings of approximately \$53,000.
Electrical Demand: Installed an energy optimization system.	Helped better manage peak demand operations and protect the site from spikes in demand.
Furnace Burner Tubes: Replaced laminar flow burner tips with cyclonic burner tips, substituted ceramic burner tubes with silicon carbide burner tubes, and installed radiative emitter inserts to reduce heat losses, improve heat transfer, and increase tube life.	Raised emissivity to 0.95; reduced natural gas needs by 20%.
Lighting: Replaced 44 older 400-watt metal halide fixtures with 88 new 8-foot fixtures with 4 lamp F32T8 fluorescent bulbs.	Reduced annual lighting operation and maintenance costs by 52%.

natural gas to heat the furnace, as well as generate an appropriate “atmosphere” inside the furnace during heat treatment processes.

Heat treating processes vary depending on the type of metal being used and the intended strength of the treated part. Some of

Mid-South Metallurgical's parts require furnace temperatures up to 2375°F, while others call for temperatures of 120°F.<sup>1</sup> Some of the energy challenges experienced by Mid-South Metallurgical involved not being able to shutdown particular equipment due to expansion and contraction problems, as well as heat losses. In an effort to resolve these issues and identify other opportunities for improvement, the company underwent an energy assessment from the DOE-sponsored IAC program in 2008. During this time, faculty and engineering students from the Tennessee Technological University IAC visited the site and conducted an assessment that focused on identifying energy efficiency, waste minimization, and productivity improvement opportunities. The assessment team found a number of energy saving opportunities in several key areas of the plant's operations, which included better insulating the site's furnaces, lowering peak energy demand, replacing furnace burner tubes, and making lighting system improvements.

## Energy Efficiency Improvements

### Furnace Insulation

One energy issue experienced by Mid-South Metallurgical involved heat losses associated with the site's two barium chloride salt baths. Specifically, the company was not able to shutdown the salt baths because the barium chloride would harden, causing damage to the equipment that would require expensive maintenance to repair. Therefore, in order to try and preserve energy, over the weekend the site was reducing the preheat bath's temperature from 1600°F to 1200°F and reducing the second bath's temperature from 2200°F to 1600°F. Due to the high temperatures of both furnaces, it was determined that a large amount of heat was being lost and an opportunity for significant energy savings existed.

In order to reduce heat losses, the company covered and insulated both salt baths when they were not in use. As a result, heat losses associated with the baths have almost been stopped altogether. To date, the furnace insulation improvements have produced annual electricity cost savings of approximately \$53,000.

### Electrical Demand and Power Factor

Another area that proved to offer significant efficiency improvement opportunities involved the site's electrical energy use—specifically, its demand and power factor. Standard electric delivery to Mid-South Metallurgical's three facilities is 480 volts, and peak energy demands range between 825 and 875 kilowatts (kW), depending on the season. Historically, the company rarely considered electrical demand in its operations. Moving forward, to help manage the site's electrical demand, Mid-South Metallurgical had an energy optimization system installed, which networked all energy consumers (the furnaces) into a central process unit that managed energy flow. Individual electronic control modules were installed on each unit, and the central process unit monitored overall operation and optimized consumer's switching actuations to control energy balance. This

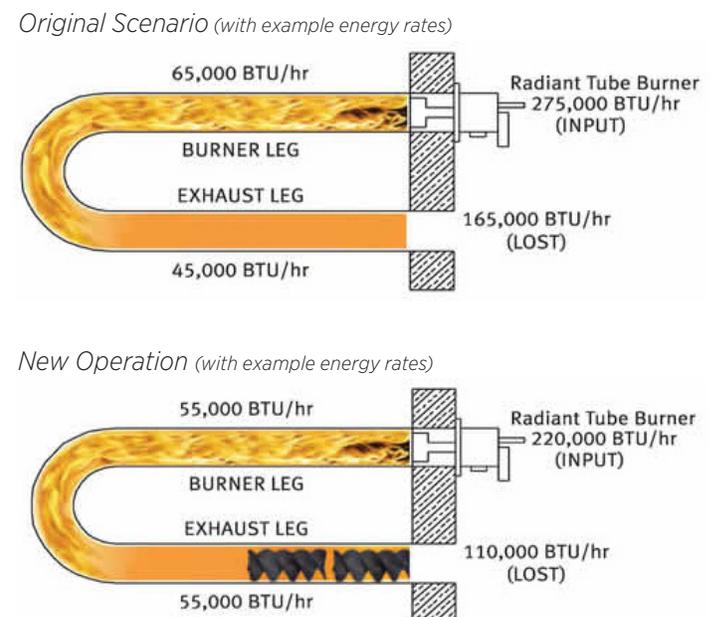
process helped Mid-South Metallurgical better manage its peak demand operations and better protect its facilities from spikes in demand.

Mid-South Metallurgical also learned that it had an average power factor of 76%. The company plans on installing new capacitors to help correct this relatively low power factor and improve its operational level above the desired 87%.

### Natural Gas Upgrades

Mid-South Metallurgical has three atmospheric furnaces throughout its facilities, each equipped with eight pre-mix style laminar flow burners. The delicate ceramic tubes had no radiative emitters and were subject to frequent breakage due to constant thermal expansion and contraction. Additionally, the design of the tubes resulted in inefficient heat transfer and excessive waste heat exhaust.

Figure 1. Natural Gas Equipment Improvements



Radiative Inserts

To resolve these efficiency issues, the company replaced the system's laminar flow burner tips with cyclonic burner tips, which offer greater thermal uniformity along the length of the burner tubes. Flame breakers are also unnecessary in this application, and the high-grade heat resistant steel RA330 lowers the incidence of oxidation. In a cyclonic design, the drill holes are shaped in an angled fashion to produce a helical flame pattern. This swirls the combusted gases evenly along the length and cross section of the burner tube, which allows for higher tube surface temperatures and less heat loss up the exhaust of the burner tubes. This heats the radiant tube more efficiently and reduces single-point heat accumulation. Not only does this provide for more uniform heat distribution, but it also leads to longer tube life.

Additionally, Mid-South Metallurgical replaced its ceramic burner tubes with silicon carbide burner tubes, which allow for greater heat transfer from the burner tubes to the furnace. This results in more heat being projected into the furnace instead of it exiting as exhaust heat. Along with the new burner tubes, the company also installed radiative emitter inserts that radiate and reflect combustion gases better than other conventional tubes. Additionally, the emitter inserts facilitate a more even heat transfer from burner to furnace.

In a traditional radiant tube, 45% more energy is released in the burner leg than the exhaust leg due to the highly luminous flame. Both radiation and convection heat transfer are present in the burner leg, but not in the exhaust leg. Hot gases in the exhaust have an emissivity of less than 0.05; convection heat transfer is dominant in the exhaust leg. Mid-South Metallurgical installed inserts in the last two-thirds of the exhaust leg, which raised emissivity to 0.95. With both radiation and convection heat transfer present, this balanced heat transfer between the burner and the exhaust leg. The fin-twisted inserts doubled the amount of surface area, and energy input into the radiant tube burner reduced natural gas needs by 20%.<sup>2</sup>

### Lighting Upgrade

Another project recommendation identified during the IAC assessment involved upgrading the site's lighting. Before implementing efficiency improvements, the process and storage areas of the company's three facilities were lit by 44 older 400-watt metal halide fixtures. The assessment team determined that upgrading to 88 new 8-foot fixtures with 4 lamp F32T8 fluorescent light bulbs would help Mid-South Metallurgical achieve considerable energy and cost savings.

The old fixtures consumed 460 watts of energy each and carried annual maintenance costs of \$50.67 per fixture, while the

### Mid-South Metallurgical's Savings Over a Three-Year Period

	Year 1 (base year)	Year 3	Total Savings
Natural Gas	\$17,984	\$13,267	26%
Electricity (MMBtu)	10,614	9,128	14%
Average Monthly Demand (kW)	873	688	21%
Total Costs	\$425,557	\$347,067	18%

new lighting retrofits only consume 110 watts of energy each and carry annual maintenance costs of \$13.29. In total, the upgrade allowed Mid-South Metallurgical to reduce its energy consumption, which resulted in the company lowering its annual lighting maintenance and operational costs by 52%.

### Results

The energy efficiency improvements implemented by Mid-South Metallurgical have resulted in significant energy savings. Altogether, the company has decreased energy use by 22%, cut peak electrical demand by 21%, and reduced overall energy costs by 18%. Table 1 shows details about these savings over a three-year period.

### Conclusion

The heat treating industry, like most industries, suffered revenue declines as a result of the 2009 recession (industry-wide revenues declined by 30%). Mid-South Metallurgical was able to avoid this consequence and outperform others in the heat treating industry, largely due to the company's efficiency improvements and its diverse customer base. Since implementing the efficiency recommendations from its 2008 energy assessment, Mid-South Metallurgical has continued efforts to become more energy efficient. Process improvements will continue this year, including the installation of a batch IQ line.

### Endnotes

<sup>1</sup> Mid-South Metallurgical, "Heat Treating Factors," <http://www.midsouthmetallurgical.com/HeatTreatingServices/tabid/54/Default.aspx>

<sup>2</sup> Avion Manufacturing, "SpyroCor™," [http://www.avionmfg.com/pages/spyrocor\\_us.htm](http://www.avionmfg.com/pages/spyrocor_us.htm).