Cost-Effective Furnace Rebuild Gives New-Furnace Performance

Situation:

Bodycote Thermal Processing (Indianapolis, Ind.) is one of the largest commercial heat treaters in North America. Bodycote commercial heat-treating operations keep detailed records on the performance of all heat treating furnaces, tracking a number of factors including energy consumption, furnace productivity, maintenance costs, operating costs and downtime. To support this data, the company also maintains time and temperature profile charts for every load of parts processed through its facilities. Bodycote has been able to establish performance and quality benchmarks for all of its heat-treating equipment by analyzing this data. Jeff Hemmer, plant manager of the Indianapolis facility, used this kind of information as the basis when he requested that the Bodycote engineering staff review rebuilding a 30 in. × 48 in. × 30 in. integral quench furnace. The primary objectives of the rebuild were to create a furnace that would support the Lindure® process, a method of heating that requires tight temperature specifications; to shorten the heat-treating cycle to increase furnace use; and to improve overall furnace efficiency.

Objectives:

- Improve furnace temperature uniformity
- Shorten the heat-treatment cycle
- Improve furnace flexibility
- Improve overall furnace efficiency
- Minimize investment cost
- Improve heat-treated product quality

Solution:

The engineering staff reviewed many options before deciding to install a Kromschroder frequency-fired combustion and control system. According to Hemmer, the package provided the greatest flexibility and the best return on investment. The renovation would consist of a complete furnace reline, replacement of the radiant tubes, and installation of a new combustion and control system.

"In today's competitive market, the decision to replace a combustion system cannot be made solely on fuel efficiency," says Hemmer. "Typically, we would not replace the combustion system when relining a furnace. Relining is routine maintenance that is required periodically. Even with steadily increasing fuel costs, it still is difficult to justify the cost of replacing the combustion system. It has to be based on multiple factors, including recovery time, reduced downtime, reduced maintenance costs and increased tube life."

Bodycote was convinced the additional expense was justified after Brian Strebing, Bodycote's corporate engineering manager; and furnace specialist Doug Parizek met with Brian Hall of Kromschroder Inc. (now managing partner at TPS).

Kromschroder proposed an equipment package for Bodycote that would pay many times over the cost of upgrading the furnace. The upgrade focused on lowering fuel consumption, shortening process cycle times and improving radiant tube life. "Improvements in these areas have the greatest impact on operating costs," says Brian Hall, Kromschroder's then sales manager and combustion specialist. "Indirectly, they will improve furnace efficiency and temperature uniformity. Ultimately, this will improve the quality of the products being heat-treated," he adds.

Kromschroder BICR single-ended, self-recuperating burner and Kanthal tube

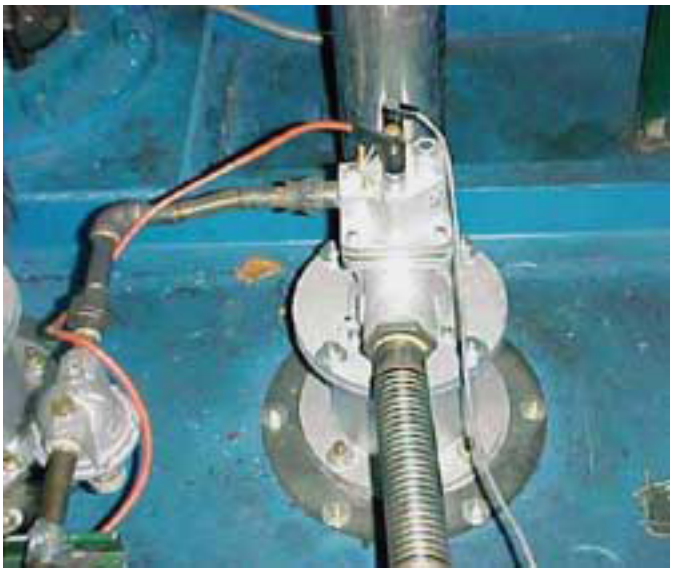
Combustion system upgrades

The original combustion system was replaced with six Kromschroder BICR single-ended, self-recuperative burners and a Kromschroder PF-19 flame management and frequency firing control system. The existing fuel train, air train, and combustion blower were retained to help lower the total cost of the rebuild project. The PF-19 flame management and frequency firing system accepts a 4 to 20 mA control signal from any single loop controller. The brain of the PF, or process firing, system is an MPT controller, a microprocessor-based control unit that converts the 4 to 20 mA analog signal to up to eight digital outputs. Each output is connected to individual PFS-778L flame management cards that control the ON/OFF operation of each burner.

The MPT works like a distributor. It randomly selects which burners and how many to turn on or off depending on the heat demand. This optimizes the heat distribution within the furnace, providing extremely tight temperature uniformity. The PF-19 system, when coupled with the BICR self-recuperative burner, provides safe, efficient, trouble-free operation.

Increased furnace throughput

The new combustion and frequency firing system provided Bodycote with a number of advantages over the original proportional-control system. "One of the most significant benefits is reducing heat-treating cycle times," says Hall. Prior to rebuilding and upgrading the furnace, the heat-treating cycle was 65 minutes to process a 1,500 lb load of parts. By comparison, the cycle after the rebuild is 45 minutes, a 30% improvement. This translates into one or two additional loads of parts per day, or as much as 300,000 lb of additional furnace throughput annually.



Kromschroder flame-management system, combined with other upgrades, reduced furnace fuel consumption by 40%.

Six Kromschroder BICR single-ended, self-recuperating burners, a flame-management system, and Kanthal APM radiant tubes reduced gross heat input to the furnace by 22%.

Fuel efficiency also improved. Before the upgrade, the furnace had a gross input of 880,000 Btu/h compared with a gross heat input 680,000 Btu/h after the upgrade, a 22% reduction in fuel use.

Hemmer says, "The combination of the new burner system and frequency-firing technology resulted in a 40% fuel savings. We also have improved our furnace uniformity to within +6°F, -4°F. The combined benefits have raised thermal efficiency to 65%. In addition, the implementation of a cooling cycle has opened up the potential for additional products for the furnace."

Longer radiant tube life

Hemmer indicated in initial discussions that he wanted to increase radiant-tube life, as tube failures result in loss of production time and increased maintenance costs. This led to the selection of the Kanthal APM alloy radiant tubes, which have a minimum projected service life of 48 months. Bodycote had success with APM tubes in the past.

Custom Electric Manufacturing Co. (Wixom, Mich.) supplied six 5.7 in. diameter × 68 in. long single-ended APM alloy radiant tubes, which were vertically mounted in the furnace. The Fe-Cr-Al APM tubes form an aluminum oxide layer on the tube surface at high temperatures, which resists carburization and sulfurous atmospheres to prevent premature spalling. Advantages of APM material include longer service life, increased watt density over conventional alloys and superior performance at temperatures as high

as 2250°F (1230°C). According to Custom Electric president Bob Edwards, APM tubes have been in service for more than five years in similar integral quench furnace applications, and significantly reduced furnace-operating costs.

Vertically mounted APM radiant tubes have a projected service life of 4-6 years.

Quick return on investment

After being in service for more than 18 months, the rebuilt integral quench furnace has exceeded all expectations and performance objectives. Fuel consumption dropped 40%, gross heat input was reduced by 22%, thermal efficiency was improved to 65%, and furnace throughput increased by up to 3,000 lb/day. In addition, overall product quality was improved and the furnace has been maintenance free for 18 months. "Based on fuel savings alone," says Hemmer, "we would easily have recovered our investment in less than two years. If we annualize the economic impact of all the other improvements we have documented, the upgraded integral quench furnace paid for itself within one year of being returned to service."

Brian Hall is currently a managing partner at Thermal Products & Solutions.

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