techapplication

EPRI

Electric IR Booster Speeds Aluminum Aging Process

The Challenge: Increase Production

Superior Industries, the world's largest producer of cast aluminum wheels, operates five automotive wheel plants in the US, one in Hungary, and one in Mexico. Superior also operates one automated chrome plating operation. These plants aim for high production rates and low capital equipment and operating costs. Because of the desire to increase productivity and lower operational costs, Superior's Fayetteville, Arkansas, plant wished to determine the advantages of using electric IR in place of some of their gas-fired, aging ovens.

Superior Industries is striving to increase cast wheel production while maintaining required high quality in all their plants. Like all makers of aluminum wheels, they also are struggling to meet the demand created by auto manufacturers who must find ways to meet government imposed CAFÉ (corporate average fuel economy) standards. The wheels must be strong and impact resistant, yet their weight has been reduced over the years by as much as 15%. Superior has incorporated processes and equipment that closely control the heat treating process to ensure achievement of necessary metallurgical properties.

The Conventional Method

Many aluminum wheels are cast today using a low-pressure process. Wheels are also cast using a gravity poured process. Superior uses a A356 prime foundry alloy. The wheels were cast in steel molds, removed when mostly cooled, thoroughly inspected, and precipitation hardened. The precipitation hardening process involves: heating to 1000°F (538°C) and soaking for eight hours, rapidly quenching, and artificially aging at 325°F (163°C) for 30 minutes. Close temperature controls were required during all aspects of heat treating and aging to ensure desired mechanical properties.

Previously, the wheels were artificially aged in a 300-foot-long (91 m) gas oven. At their desired line speed of 10 ft/min (3 m/min), the wheels were in the oven for 30 minutes. During this period, only half of the required 30 minute aging cycle could be completed because it took nearly half the residence time to get the wheels from room temperature to 325°F (163°C). Tests showed that to achieve a wheel temperature of 325°F (163°C) halfway through the oven, the oven temperature set point had to be raised to 375°F (168°C). Increasing oven temperature increased the heat-up rate, but the resulting wheel exit temperatures were judged too high.

Since only half the required 30 minute aging could be completed in one pass, it was necessary to process the wheels twice. This was inconvenient, and at times, required additional material handling.

The New Way

A short wavelength IR booster oven was designed and constructed by BGK Finishing Systems of Minneapolis, Minnesota. Bob Bracy, Superior's Vice President of Facilities Engineering, cooperated extensively with BGK during the design, development, and installation phases of the work, and the EPRI Center for Materials Fabrication (CMF) provided technical assistance. The booster oven was designed with the goal of raising the temperature of the wheels to at least 300°F (149°C) in a 14 ft (4.3 m) electric IR oven section prior to entering the gas oven. The IR oven is located at the entrance to the gas oven and actually protrudes slightly inside. It features

- Modular construction
- Three fully independent zones of control
- Automatic sensors that indicate wheels are about to enter the oven
- Manual controls.

A short wavelength IR booster oven, designed for Superior Industries and installed at the entrance to their gas oven, has increased the production rate 100% while maintaining a consistent, uniform quality product.

Also, the oven is configured to reduce power to idling conditions if no wheels are being processed. A line speed of 8.5 ft/min (2.6 m/min) was chosen to achieve the maximum production rate and meet the optimal metallurgical properties. Wheels are exposed to the IR for 98 seconds. The design accommodates a connected load of 735 kW, but operational power use is considerably lower (actual metered usage is 480 kW while operating) due to a built-in safety factor. The idle load was measured during operation at approximately 64 kW.

With the IR oven located at the entrance to the existing gas oven, the temperature of incoming wheels is rapidly elevated to the desired 325°F (163°C) aging temperature. Since wheels no longer enter the gas convection section at room temperature, Superior is able to hold the gas convection oven temperature very close to 325°F (163°C) throughout its entire length.

The Results

Use of the IR booster oven has enabled Superior to hold the temperature of the gas convection aging oven to a more uniform level than ever before. Because of the rapid heat-up capabilities of the IR oven, the entire 30 minute artificial aging cycle can be completed in one pass through the gas oven. This has reduced the emission of products of combustion at the plant site because gas ovens are shut down when not needed.

High Production Rates

Consistent with the goals established at the start of this program, the production rate has doubled with the combined IR/gas system. That represents a 100% increase in production rate while at the same time maintaining a consistent, uniform quality product.

Project Cost

The delivered cost from BGK Finishing Systems, Inc., was approximately $93,000. This price did not cover the in-plant power and control wiring and the exhaust ducting that were required for installation.

The Bottom Line

Use of variable output IR booster ovens can enable heat treaters to increase throughput, and accommodate castings of various weights and configurations, while allowing the gas ovens to remain at the required soak temperature. Workpiece temperature variations experienced with all gas systems can be eliminated by virtue of the automatic controllability of the electric IR oven.

Assistance from Local Utility

Bud Clark, of Central and South West Services and Mark Mobley of SWEPCO, Superior's electric utility, suggested using IR in one potential application as a trial. Working closely with SWEPCO and CMF, they procured and applied a custom-designed, electric IR booster oven in series with their existing gas convection aging oven. This installation has more than doubled the production rate, provided closer temperature control, lowered emissions, and reduced labor. The success of the IR booster oven has not only stimulated interest in other potential applications, but has resulted in the installation of IR booster ovens in other Superior plants.

Other Applications of Infrared Heating

Infrared heating is an efficient means of imparting energy into a wide variety of materials. Heat treating materials, curing coatings for finishing, and heating for curing adhesives are a few of the many applications for clean, efficient infrared heating.

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24, 25, 33—all; **35-39—**all

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