TECHAPPLICATION

Electric Resistance Ladle Preheating Improves Foundry Operations

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THE CHALLENGE:

To Provide Energy Efficient Ladle Preheating While Reducing Noise and Improving Production Efficiency

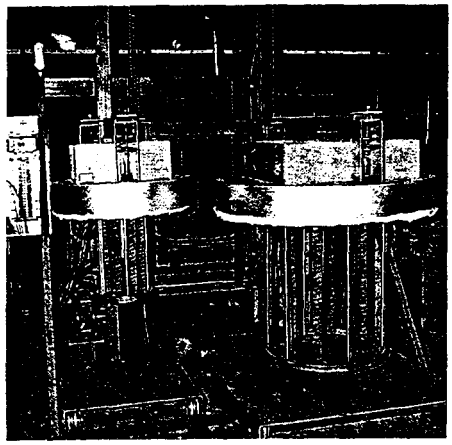
Background

Regal Cast, located in Lebanon, Pennsylvania, is a high-alloy foundry specializing in stainless steel and copper-nickel castings for the defense, nuclear, chemical, and aerospace industries.

Regal Cast's foundry was essentially designed with few constraints because the plant was installed in an existing empty building. This freedom allowed the staff to select the optimum combination of equipment and processes to serve their selected market.

In order to meet customer's quality demands and provide an efficient and profitable operation, Regal Cast chose to go to all-electric melting. Current metal requirements of 40 tons/month of shipped castings are being met through the use of two coreless induction furnaces using one power supply. A 1000 kW solid state power supply is switched to operate either a 1000 lb. furnace (one available) or a 6000 lb. furnace (two available). In addition, a 4-ton AOD (argon-oxygen-decarburization) unit is used for steel refining. All molding and coremaking is done with conventional chemically-bonded sands, and all cleaning and finishing is done at PRL.

In the overall design of the new foundry, special attention was placed on the ladle preheating practice.



30 kW and 60 kW ladle preheaters at Regal Cast.

Efficient and safe foundry practice requires that ladles be dried and preheated when using conventional refractory linings. Insufficiently dried ladles will add hydrogen to the metal when the ladles are filled for the first time leading to pinhole casting defects. The resulting water vapor is also highly oxidizing and can result in reoxidation defects with susceptible alloys such as some stainless steels. Further, excessive amounts of moisture can lead to explosive vaporization.

Ladles must be preheated to a sufficiently high temperature to prevent premature freezing of the metal in the ladle resulting in "metal skulls". The preheat temperature varies with the melting temperature of the alloy being produced, but can be as high as 2400°F for steel.

THE CONVENTIONAL METHOD

The most common method of ladle preheating used in foundries and steel mills is gas-fired burners. The thermal efficiencies of these units range from 5 to 15 percent with larger steel- mill size ladles, and even lower with the smaller foundry ladles. Because of the combustion process, heat losses flow into the shop environment and often cause undesirably high temperatures in the work area. Gas preheaters are often noisy due to the high volumes of gas exiting from the nozzle jets, and may also contribute to poor air quality in the shop.

THE NEW WAY

Electric preheaters can raise ladle temperatures with much greater thermal efficiency, up to 80 percent, and with greatly improved safety and environmental conditions. Early electric ladle preheaters experienced element breakage. However, through modern design and controlled operating practices, high maintenance costs from broken heating elements have been minimized and good life expectancy can be expected.

BENEFITS:

- Prevention of explosions resulting from entrapped moisture
- Elimination of metal solidification in the ladle (skulls)

- Reduced tapping temperatures—energy savings in melting
- Reduced thermal shock of refractories—less wear
- Controlled drying of refractory—improved life
- Improved quality of melt
- Improved working conditions—noise, heat, fumes eliminated

DESIGN AND INSTALLATION

Based on the above considerations, in 1989 Regal Cast chose to install an electric resistance ladle preheat system called HEAT-TRAK, manufactured by Electric Melting Services Co. Inc., a subsidiary of Inductotherm Corporation, Massillon, Ohio.

The original suggestion of using one unit to fit both ladles was ruled out in favor of a dual-head unit with one power supply. The dual-head unit permits only one of the two heating heads to operate at a time. However, this has not caused any scheduling problems.

A 30kW head was designed to accommodate the 1000 lb. ladle, and a 60 kW head was designed to accommodate the 6000 lb. ladle. Power was transferred from the feed line through an SCR controller to a transformer. Two taps were selected on the transformer secondary to supply power to the heating heads. Because each head operates at a different power level, and each heating element has differing element arrangements, it was necessary to have two voltages available. Each output from the transformer secondary was selectable through a contactor. To select the appropriate heating head, the contactor coils were tied into the control circuitry. This system allows the ladles to be preheated to 2000°F in about 4 hours. The estimated average electrical energy required to preheat the 1000 lb. and 6000 lb. ladles is 122 kWh and 388 kWh, respectively. Because heating by electricity is significantly more efficient, energy costs were shown to be approximately one-half the cost of gas preheating.

OPERATING EXPERIENCE

Experience to date indicates that the installation of the electric resistance ladle preheating system was a sound decision. Proper ladle temperatures are routinely achieved with low energy consumption. Ladle spout freeze-up is not a problem, and noise and air quality goals have been achieved. Maintenance has been within normal limits.

The excellent results are best stated by Mr. Tony Regina, Executive Vice President: "When we started Regal Cast, Inc., we decided that electric heaters would be the cleanest, quietest, most efficient way to heat our ladles." According to Dan Chandler, Energy Services-Marketing Department of Metropolitan Edison: "REGAL CAST has proven that electricity is economical for ladle preheating and has improved their internal environmental conditions."

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COMPANY PROFILE

PRL, Inc. is the parent company for PRL Industries, Inc., Brenner Machine Company, LTC, Inc., and Regal Cast, Inc.

Regal Cast, Inc., a foundry, was established in the spring of 1989 after the purchase of its building in Lebanon in February. Adding a foundry to PRL, Inc. enhanced corporate capabilities in meeting customer requirements. Regal Cast's first pour was the week of July 10, 1989.

Regal Cast currently employs nine individuals, including Tony Regina (Executive Vice President) and Larry Snyder (Plant Superintendent). It is anticipated that as business increases, Regal Cast, Inc. may employ up to 15 people.

l to r George Pushkar, Regal Cast; Tony Regina, Executive Vice President of Regal Cast; Patricia Herschkowitz, Director of Public Relations & Advertising of PRL Inc.

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