Induction Heating producing Aluminum

THE CHALLENGE:
Obtaining Smooth Operation From Twin-Belt Continuous Aluminum Strip Caster

Background
Barmet Aluminum Corporation produces 300 million lbs. of aluminum sheet per year and has plants located in Uhrichville, Ohio and Carson City, California. At the plants, scrap and ingots are melted in gas-fired reverberatory furnaces and the molten aluminum adjusted for chemistry in reverberatory holding furnaces. The molten aluminum is poured into a Hazelett twin-belt caster to produce a continuous strip. The strip is fed directly into a hot-strip mill and then into a cold mill where it is reduced to sheet gauges. The coiled sheet product is then batch annealed in electric resistance heated furnaces. After annealing the product is tension levelled and shipped to customers.

Problem
A Hazelett twin-belt caster is comprised of two carbon steel belts driven by nip pulleys, see Figure 1. The belts are mounted such that the front surface of one belt is facing the front surface of the second belt. A pair of dam blocks are arranged to travel along the outer edges of the lower belt and create a defined casting region as shown in Figure 1.

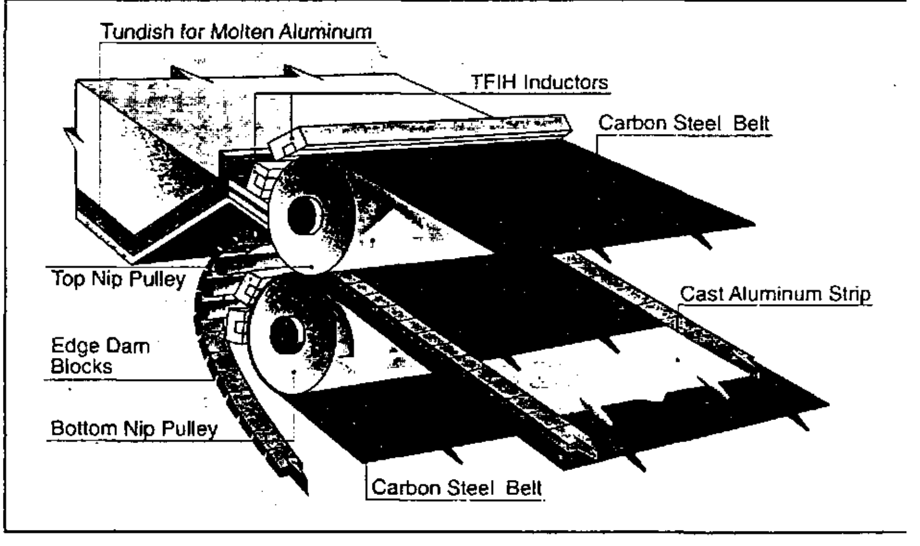

Figure 1
Hazelett's Twin-Belt Continuous Caster for Producing Aluminum Strip.
(Ajax patent # 5133402)

The height of the dam blocks determines the thickness of the metal strip being cast. The casting area is arranged to include a casting zone for receiving molten aluminum and a.cooling zone for solidifying the metal. As the molten metal is received into the casting zone a cooling fluid such as water, not shown in Figure 1, is delivered to the back sides of the belts. The water draws the heat away from the belts lowering the temperature of the aluminum causing the molten metal to solidify.

When the molten aluminum is introduced into the caster it contacts the carbon steel belts which heat up in an unregulated manner. This unregulated application of heat causes the belts to expand in an uneven manner and results in distortion of the aluminum strip being cast. In order to eliminate the undesirable effects of this uneven heating, various methods of transferring heat to the belts before entering the casting region have been considered. Both steam heating and electric infrared heating of the belts have been tried. Steam preheating the belts to the required temperature of 300 to 500°F was determined to not be a practical solution. When using infrared to preheat the belts to the required temperature, the belts needed to be heated over an extended area for considerable time which created engineering and construction problems in order to provide available space within the caster. Direct flame infrared heating damaged the belts.

The Solution

Recognizing the quick response and compact design advantages of induction heating, Stan Platek, Vice President of R & D for Barmet Aluminum Corp.

The basic principle of induction heating is quite simple. Heating is caused by electrical resistance to eddy currents induced in the workpiece, in this case the carbon steel belts. In the twin-belt Hazelett caster the belts form essentially flat plates prior to encircling the pulley. In order to heat the belts it would be necessary to induce currents in the plane of the belts. To do this, it is necessary to have the magnetic field impinging on the belt at right angles or transversely. This would then place the current in the inductor in the same plane as the belts. To achieve this, Nick Ross of UIHM recommended that transverse flux induction heating (TFIH) be used. "The location of the inductors was the result of considerable discussion and experimentation", said Mr. Ross. If placed too close to the casting region, buckling of the belt occurred. If placed too far away, it required high temperatures in the belts due to thermal losses on the way to the casting zone. Finally, two pairs of TFIH inductors were located at the entrance of the casting region and in close relationship to the belts, see Figure 1.

Since the twin-belt caster is a continuous caster that achieves equilibrium conditions very quickly, it was found that temperature control of the belts was achieved by controlling the inductor power. With a special ramp circuit, the inductor is brought to operating settings within the time the caster reaches operating parameters.

According to Stan Platek, "The TFIH preheating is very reliable with great flexibility and allows for continuous smooth casting. The inductors, which are adjustable, can be made to accommodate any width belt at various positions for optimum performance. As a result of the excellent performance, Barmet has installed TFIH inductors on the Hazelett casters at all three of their plants."

Benefits

Smooth Casting

Following installation of the TFIH inductors on the casters, no deformation or buckling of the belts has been encountered thereby permitting smooth continuous casting of strip.

Higher-Quality Cast Strip

With the elimination of the buckling of the belts, a flatter, higher-quality, strip is being cast.

Ability to Cast Other Alloys

The more controlled uniform belt heating by induction has allowed the production of cast strip with smaller transverse and longitudinal temperature gradients. This, in turn, allows for the acceptable casting of a wide variety of aluminum alloys.

Other Applications of TFIH Induction Heating

- *In-line, full annealing of aluminum sheet*
- *In-line heating of light gauge (<0.5 inch) metal for the purpose of adding heat between stands of a rolling mill*
- *In-line heating of light gauge metal for the purpose of increasing throughput of an existing furnace*
- *Replacement of gas-fired furnaces for annealing light gauge metal.*

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