TST Trials New Pump Technology Based on Magnets

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TST Inc., headquartered in Chino, CA, is a vertically integrated secondary aluminum company, producing ingot, billet, and cast plate for the automotive, aerospace, forging, tooling, and other industries. The company operates five divisions across four locations in North America, with more than 300 employees.

As a family-owned company, TST is focused on ensuring both the health and safety of its employees and environment, while also ensuring the efficient production of high quality products. With that aim in mind, the company invests in the latest technologies. Recently, TST worked with Zmag America to trial a new pump technology designed to replace traditional mechanical pumps in secondary aluminum operations (Figure 1).

Figure 1. The side-well furnace at the Fontana operation was outfitted with a new MagPump (seen in front), which replaced the existing mechanical pump.

Addressing the Problems with Mechanical Pumps

Addressing the Problems with Mechanical Pumps Secondary aluminum companies often use side-well or dual-chamber furnaces to process aluminum ingot or scrap into molten metal. Both types of furnaces work in similar ways, with the raw aluminum being initially heated and melted in the side well (or first chamber) prior to being moved to the main area of the furnace for alloying prior to casting.

Mechanical pumps are commonly used throughout the secondary aluminum industry as a low-cost means of stirring the molten metal and transferring the melt from the side-well to the main furnace area. Mechanical pumps are generally comprised of a motor supported by three posts and a central shaft in which is housed a rotating impeller that is submerged within the molten aluminum. The aluminum is agitated by the impeller.

The benefit of mechanical pumps is that they have relatively low set up costs and are good at circulating and homogenizing the melt, speeding up the melting process and improving the metal yield. However, the drawback is that every mechanical pump will eventually break. This can be caused by a number of reasons. As the impeller operates within the melt, it can be corroded with buildup of dross, which narrows the entry point through which the molten metal moves. In addition, the impeller is exposed to intense conditions that cause it to be worn down over time. These conditions make the impeller vulnerable to chunks of dross or pieces of refractory floating within the metal, which can strike the impeller and crack it.

Every time the mechanical pump breaks down, the furnace remains idling while the pump is replaced. This stops production and results in the natural gas being wasted, causing the furnace to emit CO_2. Generally speaking, installing a new mechanical pump is a time-consuming process. The pump has to be slowly lowered into the melt to prevent thermal shock, which can crack the impeller before the pump is even fully installed. When that happens, the entire process of removing and installing a new pump starts all over again, thus extending the furnace downtime.

A casthouse usually keeps track of the running and consumable part costs for mechanical pumps, however, rarely pays enough attention to loss of profits caused by downtime required to repair/ replace mechanical pumps. This can be calculated via the following equation:

annual profit loss = melt rate per hour x # of hours to replace the mechanical pump x # of replacement events per year x profit per ton/pound.

Generally, when a mechanical pump breaks, the furnace has no metal circulation for around 4 hours, while the pump is being replaced. Casthouses typically need to replace the mechanical pump about twice per month on average. Actual numbers vary among casthouses (due to alloy, melt rate, etc.), however, it can be estimated that in some cases using and replacing mechanical pumps can cost a casthouse an estimated profit loss of $250,000 per year per furnace (outside of the actual running/consumable part costs).

Some mechanical pumps also incorporate gas injection pipes into their design, with the pipe attached to the base of the pump. The aim is to have the gas as close to the circulation created by the pump, so that it will be evenly dispersed throughout the melt. However, if the gas injection pipe breaks, then the entire pump has to be removed from the melt in order to replace the pipe, which results in further downtime.

Outside of cost, another area of concern regarding mechanical pumps is safety. Casthouses regularly have to empty the furnace for a variety of reasons, such as changing alloys. Mechanical pumps are designed to suck the metal up through the top of the base as part of their de- sign. As the metal level 'lowers in the furnace during the emptying process, the mechanical pump will often begin splashing molten aluminum around creating a hazard and making it unsafe for personnel to be near the furnace.

With these two concerns in mind, Zmag has introduced MagPump ™, a new proprietary technology that utilizes Zmag Permanent Magnetic Circuit (zPMC) developed by Zmag in Japan. The zPMC is a noncontact magnetic field-based technology that creates a virtual impeller to pump and circulate the molten aluminum. Since the design does not have any breakable components, the technology is maintenance free. In addition, it eliminates the risk of splashing metal, since the design draws the aluminum up through the bottom of the pump, rather than the top.

Trial Results

TST trialed the MagPump technology for seven weeks at its TANDEM Division, which operates a facility in Fontana, CA. The division produces about 5,000 tonnes of aluminum per month in the form of high quality billet (6-43 inches in diameter) for extruders and forgers, as well as sheet ingot. The MagPump was installed on the facility's 130,000 lb. furnace (Figure 2), which has a charge well and a pump well.

Figure 2. Standing in front of the MagPump installed in the pump well of the furnace (L-R): Oscar Perez, plant manager for TST's Fontana operation; Tom Moore, aluminum casthouse sales engineer, The Schaefer Group, Inc.; and Eishin Takahashi, president of Zmag America.

Installing the new pump was a simple procedure, re- quiring only the removal of the old mechanical pump and dropping the MagPump in its place. "We have been looking for a cost effective way to try out some of Zmag's products without having to build an entire furnace around one." Said Jeff Stein, purchasing department manager for TST. "These pumps drop right into the well that the mechanical pumps would sit in with very little modification to the furnace."

Once the pump was installed, it was easy to operate and was essentially hands free, running smoothly with no downtime. The circulation that the pump created was also peaceful, with little to no disturbance to the bath surface, which meant less dross. "While charging and monitoring the furnace, I observed that the movement within the melt was fast and efficient and maintained a good homogenous temperature at all times," said Oscar Perez, TST's plant manager in Fontana. "We played around with the RPMS a little bit to see how it would affect the melt. However, we quickly realized that we didn't need to adjust the RPMs much at all. We didn't even need to lower the RPMs when draining the furnace. Even when the metal level got really low, we observed no splashing outside of the well. It was very safe for our operators."

Due to the reduced maintenance requirements, TST also found that it could make more efficient use of its manpower and operation. "The MagPump reduced the time that operators spend cleaning the and well from dross buildup," said Stein. "We saw a great time savings with this pump, as we were able to have our operator work on other parts of the casting process. We also did not have to worry about pump parts breaking in the middle of the cast."

Check Out the Article in Light Metal Age August 2022