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THE RESTART OF TWO IDLED POT LINES AT ORMET PRIMARY ALUMINUM

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Abstract

In November 2010, Ormet Primary Aluminum Corporation announced an aggressive plan of restarting two potlines before the end of the 1st quarter of 2011. In order to accomplish this goal several key factors were utilized including the experience of the plant personnel, management of anodes and bath generation at start-up, initial power and chemistry control of the pots, and the fact that the shutdown of the lines was efficient and controlled. The total time from the restart announcement until all 344 pots were brought on took only 92 days, and the time from when the first line was energized until the final pot was cut in on the second line took only 71 days. This paper will discuss the key factors and obstacles that had to be overcome to allow Ormet to achieve this goal while also striving for safety as no recordable accidents occurred during the restart.

Introduction

Ormet Corporation is a major producer of primary aluminum in the United States. Its aluminum smelter, located in Hannibal, Ohio, is capable of producing over 270,000 MT of aluminum per year when all six lines are operating. The technology employed at Ormet is side-by-side, center work, pre-bake pots, based on the OR-10-SE (UPCN)[1] design, with full break feeding. At the time of the restart, capacity was limited to 180 MT due to lines 5 and 6 being curtailed in 2009. The curtailment was the result of an alumina force majeure, which required the plant to idle two lines in order to conserve ore. This was most unfortunate as the entire plant had been restarted from a dry condition starting in December 2006 with all 6 lines running by the following December. Lines 5 and 6 were the last to be restarted from the initial restart, but due to the number of pots that were restarted actually had the highest average ages. As the restarts progressed, the procedures were modified and personnel gained valuable experience that allowed them to bring on the group of restarts more efficiently than what had been done with the other four lines, thus keeping the average age elevated.

Figure 1. Aerial view of the Ormet Smelter in Hannibal, Ohio.

The potlines had been shutdown at various times in the 3 years preceding the restart. Initially lines 5 and 6 were curtailed in December 2003 due to market conditions. Line 4 was curtailed in April 2004 for the same reason. Line 3 was curtailed in November 2004 due to a labor dispute and subsequent strike, which also lead to the curtailment of lines 1 and 2 in January 2005. This created a unique situation for the plant because some of the pots that were lined in 2002 would be restarted in 2010-2011 due to the long curtailments of the lines.

Shutdown Procedure

At the time of the 2009 shutdown, all efforts were made to bring the lines down in a controlled and efficient manner with the full expectation that they would be restarted at a later date. This was unlike some prior shutdowns where entire lines were tapped down in as little as 24 hours before power was dropped. During the 2009 shutdown pots were taken out of service individually to minimize the amount of metal pad in the pots and also prepare them for the restart process. This was done by tapping as much liquid bath as possible and putting the pots on a metal bake. That allowed the remaining bath to freeze out, and the remaining metal could then be tapped when the pot was cut out. The tapped bath was then crushed and bagged and stored on site in anticipation of a restart. This helped reduced the lead time for bath, helped ensure a high quality of material was available for the restart, and lowered the cost of the restart.

10-20 pots were cut out per 8-hour shift using the above procedure. This allowed for much smaller metal pads being left in the pots, which would ease the restart process as well as minimize aluminum inventory left in the pots. Once the tap down reached the center of the potrooms a crossover bus was installed to fully cut out the East half of the line. This also allowed for fewer cutout plates to be used as the ones that were used on the East end could now be taken off and used for pots on the West end. Once half of the line remained the procedure of cutting 10 pots out per shift continued until 30 remained that had to be taken down at one time due to the rectifier limitations. After the entire line was idled, a heavy plastic cover was draped over the pots to protect from water damage.

Restart Preparation Work

Once the lines were cut out almost immediately pot service began preparing for a restart of the lines. Personnel were utilized from other areas to begin scaling (removing the solid bath and metal) from these pots, including pots that were to be relined that also had the cathodes and shells removed. However, no pots were actually relined until November 2010 when the announcement was made that Ormet would restart the lines. From the period of November 2010 through February 2011, the pot service department concentrated almost exclusive on putting the new pots in line 6 and then line 5. The other four lines had maintained at or close to a full pot count during 2010, so pots were replaced only when it became necessary for the rectifier operation. If the pot counts had not been maintained at such a high level on the other lines the restart would have been delayed. Another important aspect of the preparation work was the generation of bath material that could be used for restarts. Each pot to be restarted needed to be banked with approximately 4 tons of crushed bath material. Using the material from the shutdown as well as generating bath and storing it, Ormet was able to perform the restart without requiring outside material.

Types of Restarts

During the restart two different methods were used to restart the pots a crash restart (Figure 2) and a resistor bake restart. The lines also contained new pots that were also resistor baked, which is typical for Ormet during normal operation. Because of the vast amount of resistor bake restarts and new pots some alterations had to be made from normal operation for the restart. During normal operation roller clamps are used on new pots to allow for expansion of the copper rod. However since we only have two sets of roller clamps, during the restart clamps were loosened and then retightened every hour to allow for expansion. Wooden T's were also used to block anodes out during the bake to help control the current distribution. During normal operation cathode temperature is the determining factor for when a bake on a new pot is complete, but with the restart we had to allow the new pots to be started with lower bake out temperatures because of rectifier limitations and timing. Temperatures were taken on all bake pots the following day and those that had achieved the highest temperatures were brought on first, giving an opportunity for the other pots to continue to heat up.

Figure 2: Blowing in bath on a crash restart pot

Rectifier Operation and Early Power Control

The rectifier operation and personnel associated with the rectifier were also major reasons for the successful restart. The rectifier systems at Ormet vary from line to line and each has different capabilities. A big reason for the differences is due to the different construction times on the lines. Line 5 was constructed in 1957 with GE half-wave rectification technology used in the rectifier. Line 6 was constructed in the 1960's with full-wave rectification employing Westinghouse, Alstom and Fuji technology. For the restart the rectifier needed 150V initially, which required the electrical resistor bake of 32 pots. This was done using only pots on the West end of the line while using a crossover bus to keep the East end isolated. The amperage was kept to 50 kA for the initial hour and gradually increased to 80 kA throughout the first 8 hours of the re-start. This was done to allow the bus work and all the connections to come up to temperature. As the voltage of the bake pots fell off more resistance was needed on the pot line and was supplied via crash restart pots. The crash restart pots were brought on from a cold state, but had been in operation prior to the shutdown. The crash restarts supplied up to 50V of demand power per pot and because of the configuration of the lines it was possible to do two restarts at a time, one in each room. This allowed the rectifier to stay within a 100-volt range, which was required due to the use of a "no load" transformer. Each step on the transformer was worth 100 volts, but as the name implies the load had to be taken down in order to step up the voltage. These steps were coordinated with the pot rooms in order to minimize down time by taking the step up when the load was dropped to bring on crash re-starts. Normally about 14 pots could be restarted between steps depending on how fast the voltage was reduced after the initial bath up.

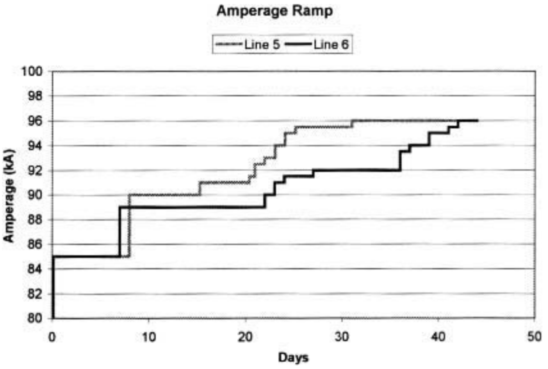

Figure 3. Amperage ramp for lines 5 and 6 from the initial start dates

Pre-soaking Anodes

During the restart no new anodes were used in the crash restart pots. This was done based on an observation that new anodes were cracking in crash restarts at a higher frequency than bath pre-soaked anodes from operating pots. Prior to restart a schedule was developed to take advantage of skip sets in the operating lines to generate the 600 pre-soaked anodes needed for the crash restart pots. An extra crew of anode setters was used to pull the anodes from the designated pots 12 shifts (96 hours) back and replace with new anodes. Typical anodes at Ormet are pulled at either 48 or 52 shift so these anodes were less than 25% used. This same procedure was repeated 3 more times in the same pots at the same anode position to get the pots back on a typical anode rotation as well as generate 8 anodes per designated pot. The total copper rod inventory and storage were limiting factors during the process. The schedule was started when pot service had the pots ready for the anodes to limit the number of rods taken out of operation. Often the anodes would be pulled, then loaded on a wagon the next shift and hauled to the line where they were needed and then put in the pots. During the restart very few anode problems occurred and no cracking problems appeared during the initial bath up in the crash restarts. By using anodes so quickly they had less chance to absorb any moisture which could create a safety issue when restarting pots. As an additional step for safety a special plexiglass shield (Figure 4) was used which allowed personnel to directly observe a restart bath up and direct the bath tappers and anode position. This helped eliminate the possibility of an injury due to bath splashing out of the pot.

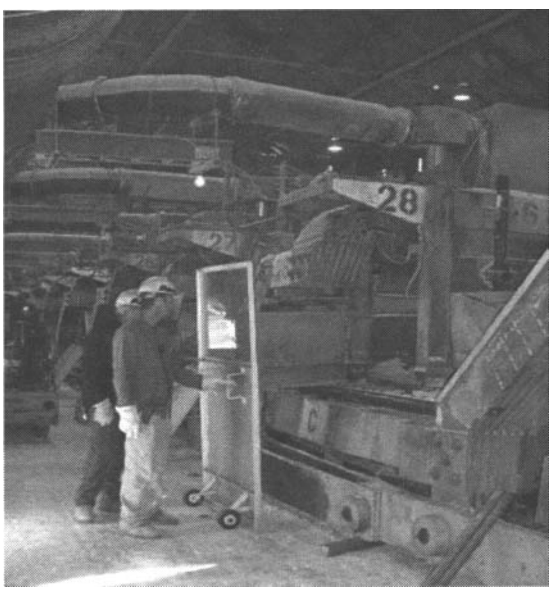

Figure 4: Personnel utilizing safety shield during bath-up.

Initial Start-up and Control

An important aspect in the initial control of the pots was that the amperage was kept at 90% of the 96 kA (normal set point) until the line was completely energized. By running at a lower rate the heat input of the pot was reduced and pots that would have failed if they were brought on at the full current could be operated initially. By operating pots that were double restarts (pots that had been cut out twice previously due to line shutdowns) we were able to speed up the process of starting the line. The pots could be used to generate bath and anodes as well as hold the voltage requirement for the rectifier. Due to the decreased amperage, a minimum voltage was established of 5.0 V per pot in order to keep the heat input to the pot elevated, and generate bath. New pots that were brought on followed the Ormet strategy for new pots that would be brought on during normal routine operation. This strategy allows the voltage to drop in a controlled manner from 6V to 5V in the 18 hours following the initial bath up. For the crash restarts, outside personnel with an exceptional amount of restart knowledge were brought in to monitor the restarts for the initial 24 hours after the pots were brought into operation. By having these experienced operators monitor the pot condition, anode effects, bath action and anode performance the pots could be brought on and put into a productive state much faster. The technical department would then monitor the voltages of the pots in order to get the pots into a computer-controlled state as quickly as possible. This was advantageous because the Celtrol computer control system could then make audible alarms for anode effects. When the voltage had dropped below 6 volts the pot could be put in automatic control to continue to lower the voltage while attention was given to the most recent restarts.

Regarding bath chemistry, the bath ratio was controlled to an elevated target to help induce sidewall ledging. By keeping the ratio elevated the pots that would have been most at risk for tapping out could be protected. That in turn would allow those pots to produce bath and anodes to aid in the restart of the rest of the plant. Another advantage of the increased ratio is the lower resistance of the bath and increased ability to isolate and work on noisy pots. The ratio targets were not adjusted down until after the 96 kA operating amperage had been achieved. At the time the elevated bath ratios were at 1.15 to 1.18 and gradually brought down to an operating ratio of 1.10 to 1.13.

MACT Compliance at 6 Months

Under United States law the MACT (Maximum Achievable Control Technology) standard has to be met within 180 days of start-up. For line 6 the 180-day period ended in May, making June the first full month in which compliance had to be met. For Ormet, fluoride emission compliance is determined by weekly roof monitor testing added to a fixed amount for dry scrubber testing. The results are reported as lbs. of F/ ton of Al and the first month yielded numbers of 1.3 as an average for the roof testing with a dry scrubber adder of 0.20. This made the final reported number 1.5 lbs. F/ ton of Al for line 6 in June, which was within the limits established for Ormet. For line 5, the 180-day period ended in July. The initial roof monitor test for that month was 1.0 with a dry scrubber adder of 0.15 for a total of 1.15 lbs. F/ ton Al for line 5, also within the compliance limits for Ormet.

Anode Setting and Bath Management

For the Ormet restart, it was desired to have the majority of the crash restarts occur on day shift. This would allow more plant personnel to be there to help with the most critical part of the operation. In order to ensure most of the restarts could occur on day shift the anode setting routines and bath generation had to be scheduled for the two off-shifts. Early on bath generation was done on the four operating lines with specific quarters of the lines being designated for bath generation on certain days. There are four main routines at the Ormet facility: Tapping Metal, Setting Anodes, Stub Bath Return to Pots, and Free Quarter. The "free quarter" as the name implies was not under a specific work routine for that shift. It was possible to schedule the free quarter on the four operating lines to have excess bath generated for the day shift by banking the pots during the previous 16 hours. After the second day of operation of line 6, bath-generating responsibilities were transferred from the other 4 lines. Once the bake pots had proven stable, they would be banked with crushed bath on the two off shifts. The crash restart pots for next day would also be pre-banked with crushed bath or cryolite that was generated on site. By pre-banking the pots (Figure 5) the day shift could concentrate on moving only liquid bath and bringing on the pots. This routine of tapping bath on day turn and banking pots on the off-shifts would be maintained until the restart was finished. Line 6 supplied the initial bath for line 5 until it could be self-sufficient.

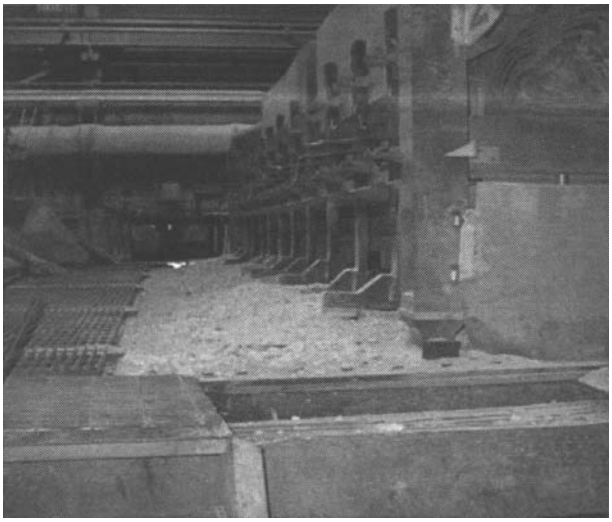

Figure 5: Restart pot after "pre-banking"

For anode setting, the normal setting routine occurs at 32 shift intervals for individual quarters of a line. However, with the reduced pot count initially it was possible to set the two operating quarters on the two off shifts. This scheduled allowed the pots to get into a normal anode change-out sequence and also kept the quarters open on day-shift for bath tapping. Some of the large anodes could then be used for the other crash restarts in the same room. This efficient use of materials aided greatly in the successful restart of the two lines.

Conclusion

The restart was completed on February 14, 2011; just 71 days after the restart began. All 344 pots were started ahead of schedule and without any injuries. Much of the success can be attributed to the manner of the shut down and the amount of preparation that took place before the initial energizing of line 6. It was a very important factor for a successful restart to be mindful of the future and do what was best for a potential restart. Also important was the ability to meet the MACT requirements by the end of the 180-day start-up period, which was possible due to the efficiency with which the lines were started. By having the potlines up and running rapidly more time was available to get into MACT compliance before the start-up period ended.

Acknowledgement

This restart could not have been done as rapidly or efficiently without the cooperation, and shared focus of Ormet's management and work force.

Reference

[1] Tabereaux, A., "Prebake Cell Technology: A Global Review", (JOM); 52 (2), 2000, pp. 22-28