Metal Crucible Tracking System at EGA Using Digital Technologies

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Abstract

Lack of visibility of the metal crucible along its journey is a common challenge in many of the aluminium smelters. Unavailability of metal crucibles disturbs the metal flow which might lead to pending activities. This challenge occurs due to the number of different stakeholders involved in the journey of the crucible and data being scattered and analyzed differently among them. The objective of the solution is to provide full transparency and visibility for all the stakeholders involved (Potroom, Potroom Services, Casthouse, Maintenance) as one single source of truth. This is done by collecting and capturing time and location of each crucible at all different processes along the journey from different machines and systems. A comprehensive dashboard was developed along with an auto generated report for all the different stakeholders to monitor the operation performance at each step in the journey. In addition, crucible tracking application was developed for the crucible transfer vehicle (CTV) operators to collect missing data and operate based on automated prioritized live work-order. The full visibility and transparency of the metal crucible journey allows to draw solid duration baselines for each process, therefore, introducing new KPIs for each process owner. In addition, providing the visibility to the CTV operators allows to shift from experienced-based to data-based operational decisions. The crucible tracking system helped to reduce pending metal tapping incidents, respond faster to debottleneck impediments, reduce cycle-time, reduce frozen crucible incidents, and reduce overweight crucibles.

Keywords: Industry 4.0, Aluminium smelter, Metal crucible tracking system, Metal crucible transfer vehicle, Metal flow.

1. Introduction

Pending tapping and unavailability of crucibles is a common challenge in many smelters around the world. There are many reasons why delays in tapping occurs, such as pot tending machine breakdown (PTM), unavailability of empty crucibles, furnace breakdown, emergency situations, etc. In some extreme cases, delayed tappings accumulate to a level where the line amperage is reduced to catch-up with the pending activities resulting in loss of production.

The lack of visibility in the metal crucible journey in the plant causes longer time to take the right actions to debottleneck the situation. The data along the journey is scattered, each team analyzes the data differently based on their perspective, making it hard to take a collective decision.

Having full visibility of all the crucibles in the plant enables all different teams to work collectively to overcome the different challenges along the crucible journey. Optimizing the crucible flow can reduce the turnaround time of the crucible by minimizing the idle durations in different processes along the journey. This will lead to deliver a hotter metal to casthouse, reduce the emission from the exposed tapped metal, and reduce the frequency of crucible cleaning. The transparency of the crucible movement allows the operators to move from experience-based to data-based operational decision.

This paper explains how the visibility of all the crucibles in the plant was obtained through the developed crucible tracking system and how this system helped improve the operation in EGA.

2. Operation Prior to the System

The job of the CTV operator is critical and challenging due to the number of stakeholders involved in the crucible journey from Potline, Casthouse (CH) to maintenance. During the shift change, the CTV operator is briefed by his/her colleagues about all the crucibles that he/she is responsible for. This is a manual process which might not be very accurate due to large number of crucibles and multiple operators working together. The operators communicate with each other using radio telecommunication, WhatsApp, text messages, and phone calls.

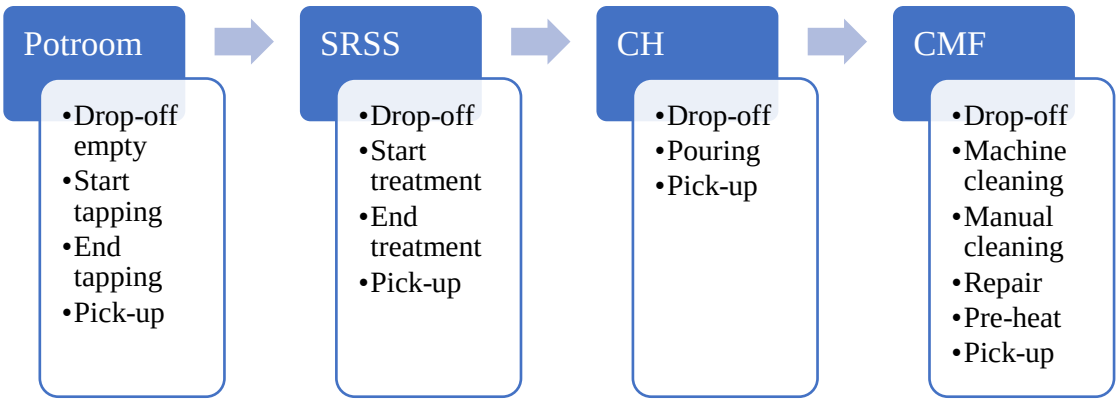

Figure 1. Diagram of the main processes along the metal crucible journey.

Starting with potlines, as shown in Figure 1, the CTV operator needs to ensure enough crucibles are available so the potline operator can perform metal tapping without any delay, as well as move the full crucibles to the next process as fast as possible to minimize the metal temperature drop and avoid frozen metal incidents. The CTV operator is fully dependent on his/her experience to predict the crucible status in the flow. If there is any long delay, potline supervisor communicates with services team to expedite the transfer of full metal crucible.

Next, the full crucible is transferred to sodium reduction and skimming station (SRSS) for treatment. After dropping, any other treated crucible is then moved to the assigned furnace in Casthouse. After the drop, the operator manually searches for any empty crucible in front of the furnaces to be used for the next tapping. This process is manual; therefore, the operator cannot perform first-in first-out (FIFO) to ensure hotter crucibles in the loop. As and when required, the

Due to the absence of data before implementing the system, we were unable to quantify how much the visibility to the CTV operator through the application resulted into reduction of idle/wasted time waiting to be picked up. However, the number of complaints due to delays in crucible operation reduced by 75 % after the system implementation (dropped from 35 to 8 complaints in the past 6 months). In addition, since the system was deployed (approximately 6 months), there have been no frozen crucible incidents recorded yet. Based on Potline and CH feedback, it was noticeable that the visibility the new system provided improved the operation significantly.

Another important insight the system visibility provided is the optimum number of metal crucibles required in the loop. Having fewer crucibles in the loop will lead to pending tapping. On the other hand, having excessive number of crucibles in the loop will lead to colder crucibles, therefore, increase in crucible cleaning frequency. In average, the number of overweight crucibles dropped by more than 85 % after implementing the system (from approximately 35 to 4 overweight/dirty crucibles). This had significant impact on overall work flow efficiency.

Potroom services team decided to allocate a physical location in the loop where the crucibles are dropped when they are not needed and sitting idle. Figure 9 shows the trend of how many crucibles were dropped in idle location and the average duration. The graph assists potroom services team to take an informative decision to either remove or add crucibles in the loop.

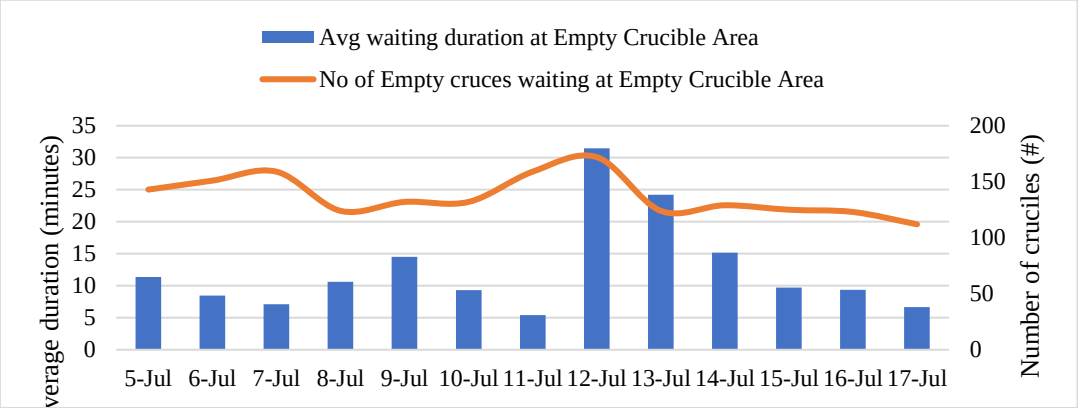

Figure 9. Number of empty crucibles and its average duration in idle position.

6. Conclusion

Full visibility and transparency of the entire crucible journey was achieved through the developed crucible tracking system. It consists of a mobile application for CTV operators and one-stop dashboard. Data from Potline, SRSS, CH, and Maintenance were combined to close the loop on the crucible journey. The mobile application was used to collect missing data and provide an automated prioritized work-order list for CTV operators. On the other hand, the developed dashboard was used to assist various teams to debottleneck the challenges. Detailed process breakdown of the entire crucible journey was obtained. This supports the operation to set new KPIs for each process in the loop to reduce the crucible turnaround time. After implementing the system there was a significant reduction in number of pending tappings, overweight crucibles, and frozen crucible incidents.