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Productivity Improvements at Direct Chill Casting unit in Aluminium Bahrain (ALBA)

, Aref Ahmed Mohd Noor[1], Sukanta Chatterjee[2]A. Rasool Ahmed[1]
[1] Casthouse, Aluminium Bahrain B.S.C. (c), Kingdom of Bahrain
[2] R & D, Aluminium Bahrain B.S.C. (c), Kingdom of Bahrain
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Abstract

ALBA has been producing Rolling Ingots utilizing two DC casting units viz., DC1 & DC6. Out of total annual production of 140,000 MT of Rolling Ingot, DC6 production was 100,000 MT (1xxx, 3xxx & 8xxx series alloys) while DC1 production was 40,000 MT of 5xxx series alloy. Due to higher cost of production & low productivity at DC1, ALBA management decided to close down DC1 as a part of restructuring exercise and maximizing production at DC6 to meet customers demand. An extensive study was carried out towards improving productivity. Four levers of improvement which has the maximum impact were identified e.g., furnace preparation practices, preparatory activities between casts, increasing casting speed etc. Various action plans were drawn up & were implemented. These actions were closely monitored by DC operators themselves by using trend charts. As a result a 30% improvement in productivity was achieved at DC6 on a consistent basis.

Introduction

Aluminium Bahrain (ALBA) started its operation in the year 1971. The first Casthouse was commissioned in the same year with the production of Rolling Ingots (DC1) & Tee Ingots. Subsequently over the year Casthouse 1 expanded the operation by adding facilities for casting Extrusion Ingots. During 1992 ALBA went for major expansion by adding Potline 4 which necessitated setting up of additional casting facility. As a result Casthouse 2 was commissioned with Standard Ingot Casting Lines (P1020 & Foundry grade) and Rolling Ingot Casting facility as DC6. ALBA has been producing Rolling Ingots from 2 DC units viz., DC1 at Casthouse 1 and DC6 at Casthouse 2. Over the years Rolling Slab casting facility at ALBA underwent many upgrades like top control to bottom control system for metal distribution, change over from 420 mm to 460 mm thickness slabs along with increase in furnace capacities. Total Rolling Ingot production capacity at ALBA stood at 140,000 MT per annum.

Background

ALBA has been producing Rolling Ingots of various alloy types, viz., 1xxx, 3xxx, 5xxx & 8xxx between 2 DCs, viz., DC1 & DC6. As a part of convenience & logistics DC1 has been producing 5xxx series alloys while DC6 has been producing 1xxx, 3xxx & 8xxx series alloys. Total annual production of Rolling Ingot is around 140,000 MT. DC1 has been producing 40,000 MT while DC6 has been producing 100,000 MT per annum.

During the year 2005 ALBA went for another major expansion by commissioning Pot Line 5 and Casthouse 3. New Casthouse 3 was commissioned with state of the art Extrusion Ingot casting facility. This expansion has made Extrusion Ingot casting facility at Casthouse 1 redundant. Once the operations at Casthouse 3 stabilized, total production at Casthouse 1 reduced drastically and Casthouse 1 is left with only production of Rolling Ingot at DC1. This resulted in increase in cost of production at DC1, Casthouse 1 due to high fixed cost to maintain all the infrastructural facilities. Around this time the price of Aluminium started to dip as a result of worldwide financial crisis . This forced ALBA to take a stock of situation and optimize cost of production.

It was found that cost of Rolling Ingot production per ton at DC1 is almost 2 times than that at DC6 which makes DC1 unviable. After lot of deliberations ALBA executive management took a decision to close down operations at DC1. It was expected that by doing this total Rolling Ingot production capacity will be reduced by almost 30% as per existing levels of production. ALBA took a decision look into feasibilities of improving productivities at DC6. A core team comprising of representatives from operation, maintenance, technical was formed to carry out this study by applying principles of lean manufacturing process [1].

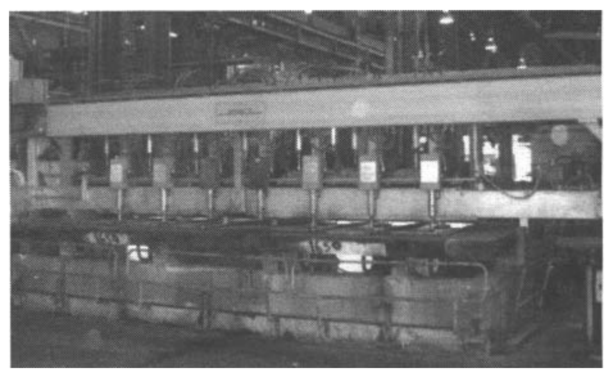

Figure 1 DC6 Casting Unit with automatic metal level control system

Figure 2 DC6 Casting Unit with 460 mm thickness Rolling Ingots

Study for Productivity Improvement

To get maximum benefit out of the study, an external consultant was appointed give exposure to techniques of lean management. Interactive training sessions were organized for all the supervisors & operators to buy-in the lean concept.

The core team along with supporting members studied all the activities / processes related to production of Rolling Ingot at DC6,

- Metal receipt from Pot lines
- Pouring metal into furnaces
- Furnace batch preparation
- DC preparation
- In between cast activities
- Actual casting process
- Waiting time before ingots are ready for discharge
- Drying of ingots
- Time to discharge ingots
- Station change activities
- Net yield per cast

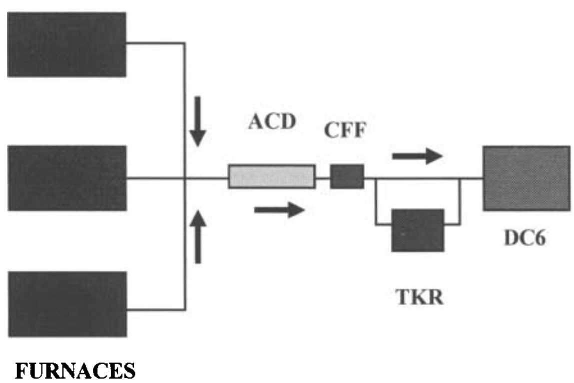

Figure 3 DC6 Layout (Schematic)

As per ALBA's definition 1xxx & 8xxx series alloys are considered to be soft alloys while 3xxx & 5xxx series alloys are considered as hard alloys.

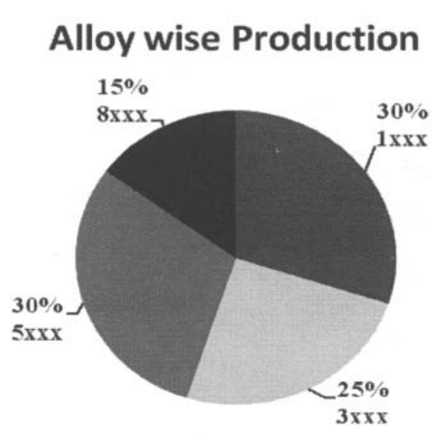

Figure 4 Alloy wise Production trend of Rolling Ingot [2]

With the closure of DC1 entire 5xxx series alloy production is required to be produced at DC6. This would necessitate additional furnace washes after each campaign which has an adverse impact on the productivity. Addition of casting 5xxx series alloy in DC6 range of alloys posed a challenge for the team.

The present study was initiated in October 2009 and the production figures of year 2008 was taken as a reference. However it was made adequately clear to the team that although productivity improvement is the prime objective of this exercise, one cannot compromise on safety & quality.

Initially OEE (Overall Equipment Effectiveness) study was carried out for DC6 operations. This involved contribution of the following factors,

- Planned maintenance and shutdown
- Pit cleaning
- Machine breakdown
- Furnace washes for alloy changes
- Delays due to operational & technical reasons
- Preparation time between casts
- Station (size) change time
- Casting time
- Time loss due to abort casts
- DC utilization for maximum number of ingots
- Scrap & defects (planned & unplanned)

After a thorough measurement & analysis of the above the factors which can contribute to maximize the OEE were identified.

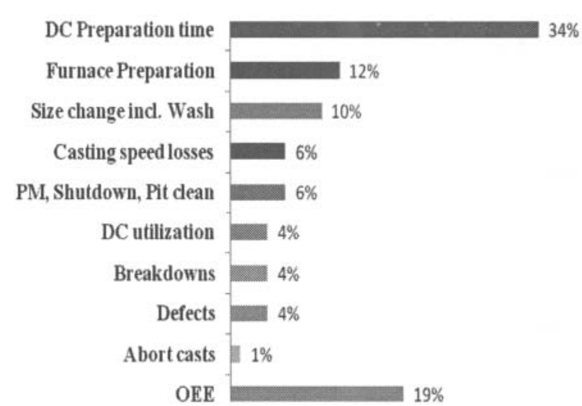

Figure 5 DC6 OEE (%) Analysis based on year 2008 production [3]

Based on the study following 4 major levers were identified where there potential to minimise losses and improve OEE.

1. DC Preparation time
2. Furnace preparation
3. PM, Shutdown, Pit Clean
4. Casting speed losses

DC preparation time

Activities from stopping the platen at the end of cast until starting of the next cast were mapped, as shown below,

- Shift Casting launder to parking position
- Cooling the ingots for complete solidification
- Tilting mould frame up
- Drying the ingot head
- Discharging ingots from DC pit
- Tilting mould frame down
- Cleaning the mould
- Engaging starting head into mould
- Drying starting head including water drain
- Shift casting launder to casting position

Brainstorming sessions were carried out with all the casting crew to generate ideas for minimizing preparation time. Going through this exercise it could be established that there is potential to improve DC preparation time by 40% by doing the following,

1. Standardizing cooling time ingot size wise
2. Use 2 operators to dry ingot head
3. Establishing & marking reference points on the ground as well as on the crane for hoist positions for discharging ingots at various locations
4. Follow the best path from DC to ingot laydown conveyor for fastest turn around time
5. Coaching of all the operators by most skilled / senior operators
6. Carrying out several activities in parallel like moving starting head upward while discharging last ingot from the DC pit

Subsequently all the ideas generated were validated in the shop floor and were integrated into the Standard Work Instructions for DC6. The implementation was easy since most of the ideas were generated by shop floor personnel only.

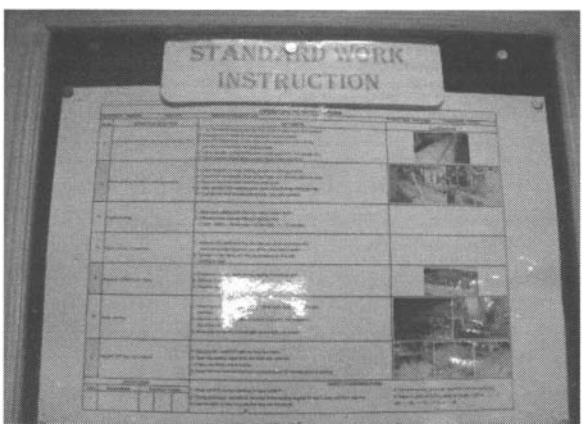

Figure 6 Standard Work Instructions displayed in the work area

During implementation period shift wise performances were closely being monitored by operators with the help of trend charts. Performance review meeting was being held at the end of each shift. Any deviations from target was discussed & recorded on action list and suitable corrective actions for these deviations were derived.

Furnace Preparation

Following activities of furnace preparation were looked at for idea generation,

- Crucible pouring
- Alloying
- Stirring
- Sampling
- Skimming
- Settling

During brainstorming sessions some of the ideas were,

1. Changes in sequences of crucible pouring & alloy and other cold charge addition to furnace to ensure faster melting
2. Doing some activities in parallel
3. Ensuring liquid metal availability as & when required by close communication with TAC plant
4. Focus on getting furnace "on spec." in the 1st attempt
5. During shutdown of 1 of the 3 furnaces only soft alloys to be planned to lower no. of attempts required for on specification metal
6. Train / retrain operators for "best practice" procedures

The saving potential is envisaged to be 25%. The major emphasis has been to prepare the furnace in 1st attempt.

PM, Shutdown & Pit Clean

Maintenance activities play a vital role in productivity of the equipment. The objective for the team was improve maintenance performance without compromising productivity of DC6. During the brainstorming exercise 5 areas were identified.

1. Planning & Scheduling
2. Improved Execution
3. Equipment Strategy
4. Autonomous Maintenance
5. Spare Parts Management

The action plan evolved out of this brain storming activities are as follows,

- Preprocess all the requested jobs to screen real needs (Gate Keeping)
- Define fixed accountability for job execution
- Improved workplace organization
- Improved remote work place organization
- Create SOPs for most recurrent complex jobs
- Equipment failure analysis for corrective/preventive action

- Execution of simple clean & check activities by production operators and develop SOP
- Optimization of spare store room layout to reduce handling time
- Carrying out some activities in parallel like overhauling actuators/sensors in between casts, pit cleaning during PM etc.

Based on the above it was possible to change over from bi weekly PM schedule to four weekly schedule. As a result it was found that about 200 hr of production downtime could be eliminated.

Casting Speed Losses

Casting productivity is one of the area where work was already initiated from the beginning of year 2009. The existing steady state casting speed for various alloys and sizes were reviewed. The following aspects were looked into during this exercise,

1. Maximum design speed for the type mould
2. Maximum metal flow rate for the existing down spout without causing turbulence
3. Maximum metal rate for the existing distribution bag
4. Dimensional tolerances for the output ingot viz., concavity
5. Grain size (macro) for the ingots after etching
6. Shell zone depth for the ingot
7. Any other obvious surface defect

It was found that it is possible to reach maximum design cast speed for majority of size / alloy combination. This would result in an increase of casting productivity by 7%. For implementations some of the parameters needed to be adjusted e.g., steady state water flow, steady state metal level in the mould etc. The implementation was carried out in incremental steps of cast speed increase prior to reaching the target speed. The quality of the output ingots were very closely monitored and only after ensuring that it meets the customer specifications, they were shipped.

Implementation & Monitoring

Inline with ALBA's strategy towards process optimization operations at DC1 was completely stopped 31 December 2009 onwards.

Implementation of the agreed points for DC6 started to be implemented January 2010 onwards in steps and real effect of implementation was being felt March 2010 onwards.

KPIs for various activities were agreed upon and were displayed in the shop floor with clear responsibility and accountability.

Performances of the individual shifts were being closely monitored by Performance dashboard.

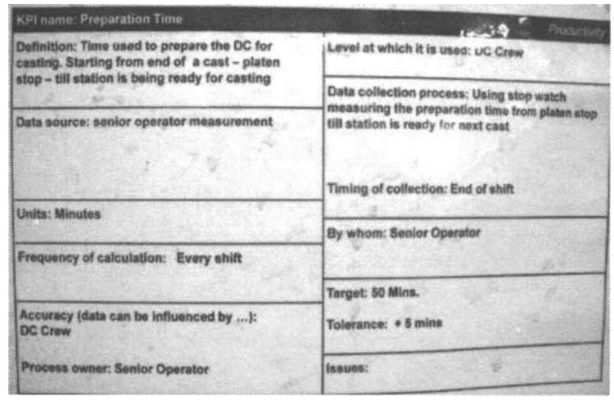

Figure 7 Procedure for monitoring KPI as displayed in shop floor

Individual shifts were conducting performance dialog at the end of every shift. During initial period of implementation these meetings were being moderated by members of the implementation core team and subsequently these meeting were handled independently. During the discussions any deviations from the targets were highlighted, possible reasons were identified and corrective actions were recorded in the board for subsequent follow up. These activities generated lot of enthusiasms among the operators and they have been driving the process.

It was also agreed that targets for various activities are dynamic and maximum validity of targets to be 1 year maximum and beyond which it must be set at higher levels.

Results

The effect of the implementation started to be felt from March 2010 onwards. The net production in March 2010 was 11363 MT of rolling ingot. To sustain this achievement ALBA's rolling ingot customer was also taken into board. A joint task force was formed with members comprising of production, R & D and marketing from ALBA and relevant personnel from ALBA's customer. Various issues which can improve production and delivery of rolling ingots were discussed in details. Some of the issues are [4],

1. Switching over from bi weekly placing of orders to monthly order placement
2. Agreement on sequence of casting various alloys to minimise requirement of furnace washes
3. Optimizing length of ingots for maximizing furnace output
4. Close communication between the companies for better alignment and fast response

The understanding is to arrive at win-win situation which benefits both the stake holders and the results, as given below, adequately demonstrates this.

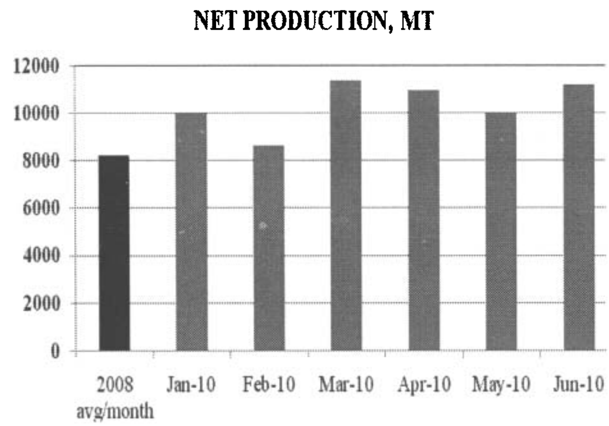

Figure 8 Trend of Net Production at DC6 [5]

Conclusion

As an out come of implementation of "lean" process and recommendations from the task force ALBA is able to achieve higher levels of production over a period. ALBA is able to record a 32% improvement in production (March – June 2010 period) on a sustained basis as compared to year 2008 levels of production at DC6.

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