The evolution of the innovative MQP Batchpilot furnace weighing system at Alunorf is explained and presented here in a joint article by Alunorf and MQP.

"Knowing the correct weight of metal in the furnace is a real step forward to higher customer satisfaction in that all the slabs supplied are now consistently of the precise length as specified by the customer in their order" - This is how the Management casthouse team at Alunorf in Germany describe the beneficial effect that the fully automated Batchpilot furnace weighing system now has on their slab production process. Over several years, the collection and detailed analysis of information by the casthouse team has contributed to Alunorf achieving the consistency of casting slabs they seek.

Aluminium Norf GmbH, or as it is usually known Alunorf, was founded in April 1965 by the former Alcan, now Novelis, and the former VAW, now Hydro Aluminium, as a joint venture. Thus was created in Neuss the biggest aluminium rolling and remelt plant in Europe for the processing of aluminium to sheet and plate for a wide range of applications.

Production at Alunorf
Alunorf’s production comprises aluminium melting units, hot rolling and cold rolling. Production is organised in shift systems that allow operation around the clock, seven days a week. The sales volume has continuously increased and now totals around 1,500,000 tonnes annually.

In the casthouse, aluminium scrap from all over the world is melted, together with Alunorf process scrap. There are 13 casting pits, each with a melting and holding furnace, allowing slabs up to 8.7 m long and 2.2 m wide to be cast. The top ingot weight is in the region of 30 tonnes.

Approximately 80% of the products are axial products such as strip for all kinds of packaging, can stock. Apart from materials for cans, the end products include strip for all kinds of packaging, automotive application, shipbuilding sheet, architectural gauges, and lithographic sheet.

Batchpilot unit
The Batchpilot story began at Alunorf in the year 2008, with a project in the melting department, aimed at optimising the number and sizes of slabs being produced per cast as a means of increasing production capacity.

It was recognised at the time that the difficulties being encountered with an issue of short casts, namely on average 600 short casts per month from a total of about 1,500 casts per month, was mainly due to the casthouse team not having an accurate knowledge of the weight of metal in the furnace.

The operators relied on a visual judgement of the metal weight in the furnace. Visual estimates of metal weight in a furnace are generally known to have an error of greater than ± 2 tonnes and can be much worse when there is a build-up of dross on the furnace walls underneath the metal surface.

A standard Batchpilot unit was installed and extensive trials carried out to examine the potential for using the Batchpilot system to achieve better control of metal transfer weight and metal weight in the furnace. This could optimise the number and sizes of slabs being produced per cast and significantly increase production capacity.

The Batchpilot system is a furnace transfer liquid metal and furnace heel weight measuring system which operates on principle of creating a relationship between the changes in the furnace cylinder hydraulic pressure and tilting angle. A schematic view of a typical tilting furnace is shown in Figure 2.

In operation, the furnace is supported by its pivots and up to two hydraulic cylinders, which means that the furnace mass is distributed between the furnace pivots and the cylinders. The location of the centre of gravity of the whole system can be calculated and due to the geometry of the system, a large furnace angle corresponds to a larger pressure in the cylinder.

Weighing the liquid metal inside the furnace using the hydraulic pressure in the cylinder can be achieved by establishing a relationship between the pressure variations caused by various amounts of liquid metal, to determine the actual metal mass inside the furnace.

None of the other systems available for measuring furnace metal weights including using radiation beams such as laser or radar can compensate for slag build up underneath the metal surface.

In the standard Batchpilot system a weight measurement is initialised by the operator from the Batchpilot HMI control panel during the production process. Furnace weight is operator dependent and relies on the operator transferring the correct information from the Batchpilot screen to the plant batching system.

Evolution of Batchpilot at Alunorf
2009

- Alunorf investigated, in two phases, the potential for using the standard, manually operated, Batchpilot system.(2)
- In the first phase, heel weight measurements were made to establish the inherent system accuracy and variation between measurements.
- In the second phase, heel weight, transfer weight, total furnace weight and slab weight were measured.
The results indicated that Batchpilot measurements were within 1% of the total furnace weights. This gave an overall conclusion that the Batchpilot system could measure furnace weights at Alunorf to within ± 250 kg.

This would bring the following benefits, as summarised by the Aluminium Norf GmbH Management:
- Total furnace weights of around 45 tonnes could, for the first time, be measured accurately.
- Frequency and scheduling of furnace cleaning became more manageable due to immediate availability of Batchpilot measurements.
- Using Batchpilot measurements it was now possible to routinely cast three 1,650 mm slabs per cast of the correct length on a specific casting unit. This was not possible before.
- Since the introduction of Batchpilot, there had been less “short” casts.
- Alloy changes were easier to manage, as the heel weights in the furnace were accurately known.
- The introduction of the Batchpilot system was regarded as one of the milestones towards increasing total production capacity at the Alunorf casthouse plant.

2011 to 2014
- During this period the eleven Batchpilots all operated in the standard manual mode and generally achieved the benefits expected.
- In 2012, at the request of the furnace operators all the Batchpilot units were modified to a partially automated system where the operator dependence was reduced by installing a press button on the control panel and a software package which enabled remote initiation of the weight measurement. This, together with other on-going process improvements, brought about a further reduction of short casts from about 35% to 15% of all casts per month as shown in Figure 3.
- The casthouse operated in this way until early 2015 when it became clear that despite a remote button initiation being installed, only an average of 60% of the casts were being measured and the number of short casts was still too high. It was recognised that to get accurate measurements they needed to increase the use of the equipment - using the Batchpilot only when needed was not an option.

2015
- In July 2015 the Alunorf Casthouse Management arranged for a daily control of all batches produced with the aim of achieving 100% measurement with Batchpilot for both heel and full furnaces.
- At the same time the Production Managers took time to explain to the furnace operators the principal effects of missed Batchpilot measurements and all the implications, which were principally:
  - Short casts, leading to short ingots, unhappy customers and loss of production and income.
  - Incorrect and over alloying, leading to the cast being scrapped and again loss of production.
  - There was a concerted and sustained effort from casthouse management to obtain worker “buy in” to achieve the goal of 100% Batchpilot measurement. The initiative was a difficult success, and as shown in Figure 4 there was a gradual increase in the hit rate for Batchpilot measurements to 80-85 % for the period July to October 2015. This resulted in a reduction to an average of about 50 short casts per month.
  - This improvement continued into 2016 with a 90% hit rate on Batchpilot measurements and short casts down to around 30 per month.
  - Regular dialogue with the furnace operators continued and led to a request from them for the Batchpilot system to be upgraded to complete automation of heel and full furnace.

2017
- This was agreed and in January 2017 a programme to convert all the Batchpilot units to full automation was carried out. This was relatively straightforward for the group of small furnaces which had sequencing, but more difficult for the larger furnaces where a signal had to be created.
- Figure 5 shows a Direct Chill (DC) casting centre with a holding furnace equipped with a Batchpilot (in the background), and Figure 6 is a close-up of a Batchpilot control screen.
- From January 2017 all the Batchpilot units were operating on full automation with an average hit rate of 95% measurements daily, as shown in Figure 7, and short casts were reduced further to less than about 20 per month as shown in Figure 8. This represents about 1% of Alunorf output - further improvement becomes very difficult and realistically cannot be achieved simply by using Batchpilot.
- Statistical process control monitoring indicated that the Batchpilot measurements of full furnace and heel weights were only in
error by an extremely small amount of less than 1.0 % against actual ingot weights as shown in Figure 9.

Since that time, and after a year’s experience of Batchpilot automation, the casting plant is now running at a hit rate of nearly 100% and the number of short casts is stable at less than about 20 casts per month.

A story of success

Alunorf first installed standard, manually operated, Batchpilot units on their furnaces several years ago after extensive trials had confirmed they would be able for the first time to obtain accurate weights of their full furnace and heels. There were real benefits of having accurate weights including, most importantly, almost eliminating short casts and making alloy changes more manageable. Furnace cleaning also became more manageable. Overall production capacity at the Alunorf casthouse plant increased.

The introduction of the Batchpilot system helped contribute to this improvement.

For several years Alunorf operated Batchpilot with a consistent routine and continued, through process improvements, to have less short casts than previously. However, the need for further improvement, especially in the number of short casts, became important for production and, after discussion with the casthouse operators, all the units were installed with remote initiation buttons. The idea was to simplify the Batchpilot practice as a means of increasing the frequency of taking measurements as defined by the hit rate, and thereby further reduce short casts.

This change brought about a further reduction of short casts but detailed monitoring revealed that the hit rate for Batchpilot measurements was still only 60%. This led to an organised education programme to encourage the workforce to buy into the fact that missed Batchpilot measurements meant more short casts and loss of production. This initiative had the desired effect, and short casts were reduced to about 30 per month.

The next instalment of the Batchpilot story came early in 2017, when the operation requested full automation. This led to the installation of fully automated systems on all the Batchpilot units and by the end of the year they were achieving nearly 100% measurement and short casts were down to less than 20 per month. "This was finally ‘mission accomplished’", and it is an excellent example of how a dedicated management team can:

• Identify a problem that exists with operating procedures
• Take time, effort and perseverance to explain the importance of 100% utilisation of Batchpilot equipment to the operators
• By close co-operation, successfully achieve operator ‘buy in’ and reach Alunorf’s ultimate goal of almost no short casts.

Final words

In concluding this article, the Alunorf casthouse management team wishes to emphasise very strongly the vital importance of the frequency of taking Batchpilot measurements in achieving the needed weight accuracy. Even 80% of all furnace batches being measured is not sufficient. You need to measure 99%, or more, of all batches to really trust the measurements obtained. This was Alunorf’s main challenge and is simply stated in their own words as “to use the Batchpilot system more and more to eventually fully trust the measurements”.

References


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