

The Opticast system is truly innovative

To be described as innovative, a process development should be radical, groundbreaking and transform the way the process itself is approached. It is therefore reasonable to say that the term innovative can be accurately used to describe the Opticast system and its growing impact on the industrial process of grain refining of aluminium alloys.

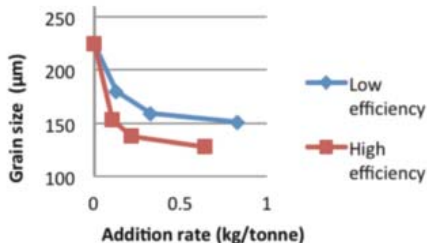
The Opticast system was conceived by Lennart Backerud and co-workers at Stockholm University. Since that time it has been extensively developed, tested and refined and today the Opticast technology and methodology are proving to be invaluable tools in carrying out optimisation and control of grain refinement practice in casthouses worldwide. The system (fig 1) allows rapid and reliable results to be generated so that accurate conclusions can be drawn allowing implementation of optimum grain refining practice.



1 Instrumentation used in the Opticast system

Implementation of the Opticast system in the cast house entails the following steps:

1. Calibration
2. Sampling in casting furnace



2 Grain refiner curves for two master alloys with different efficiency

Calibration involves establishing how a specific alloy responds to addition of fresh nuclei via the grain refining rod, in other words establishing the equations for the grain refinement curves as shown in figure 2. The figure shows a test with two different grain refiner batches in the same alloy melt. If both grain refiners are used in a cast house, the calibration must be done to handle any variations in the grain refiner efficiencies, i.e. a worst case scenario. In the actual case, this means that the calibration equation must be set up for the upper of the two curves and is used for the other one as well. There is much to gain if the grain refiners used have a constant high efficiency. For the calibration, it is important to consider the layout of the casting line and how it influences the recovery of the grain refiner used. The Opticast methodology is designed to take care of these parameters in the calibration process.

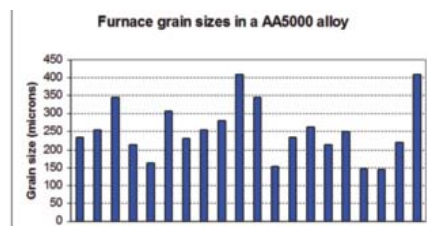
After calibration, sampling commences,

which involves taking a sample in the casting furnace and measuring the grain size. This grain size is then used to establish the grain refiner rod-feeding rate needed by using the equation already determined by calibration. The total time for treating a sample is about ten minutes, depending on the cast house routines and operators experience, and this can normally be accommodated into the normal furnace routine without disruption.

Opticast samples for calibration, and furnace samples, are taken with specially designed stainless steel crucibles. The solidification characteristics in these result in a final grain size which is comparable to that encountered close to the centre of a 400 mm thick slab. However, the whole range of cast sizes, in slabs or billets, can be covered by applying grain size correction factors.

One of the principal advantages of the Opticast system is that it can be implemented at a cast house without necessitating extra personnel or capital expenses. After a short introductory period, normally less than two weeks, workers at the casting line, or technicians, are able to perform satisfactorily the sample preparation and grain size analyses.

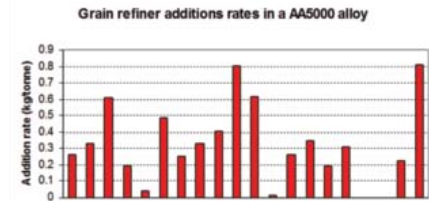
The Opticast system is currently in routine use or evaluation in several casthouses and in all cases is allowing markedly reduced addition rates of grain refiner. This also means that the level of impurities, especially boride particles, is decreased, and the quality of the casts is raised. An additional quality benefit is the consistency of grain size in the final casts.



3 Grain sizes in furnace samples taken from 20 different charges of an AA5000 series alloy

The remelt casthouse at AMAG, Austria routinely operates Opticast and provides a good example of the system capabilities. Figure 3 shows results from monitoring twenty AA 5000 alloy charges. The furnace grain sizes varies widely because individual charge make-ups vary widely, from charges based fully on scrap to charges made up from pure aluminium metal and master alloys.

By applying the Opticast algorithm, obtained from calibration, the theoretical addition of grain refiner needed to obtain a 150 micron grain size, for each charge, can be calculated as shown in figure 4. In the actual cast house, the standard addition rate for this alloy would have been 0.6 kg/ton, but the aver-

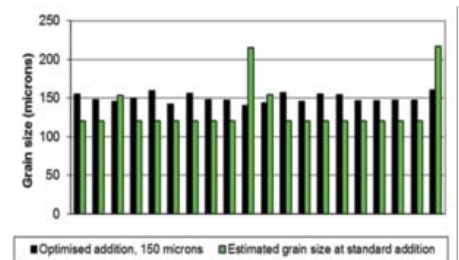


4 Calculated optimised grain refiner addition rates for the charges in figure 3 in order to obtain a 150 micron grain size.

age of the calculated optimised additions shown in figure 4 is only 0.3 kg/ton. Thus an overall reduction of 50 per cent is theoretically possible for the 5000 series alloy.

Optimised additions of grain refiner were made corresponding to the quantities indicated in figure 3 with the aim of obtaining a final grain size of 150 microns in each cast and samples taken in the casting launder after the addition of grain refiner (figure 5). The total spread in grain size values was 150 ± 10 microns in the optimised samples.

An important point is that in two of the casts the optimised addition rate was higher than the standard rate would have been, i.e. 0.8 kg/ton versus 0.6 kg/ton. Thus, by using the standard rate, the grain sizes in these casts would have been substantially larger than the aimed for 150 micron grain size, with a possible risk of ingot cracking.



5 Grain sizes after optimised additions compared with estimated grain sizes in absence of optimisation.

The variation in furnace nucleation level will lead to considerable grain size variations before grain refiner addition (in the above case from less than $150 \mu\text{m}$ up to over $400 \mu\text{m}$) and this will have a large impact on how much grain refiner is needed to achieve a final grain size of maximum 150 micron.

Finally it should be pointed out that in the optimisation programme of work it was found that there was also a large variation in the efficiencies encountered in different batches of commercial grain refiners themselves, even when from the same supplier. This observation led MQP to develop and introduce Optifine, a potent and consistent commercial grain refiner.

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