Optifine grain refiner from MQP

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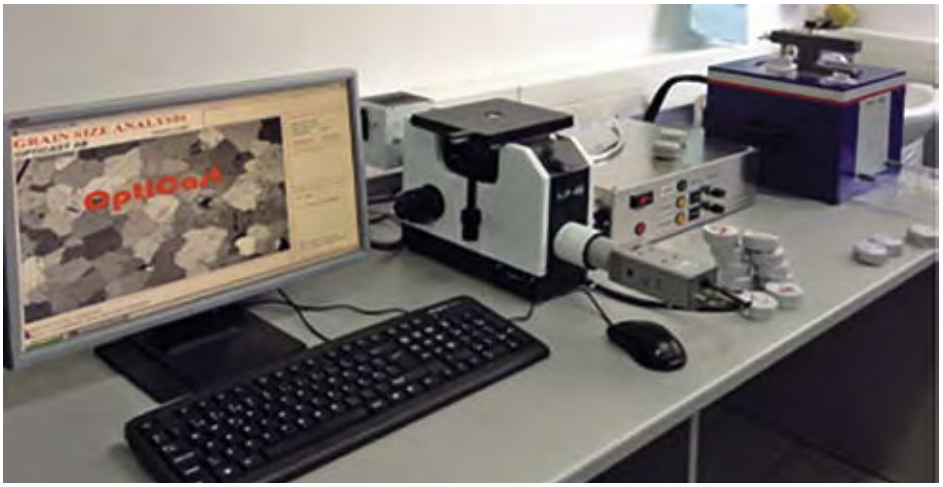
MQP, based in the UK, operates on a global basis through a network of consultants and distributors with representatives and offices in all parts of the aluminium world, from Australasia to South Africa, Europe to the Americas. Optifine was 'born' as a result of the outcome of a quest. The goal was to find a method of accurately predicting the amount of grain refiner to be added to a melt in order to achieve a required grain size.

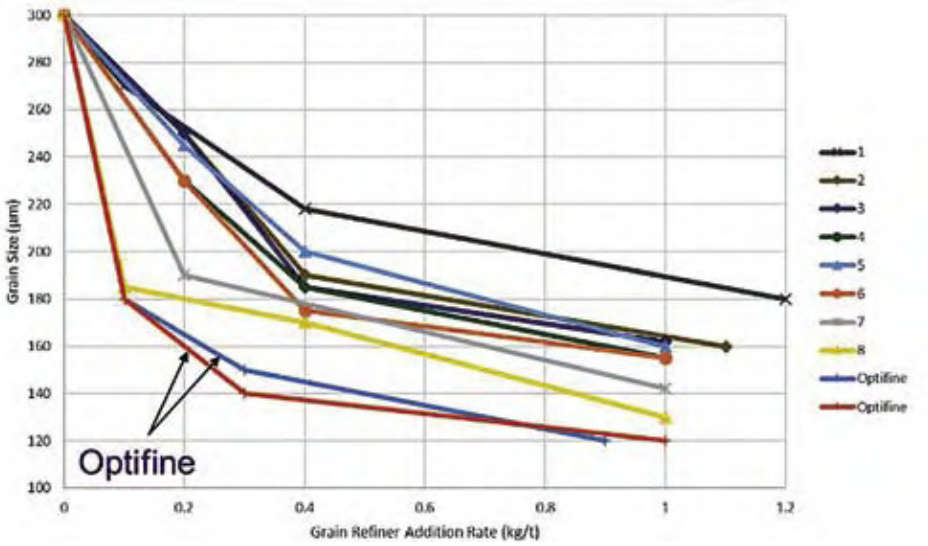


Opticast set up for Optifine testing

The method, Opticast, invented by Professor Backerud and Dr Rein Vainik is now a standard operating tool in casthouses to optimize addition rates and within MQP for quality control and assurance of Optifine quality. During the development of the Opticast method it was observed that there was a variation in the produced grain size in the Opticast samples. At first this was thought to be due to variations in the nucleation level of the melt but subsequently it was found to be due to major variations in the efficiency of the grain refiners themselves as illustrated in the diagram. Taking this knowledge MQP approached a grain refiner producer and embarked on a project to control the efficiency and efficacy of the grain refiner that became known as Optifine.

The Opticast method involves taking a crucible sample of metal and adding a known amount of grain refiner and then allowing the sample to solidify under controlled conditions. The grain size of the sample is accurately measured using an intercept method thereby allowing very small differences in grain size to be recorded, unlike the industry standard TP-1 test that relies on a visual inspection.

The sole/only purpose of a grain refiner is to obtain a grain size in the final billet or slab that prevents the cast from cracking during casting and subsequent treatment. It is the view of MQP that the addition should be done with as small an amount as possible to (a) decrease the cost of grain refinement and (b) minimize the amount of impurities added to the melt.



Grain refiner comparison tests

In the casthouse MQP regularly makes Opticast tests to calibrate the addition rate of grain refiner needed to achieve the required grain size as determined by the casthouse itself. By taking Opticast samples before and after grain refiner addition a graph is produced to show the current and proposed grain refiner addition level, as shown in the diagram.

Observing the graph, it clearly shows the consistency of Optifine as opposed to the inconsistency of standard grain refiners. The knowledge of this inconsistency answers a common question in casthouses, namely "why do we have cracked billets today when we didn't have any yesterday and we didn't change anything." Well, actually, by the changing of a coil of grain refiner the 'recipe' is changed and since one cannot see inside the grain refiner wire it is impossible to know its efficiency. It is well known that standard grain refiner production runs on very tight margins and hence ALL grain refiner has to be sold, regardless of quality, so the question we ask is "Where do all the bad batches go?"

MQP has found that by accurately measuring the efficiency of EACH batch of Optifine we can guarantee its efficacy. Testing in this way, with Opticast and our unique Opticast Nucleation Performance Test, (only available from MQP) we ensure that ALL batches of Optifine meet our exacting standards of quality and efficiency, it is the only grain refiner produced with a guarantee of its efficiency. Opticast is uniquely applied by MQP in the quality control of Optifine so if a grain refiner has not been quality tested by MQP, using Opticast technology, it is NOT Optifine.

In 2016 after five years of initial introduction and trialling, sales of Optifine really took off with 67% growth over 2015 taking tonnage to nearly 1,000 tonnes, equal to 3,000

tonnes of standard grain refiner or 10% market share MQP undertook a strategy review and concluded that going forward, as tonnage continued to increase a new production facility was needed. MQP reviewed a number of different suppliers to evaluate their suitability to produce Optifine, one of those was STNM, Hebei Sitong New Metal Material Co. The development of our high efficiency grain refiner, Optifine, an optimum and powerful grain refiner, gives MQP a huge asset in advancing casthouse melt quality.

In August 2016 STNM acquired a 70% shareholding in MQP and, thereafter, MQP undertook to introduce the Optifine technology into the plant in Baoding. MQP, under an exclusive manufacturing agreement with our partners STNM is now supplying Optifine from a state-of-the-art manufacturing plant, that is capable of producing 16,000 tpy of grain refiner. Production will be increased by almost 50% thanks to a new line commissioned at the end of 2019.

The grain refiner produced in STNM is firstly verified to a particular grain size by TP1 test in the plant and then, crucially and most importantly, all the material is quality control checked in MQP's laboratories in Sweden and the UK using our unique Opticast technology.

Alloy	Standard Addition	Optifine Addition	Reduction (%)
AA1050	0.67	0.20	70
AA3003	0.68	0.24	65
AA3004	0.35	0.10	71
AA3105	0.43	0.15	65
AA5042	0.78	0.15	81
AA5052	0.34	0.15	56
AA5083	0.62	0.15	76
AA5182	0.77	0.15	81
AA5754	0.60	0.15	75
AA6061	0.66	0.24	64
AA6082	0.70	0.15	79
(Additions in kg/t)			

Optifine is a highly effective grain refiner which can achieve the level of refinement needed to avoid ingot cracking at up to 70% lower addition rates than standard TiBor grain refiners. This results in improved quality and reduced operating costs over a wide range of aluminium alloy compositions. Savings of 30-40% can achieved in the end to end cost of grain refinement together with reducing the number of potential particles that cause casting defects.

In the early days of the project the focus was always on cost saving related to reducing grain refiner addition but as MQP gained more customers, this focus shifted more to the quality improvements that were being seen by casthouses and downstream operations. During one trial, in a slab caster in Europe, the customer commented on the fact that they would expect a certain number of

cracked ingots over a campaign and we realized then, that reducing the number of cracked ingots is probably worth more than any cost saving on grain refiner.

Other anecdotes include extruders reporting better die life, using less saws to cut billets and improvement in extrusion speed. However, when we ask them for data, they cannot provide any numbers. It is only logical to think that if the amount of grain refiner is dramatically reduced then also the number of associated borides and oxides is also reduced by the same amount. In other types of casting wire, foil and automotive trim we have been able to reduce the incidence of breakage, pin-holing and defects that only come to light at the very end of the production cycle like razor steaks in body in white parts.

There is also a consideration in non-metallurgical benefits include less warehousing, less transport cost (internally in the casthouse and externally to the casthouse) and less frequent coil changes at the casting pit.

Brand awareness and product recognition

The 'Aluminium Lady' has been used in our advertising, marketing and on exhibition stands for some time and has become synonymous with MQP and Optifine. The lady also features on our website and also on our LinkedIn and Twitter profiles.

Optifine was first used in regular production in 2010 and is now in routine use in 34 major casthouses worldwide in the production of over 3 million tonnes of aluminium alloys annually with outstanding results.

Opticast and Optifine are routinely used together in many casthouses worldwide, to both optimize current grain refining practise and during initial trials to demonstrate to customers the potential reduction in grain refining costs and the subsequent impact on quality when switching to Optifine. Indeed, providing comprehensive technical support to casthouses is an integral part of MPQ's Optifine programme ensuring that optimum addition rates for Optifine can be reached safely and consistently to deliver maximum savings. Reducing the amount of grain refiner by 70% also reduces the number of potential particles that cause casting defects. This reduction will also mean less coil storage and transport as well as less frequent coil changes in the casthouse.

Also, in conjunction with our partners, STNM, we will bring new grades of Optifine grain refiners to market in the near future.

Future developments

MQP is undertaking a major research programme at Brunel University to study the fundamental mechanism of grain refinement using High Resolution Transmission Electron Microscopy (HRTEM) to find ways to improve the efficiency of Optifine even further. This equipment is one of only four such units worldwide. The technique enables the nucleation process of aluminium grains on titanium diboride particles to be observed at the atomic level. It is known that for nucleation to occur on the particles a layer of titanium aluminide must be formed first and this process will be studied in depth with the objective of improving the efficiency and consistency.

Final remark by the author: Since I joined MQP five years ago, I don't think there has ever been a more exciting period to be working for the company. Our new partners have been incredibly supportive in producing Optifine to our exacting standards and supporting a large stock in both European and the USA. There is constant supply of our standard 3:1 Optifine coming out of the plant and the possibility to introduce new grades, like 5:1 or even 5:02, means that MQP can move into markets that were hitherto restricted."

Author

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