WORKING TOGETHER IN PARTNERSHIP – EXCELLENCE IN ALUMINIUM CASTING THROUGH COOPERATION

FOSECO

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Aluminum gravity casting production continues to grow, in many cases replacing ferrous materials, with increasing demand in industrial sectors such as energy, defense, medicine and transport. The reduction in the weight of the components is a very attractive point, and the latest technological advances, which have helped aluminum alloys to provide more mechanical strength, has opened up even more opportunities for cast aluminium components. The majority of these pieces for industrial applications require a very high level of quality control and quality assurance procedures.

To ensure sound castings it is essential that strict procedures are followed in the casting methods (feeding, filtration & simulation), manufacture and preparation of the moulds and cores and the pouring of molten metal, with its special treatments, to obtain final castings without inclusions, defects or shrinkage. Aluminium components produced by gravity casting are manufactured in medium or large series, where if a defect appears, it affects many parts and directly incurs an increase in manufacturing cost. Therefore, it is essential that within all parts of the process the correct raw material choices are made, and these decisions are critical to the successful and repeatable production of defect free castings and must be combined with the correctly applied application, technical and manufacturing process knowledge.

INTRODUCTION

Grupo Aluminio de Precision (GAP) is an aluminium foundry based in Burgos, Spain. It is a gravity, sand foundry and produces castings ranging from 0.2kg up to 300kg using either the greensand or no-bake moulding process. Production capacity is in the region of 12,500 tonnes per annum and castings are supplied to a diverse range of market sectors on a global basis.

To serve these demanding industries, GAP is providing their customers with a full supplier service, from casting design and development to production and delivery of fully machined, painted and tested cast components.

Throughout the design and implementation stage GAP works together with Foseco to optimise the casting methodology and subsequently utilizes the superior properties of Foseco consumable products to optimise casting quality, improve yield and reduce overall production costs.

This paper focuses on the partnership between Foseco and GAP throughout the development process and across several internal departments, and in doing so demonstrates the value created by undertaking such close cooperation.

DESIGN & DEVELOPMENT

When a new casting is to be produced in the foundry the involvement of FOSECO starts in the design and development stage. The main criteria are how to produce a sound casting without defects and with optimum yield to ensure cost-effectiveness. Initial discussions focus on the method of producing the casting; how the metal will flow into the casting with minimal turbulence, where filters will be placed to reduce turbulence and eliminate inclusions and where to place feeders / feeding aids to ensure there is no shrinkage in the casting itself. There are many variables to consider including the orientation of the casting and the subsequent implications on moulding and core making.

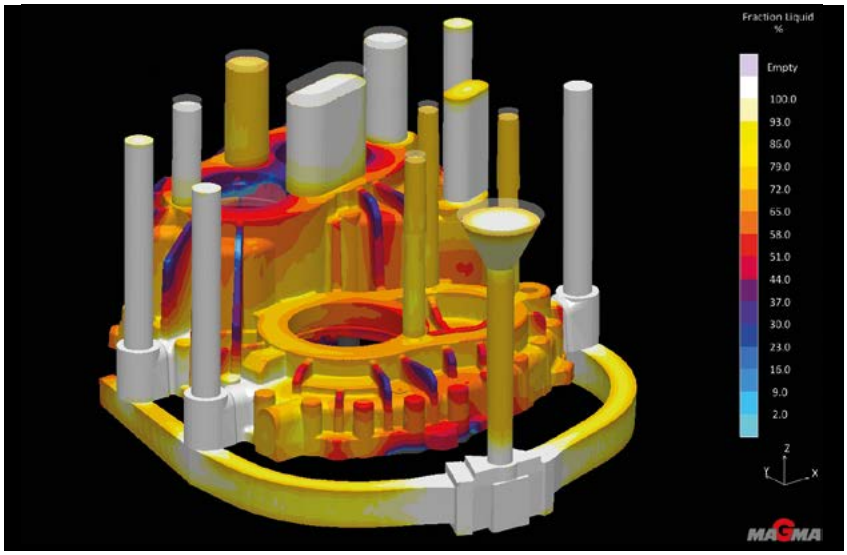

Figure 1: MAGMA simulation of casting

Fig. 2: Coreshop & cores coated with TENOTEC 7804A (inset) using the flow coating process

Typically, there is more than one potential solution and by using metal flow and solidification modelling these solutions can be evaluated and optimised to focus in on the most cost-effective method of production, whilst delivering the customer's quality and integrity requirements. It is at this stage that many of the consumable products that enhance the casting process will be selected to optimise the casting process, such as:

- KALMIN* insulating sleeves – to prevent shrinkage defects
- SIVEX* foam filters – to remove inclusions and reduce turbulent metal flow

MOULDING & COREMAKING

After the design stage is complete the required designs are passed to the pattern workshop where skilled patternmakers will produce the pattern equipment to produce the moulds and the coreboxes for core production. The high-quality production of pattern tooling is essential to the casting process in that any discrepancies at this point will be reflected in the ease of production of the moulds and cores and subsequently in the dimensional accuracy of the final casting.

For the production of cores GAP have a highly automated manufacturing line, which allows the mass production of cores without compromise of integrity or dimensional accuracy. The sand cores are bonded using a special polyurethane coldbox binder system supplied by FOSECO (POLITEC* AL320/420). The benefit of this system is that it requires very low addition rates to give high strength cores. The low binder addition rate minimizes the production of gases during thermal decomposition on pouring, thereby avoiding the potential for gas pinhole defects at the surface of the finished casting. To improve productivity the coreboxes are coated with a highly effective release agent (ACMOS* 118-63) that has superior release properties without the build-up of residues that need to be removed on a regular basis, taking the corebox out of service. Where cores are joined together a refractory putty (TAPA PLAST 41) is used to seal any gaps or small breakages. To further enhance the surface finish of the casting and to avoid sand adherences the cores are coated with a refractory coating from Foseco (TENOTEC* 7804A).
After casting the binder breaks down readily, allowing for the easy removal of the core material during the shake-out process, ensuring no damage to the casting. The casting surface finish is free from sand adherence, gas pin-hole defects or any other metal/mould reactions. GAP utilizes two modern moulding lines; the first utilizes a no-bake binder system based on polyurethane chemistry (POLISET* AL 6A & 6B), for high dimensionally accurate castings up to 300kg in weight.

Fig. 3: Assembly of POLISET bonded moulds and POLITEC bonded cores

Figure 4: Greensand line

The POLISET AL binder system has been specifically developed for the needs of aluminium sand foundries to reduce gas emissions, provide high production rates through reduced stripping times and easy core breakdown and shake-out after casting.
The second line is for smaller casting up to 80kg in weight and is based around a greensand system. To avoid sticking of the greensand to the pattern plates, small amounts of a highly effective release agent (PARTISAL* 421) are sprayed on to the pattern at regular intervals. PARTISAL is an environmentally friendly product without aromatic solvents.

MELTSHOP

The quality of the molten aluminium alloy is paramount to producing consistent castings to the correct metallurgical specification and free from defects such as inclusions and gas porosity. GAP uses a Foseco Degassing Unit (FDU) melt treatment system for the degassing and cleaning of the aluminium alloys. The FDU rotary degassing units utilize patented rotor designs to ensure rapid and efficient distribution of nitrogen or argon as finely dispersed bubbles to ensure effective degassing in short treatment cycles. Advantages are:

+ Reproducible results
+ Short treatment time
+ Reduced gas porosity and hard inclusions in castings
+ Reduced machining costs
+ Consistent mechanical and physical properties
+ Environmentally friendly

Figure 5: Effective degassing process using a Foseco Degassing Unit (left) and the patented impeller rotor (right)

The benefits of best practice in terms of melting, melt treatment and pouring of the molten aluminium are observed in the non-destructive testing laboratory with the cast materials having optimum metallurgical structures and soundness. Foseco supply testing equipment and consumables that support the quality assurance procedure such as GASTEC PRO and DENSITEC devices for measuring density. GASTEC PRO allows for the creation of a partial vacuum (up to 10 mBar) under one glass bell, in order to highlight the presence or absence of dissolved hydrogen which has a negative influence on the tightness and mechanical characteristics of aluminum castings. DENSITEC provides a direct measurement of density, a ticket can be printed, or values are recorded to a computer for traceability.

Figure 6: GASTEC PRO (left) and DENSITEC (right) density measuring equipment

GAP is also using Thermatest 5000 NG III thermal analysis equipment. These units are designed to predict and control the structure of aluminium alloys before casting, including the grain refinement and the type of eutectic structure that will be formed. Within only a few minutes, it assesses the melt quality, allowing for specific additions to be made to the melt before casting, therefore avoiding costly scrap due to shrinkage, leakage, porosity, and hot tears.

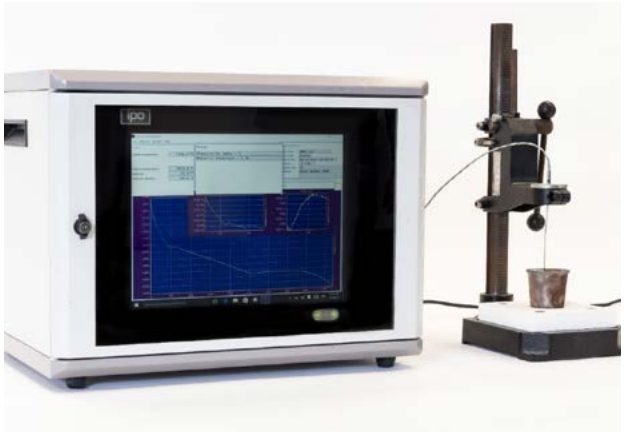

Figure 7: Thermatest 5000 NG III thermal analysis unit

CONCLUSION

FOSECO offers the aluminium foundry a full range of equipment and consumables that support the production of quality castings. In the sand foundry binders, coatings and moulding materials supplied by Foseco ensure the integrity of the moulding process and enable complex castings to be manufactured with superior surface finish. The preparation and transfer to the mould of the liquid aluminium is equally important and again Foseco products are used to improve metal cleanliness and metallurgical structure, with product performance ensuring energy costs are minimized and casting quality is maximized.
The benefits of this focus on process and consumable technology is observed in the high quality, defect free castings produced, with Foseco developed test methods providing the end user with quality assurance data.
Above all the benefits of the products themselves, it is the relationship with foundries such as GAP that elevates performance to a higher level. By working in partnership to deliver best in class solutions and creating value for the end-user a sustainable relationship is developed that ensures future success for all parties.

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