

# 2-stroke aluminium cylinder blocks

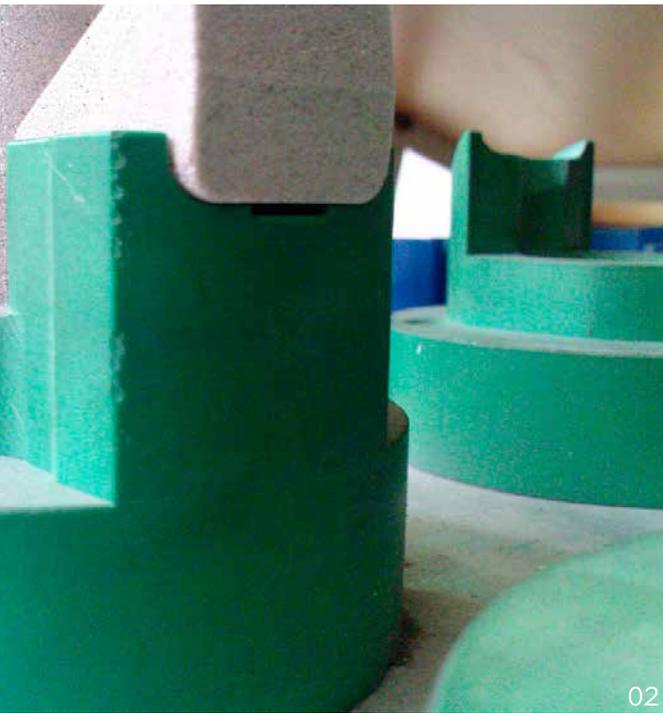
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**MAC GmbH | Consulting and Engineering** was approached by a manufacturer of combustion engine components to design and realize 2 highly automated lines for the near-net-shape casting of an aluminium 2-stroke-engine cylinder block. The casting is used in chain saws, weed cutters and other gardening equipment. The objective was to implement the production lines in an existing operation, to lift the level of automation to be mastered in the plant and therefore to make the operation fit for the future. Design capacity for the first production line was 1.1 Mio. cylinders per year and 0.8 for the second line.

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IMG 01 // **Anorganic core package for a wall thickness <3mm, coated with graphite and tellurium coating based on alcohol, mounting by robot cell.**

IMG 02 // **Core fixture which positions the combustion chamber core; fixture to be used for families of cores.**



The production steps to be integrated into the line were core making using an inorganic binder, core package assembly and coating, core package setting into the gravity casting moulds, melt handling and dosing, filter setting, pouring, extraction of the casting from the moulds and the cleaning of the moulds. The project presented a range of challenges to the project team: **delicate cores allowing a net-shape design** of the casting, the inorganic binder system, a new gravity mould concept, the design of the core and the core package grippers, the automated mounting and glueing of core packages, the coating of core packages with automated quality check and the downtime minimization for cleaning of core boxes and casting tools.

The project started with an in-depth analysis of the existing production process aiming for reduced manual operation, improved process robustness and for higher productivity of the process steps under supervision and in downstream operations. This analysis which took one week was conducted together with the product specialists of the client. The result was a holistic view of the total process and unveiling of all open and hidden potentials.

While in the beginning the client limited the project to the core making and casting operation soon it became obvious **that upstream and downstream processes needed to be involved for full potential**. On the upstream side the main change was to switch to an inorganic binder system. Here the right binder had to be determined and adjusted to the pro-

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IMG 03-05 // **Extraction, mounting and coating robots of the core package mounting cell with gripper for 4 cores and vacuum equipment.**

IMG 06 // **Aluminium holding furnace with ceramic pouring spoon mounted on a 7-axis robot supplying melt for the gravity casting.**



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07

cess. The main advantage was, that the cleaning of core boxes and gravity casting moulds could be reduced to once a day which improved the total uptime of the equipment and eliminated the need for additional tool sets. On the downstream side the client required a tolerance of 0.2 mm for the control edges in the cylinder. Meeting this requirement would allow to eliminate manual deburring downstream in the process.

Soon it became clear that the critical point were the gravity casting moulds. The actual mould concept was not suitable for the small tolerances required and could not be run in an automated way. A **new mould concept was developed** integrating certain features which are not common in gravity casting tools. Tests were conducted with the new moulding concept on a test machine and prototypes of the 2-stroke cylinder were casted. This tests minimized the risk inherent in the new mould concept.

The core making comprised of 3 core shooters with robotized core extraction, deburring and transfer station so that a central core package mounting could be installed. After automatic coating the core packages were quality checked 100% by a vision system. Initially the line was installed with a manual buffer between core manufacturing and casting. An upgrade of this function to automation was already included in the production line concept but omitted in the first stage to make sure, that the organization would be able to cope with the complexity of the line. Today, the client is very happy with the installation which finally resulted in several other improvements in the remaining operation.

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IMG 07 // **Gravity casting with 4 casting machines with automatic core setting, 7-axis robot for melt supply and automatic extraction of the casting; casting machines are equipped with automatic mould cleaning.**

BACK IMG 08-09 // **raw castings which are quenched and decored within the casting cell.**



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**The scope of services rendered by MAC in this project:**

- ▶ integrated production line concept development suitable for stepwise automation
- ▶ international sourcing and evaluation of supply partners for the equipment and the binder system
- ▶ adjustment of the anorganic binder system for delicate net-shape cores
- ▶ design of core boxes, core package and joining technology
- ▶ core package joining technology suitable for robotized processing
- ▶ mould concept development and testing
- ▶ gripper design for automation robots
- ▶ definition of interfaces between scope of equipment suppliers
- ▶ preparation of equipment specifications with comprehensive acceptance test procedures
- ▶ management of works acceptance test and final acceptance tests
- ▶ supervision of the installation and commissioning of the equipment
- ▶ management of the ramp-up phase
- ▶ training and qualification enhancement of operators, shift leaders and management

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