High Pressure Die Casting (HPDC) Lost-Core (LC) technology for the production of Aluminium Closed Deck blocks for next generation Euro7 engines

Reporting

Project Information

CORE 4.0

Grant agreement ID: 701197

Project website

DOI
10.3030/701197

Project closed

EC signature date
26 April 2016

Start date
1 April 2016

End date
31 May 2019

Funded under
Horizon 2020 Framework Programme

Total cost
€ 4 098 563,50

EU contribution
€ 2 999 493,00

Coordinated by
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Spain

Periodic Reporting for period 3 - CORE 4.0 (High Pressure Die Casting (HPDC) Lost-Core (LC) technology for the production of Aluminium Closed Deck blocks for next generation Euro7 engines)

Reporting period: 2018-10-01 to 2019-05-31

Summary of the context and overall objectives of the project

The objective of the CORE 4.0 project was the implementation of the High Pressure Die Casting (HPDC) Lost-Core (LC) technology for the manufacturing and commercialization of a new Closed-Deck (CD) Aluminium Block. These blocks are currently manufactured either by sand casting in iron (SCI), with a considerably high weight compared to aluminium blocks or by Low Pressure Die Casting (LPDC) and Gravity Die Casting (GDC) technologies in aluminium, with a very high cost compared to HPDC. The advantage of HPDC-LC technology is to enable the production of highly loaded closed deck engine blocks in light weight at affordable costs.

The aim was to bring this technology, which is currently at TRL6 up to TRL9 for market take up. During the project, a business model and an specific plan for the production of 1 Million new blocks in the following 6 years, which implies more than 100 new qualified jobs and incomes over 150M€ for the consortium, has been validated.

In order to achieve these results different technical challenges have been approached with success:
- Ceramic cores with very complex geometries have been developed, which are able to resist the extremely hard conditions of High Pressure die casting.
- A de-coring system has been developed that is able to destroy the ceramic core and clean the inner cavity created by the core inside the casting through an innovative Ultra High Pressure (UHP) water jet technology.
- HPDC technology has been developed to work with lost core process. Insertion of the core inside the die core prints has been a critical issue, as well as the selection of the right casting parameters to achieve the best metallurgical quality without damaging the ceramic core during the casting operation.

Despite the technical success achieved regarding the initial targets of the project, the business plan could not be realized as initially planned. The market trends in the automotive sector have given a turn against the diesel engines during the period of the project, and the final application has not reached the market. Nevertheless, the technology and know-how developed in the project can be applied in alternative products, some of them related to the electric and hybrid vehicles. The members of the consortium will focus on the identification and
development of such opportunities that will lead to successful market applications in the near future

Work performed from the beginning of the project to the end of the period covered by the report and main results achieved so far

WP1 is devoted to the management and dissemination of the project. Concerning management, the work carried out has included the organization of six Project meetings in different locations, the preparation and signature of the CA, as well as three amendments. FAGOR EDERLAN, as Project Coordinator, and TECNALIA, as member of the Coordination Board, have led these activities, with the involvement of the rest of the partners. Concerning dissemination activities, a dissemination plan has been followed and successfully implemented. Two leaflets and a poster have been prepared,

FERROČTALIČ, RAUSCHERT, TECNALIA and FAGOR have participated in different industrial fairs showing the developments of the project, a promotional video has been released, different press releases have been published and part of the work has been presented to the scientific community at a conference and with the publication of a paper.

WP2 is devoted to the development of the CD aluminium engine block through the HPDC-LC technology. A tool with a simplified mono-cylinder core was manufactured and the cores produced with it were tested in HPDC machine to tune the different parameters of core production and die casting process. Different coatings were tested in order to avoid metal penetration inside the core. Ceramic cores with high geometrical complexity were developed, to produce the water jacket of the engine blocks. A pressing machine had to be tailored to meet the special requirements for this application. All the necessary tooling was designed and built: core pressing tool, HPDC die, HPDC spray head, robot gripper, etc. Technical difficulties were found during the development of the core. The first batch of cores did not have the required strength to withstand the HPDC injection, and further research had to be done to find a method to strengthen it. Finally, a new batch of reinforced cores was produced which resisted the casting conditions and finally 40 engine block prototypes were produced successfully and delivered to RENAULT to proceed with the validation in WP4. Concerning the de-coring activities, a pilot equipment was designed and built to meet the requirements of the project. UHP innovative technology was applied to build a de-coring station capable of destroying the core without damaging the casting. However, the core produced with the reinforced material showed high resistance to be destroyed and the cycle time necessary for the complete cleaning of a block was far from the initial target.

WP3 is devoted to the development of the process to produce large series of CD engine blocks by HPDC-LC technology, with the final objective of validating the process. The results of the previous tasks showed that it would be irrational to devote the necessary time and energy to produce 2.000 blocks as initially planned. Instead, the activities in this WP were dedicated to improve the strength of the cores and improve the process of pressing them, as well as the optimization of the HPDC process to reduce to the minimum the stresses exerted. The de-coring methods and tools were also optimized and developed further. The limits of the different parameters were defined in order to design a water jacket that would make it feasible to produce engine blocks in an industrial scale.

WP4 has the objective of validating the product. The engine blocks prototypes have been subjected to different characterization tests at RENAULT obtaining good results. The 40 prototypes have been machined and thermal-spray coated and a complete engine has been assembled in order to proceed with the validation tests. However, some unexpected issues with the bedplates and the oil jet have delayed the realization of the endurance tests.

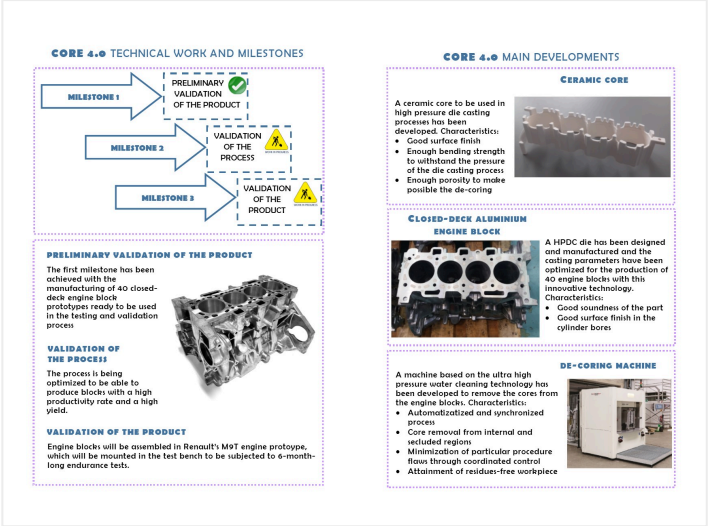
WP5 is devoted to the validation of the business model prepared during the proposal stage and the preparation of the exploitation plan. All the partners have collaborated in the definition of the exploitation strategies and agreed in the IPRs of the different Key Exploitable Results (KERs) arising of the project.

Progress beyond the state of the art and expected potential impact (including the socio-economic impact and the wider societal implications of the project so far)

The CORE4.0 project has developed a new technology that was not available in the market up to date, enabling the production of hollow castings HPDC using Lost Core technology. Applying this technology to the chosen product, the closed deck engine block, will enable the production of high loaded engine with extreme peak firing pressures in the combustion chamber in a light weight material and with an affordable cost.

The ceramic core manufacturing technology will have development beyond the state of the art, creating very complex shapes with cores which will have the strength required to resist the extreme conditions of high pressure die casting, while maintaining this strength at acceptable values that will not impede the de-coring operation.

Regarding de-coring, the developed solution will bring to the market a new concept of de-coring station, using Ultra High Pressure water jet technology. This development will open new possibilities for innovative solutions for other products and applications.



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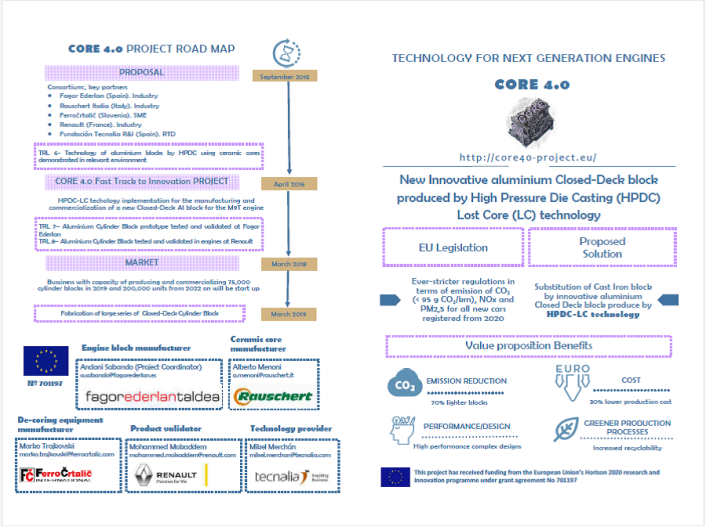

Leaflet prepared in month 12 and distributed in the Hannover Messe

Poster of the project Prepared for the World Foundry Congress

Last update: 6 November 2024

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