HardALU Report Summary

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Periodic Reporting for period 3 - HardALU (Fluidised Bed Heat Treatment Furnace for HPDC engine blocks and other transport components offering new opportunities for lightweight, cost competitiveness and energy saving)

Reporting period: 2017-08-01 to 2018-07-31

Summary of the context and overall objectives of the project

At the present, the European transport sector has to meet several challenges, such as competition of emerging countries, as well as more restrictive legislation regarding CO2 emissions. HardALU project aims at reduction of weight by substituting iron by light and high performance aluminium castings, in particular engine blocks. This will be achieved by making High Pressure Die Castings (HPDC) heat treatable using Fluidized Bed (FB) Technology, which allows reducing significantly the heat treatment time and thus avoiding blistering.

Advanced manufacturing technologies are needed in order to facilitate the production of high performance aluminium components. HPDC is a highly productive process but the conventional heat treatment technology cannot be applied due to the formation of blisters. Whereas, all the other manufacturing technologies for engine blocks, allow the application of conventional T6 heat treatment. At present FB is not industrially applied to any aluminium casting in Europe. However, FB heat treatment offers a much higher rate of heat transfer than conventional furnaces.

On the other hand, aluminium casting manufactured by other technologies: sand, low pressure, etc. that are nowadays heat treated (T6/T7) in conventional air furnaces, could also benefit from the shortened heat treatment in FB furnaces by a reduction of 80% in time and a reduction of 30% of energy consumption.

The main innovations of the application of FB heat treatments in the manufacturing process of HPDC are:

-To enable heat treatment of “HPDC” parts, thus increasing their mechanical properties and making it possible to reduce their weight or replace heavier iron castings
-To reduce by 2% CO2 emission by replacing iron (a reduction of 28kg is expected from replacing a iron engine block of average 55kg)
-Additional 30% of reduction of CO2 emission associated to the reduction of gas consumption when the alternative FB T6/T7 heat treatment is applied.
-To generate a new niche market for heat treatment lines for HPDC parts

Industrial problem:
- The most typical HPDC parts in cars are engine block, gear box and a vast number of brackets and accessories. At present, these HPDC parts cannot be fully heat treated (T6 or T7) due to the problem of blistering.
- Other important automotive parts such as cylinder heads, suspension parts, wheels and brake components are usually not
casted in HPDC and require a conventional T6 or T7 heat treatment. The T6/T7 heat treatments account for 12-25% of the value added of these castings.

- Conventional T6/T7 treatments include a quench in water from 490–540ºC to 60–80ºC. However, water quenching also causes severe internal residual stress, as well as distortion in the case of castings with a complex geometry and with high differences in thickness. Air quench or oil quench can avoid these problems, but the tensile properties are notably lower or a subsequent post-treatment (cleaning) is needed.

This innovative business will boost the company internationally in the heat treatment market as there is no competitor for this technology in Europe. Moreover, its HPDC foundry clients will be able to produce components with enhanced performance at levels above actual standards; a new niche market is expected. Within the strategy of HORMESA the transfer to other markets such as railway and aircraft castings, is considered in the following years with the companies own resources.

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

The main R&D activities carried out from the beginning of the project and their results are listed below:

A MARKET RESEARCH with the aim of analysing in detail the market needs, constraints, local regulations, production needs and product specifications for a successful business in FB heat treatment technology. The study includes:

- An ALUMINIUM MARKET ANALYSIS
- A SURVEY CONDUCTED consisting of 71 questionnaires.
- A LIST OF AUTOMOTIVE CASTING COMPONENTS candidates to be FB heat treated to improve their properties including an analytical approach of aluminium casting production needs for automotive industry.

TARGET CLIENT DEFINITION with the main objective of signing collaboration agreements with manufacturing companies all over Europe, interested in testing the new FB heat treatment in the near future. Many contacts have been done showing that many companies are interested in future collaboration with Hormesa in order to test the HardAlu technology.

Development of FB HEAT TREATMENT OF CONVENTIONAL HPDC ENGINE BLOCKS, in close collaboration with a car manufacturer, defining the design particularities of the HPDC engine blocks, the product specifications for diesel and gasoline engines, the production rates needs in order to have a clear market specification for the most adequate FB line furnace for an effective and productive heat treatment of HPDC engine block.

Development of FB AS ALTERNATIVE TO CONVENTIONAL T6/T7 HEAT TREATMENT, in close collaboration with a brake component manufacturer, defining and analyzing product specifications of front and rear callipers, production rate and ambition to have a clear market specification for the most adequate FB line furnace for an effective and productive heat treatment of aluminium casting alternative to long conventional T6/T7 heat treatment.

The DESIGN AND SCALE UP OF THE FB CHAMBERS and all the handing and transfer devices between them based on the market specifications for both HPDC engine blocks and brake callipers. The design covers the three chambers and peripheral components, such as: metallic materials, insulating materials, hydraulic pumps, pneumatic sensors locations for temperature, flow and pressure measurement, gas heaters, electric installation, cooling system, automated transportation system pack and so on.

**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)**

Existing HPDC engine blocks and brake callipers will be treated in pilot furnaces and the potential clients will be able to
compare the results with those of their conventional furnaces. The design of the industrial line will be refined on the basis of the experimentation with the pilot furnaces and the cost of FB treatment (both initial capital investment and operational including energy consumption) will be determined with a good precision. It is strongly expected that the time and energy savings will make the new equipment very attractive.

IMPACT
Automotive industry needs cheaper and lighter components, and if possible more environmental-friendly, with similar or higher technical properties. Thus, this industry is always considering improvements of the manufacturing process, using cheaper material. One of the problems that make this process difficult is the heat treatment: at present, HPDC parts cannot be fully heat treated (T6 or T7) due to the problem of blistering. If this can be solved with a different technical approach, some automobile parts could be manufactured with Aluminium (cheaper and lighter), with a huge impact in the automobile cost-competitiveness for any end-user.

The main potential impacts are:
- Possibility to heat treat HPDC parts without blistering, in particular Engine Blocks. This would vastly increase the competitiveness of Aluminium HPDC engine blocks against the heavier iron blocks.
- Enhanced mechanical properties for aluminium castings manufactured by HPDC.
- Shortened heat treatment cycles, energy savings and better properties in already heat treated PM & Sand Cast parts.
- Reduced residual stress of already heat treated parts.

Related information

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