FRAUNHOFER INSTITUTE FOR FACTORY OPERATION AND AUTOMATION IFF, MAGDEBURG

FOUNDRY 4.0:
INNOVATIVE TECHNOLOGY FOR SMART AND SUSTAINABLE PROCESS DESIGN

This is a collaborative project among promeos GmbH Nürnberg, Leichtmetallgiesserei Bad Langensalza GmbH in Bad Langensalza, the Chair for Casting and Forming, Institute of Manufacturing Technology and Quality Management, Otto von Guericke University Magdeburg and the Fraunhofer Institute for Factory Operation and Automation IFF Magdeburg.

The four institutions with expertise and project partners are collaborating in this national research partnership multidisciplinarily to redesign the energy use and supply chain in the entire melt supply in light metal casting to meet the demands of Industrie 4.0.

BOOST QUALITY AND CUT COSTS

- Reduce CO₂ emissions by as much as 80 percent
- Cut energy costs by as much as 60 percent, corresponding to approximately €300 per ton of aluminum
- Reduce primary energy consumption for non-ferrous cost parts by as much as 25 percent, corresponding to approximately 2.5 megawatt hours per ton of aluminum
- Reduce slagging by as much as 20 percent, corresponding to a savings of over 2 megawatt hours per ton of raw material and melt during casting
- Reduce the carbon dioxide equivalent by 1.4 tons per ton of aluminum output based on pure current displacement applying the 2015 CO₂ emission factor from the German power mix
- Improve casting quality significantly by using homogeneously heated tools and eliminating ladling
- Shorten cycle times significantly by enhancing the responsiveness of the melt supply and thus managing job orders efficiently
- Reorganize the factory and manufacturing structure fundamentally based on the changed manufacturing and material handling systems resulting in flexible and modular design options
- Perform referential analysis, assessment and footprinting of foundry systems’ value streams to establish system and process transparency (carbon footprint, energy use, process times, number of processes) as the basis for boosting efficiency further (normally 10-20 percent)
- Employ easy and adaptive tool- and indicator-based scenario evaluation of design options in the simulation environment as the basis for sustainable corporate decisions (e.g. major capital expenditures)
- Design supply chain systems and processes that satisfy requirements based on substantial analyses of technology and assessments of performance and sustainability as defined by total cost of ownership

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The German metals industry is the largest steel and nonferrous metal producer in the European Union. It also plays a key role in the German economy.

The issue of energy-efficient and sustainable manufacturing is now more of a priority than ever. Both technological innovations and continuous optimization of existing process flows are essential to the energy-intensive foundry industry to ensure competitiveness, especially in small and medium-sized businesses. This makes it essential to develop processes and solutions that meet demands and prioritize material efficiency and sustainable use of available energy carriers while minimizing material losses concomitant with slagging.

The partners in the ETAL research project are pursuing the objective of significantly reducing the primary energy use required in the light metal casting process chain and thus the pollutants emitted as well. At the same time, casting quality and manufacturing flexibility will be enhanced significantly. In addition, the conditions will be established for future fully automatic, digitized process control.

This unification incorporating technical solution and process optimization is highly innovative and globally unique. The technological development of so-called “heat docks”, distributed heating stations, and the design of the transfer crucible, which continuously monitors the melt charge, is another integral part of the unified design. The design’s technical centerpiece is novel burner technology based on high temperature waste heat produced by processes to preheat combustion air to boost efficiency further, thus cutting costs. The thermal energy produced will be supplied in heating stations (heat docks) and released to movable transfer crucibles. The use of such a fully movable melting and heating system will eliminate at least two transfer processes. This will also reduce the formation of oxides substantially and minimize pollutants emitted as well. At the same time, casting quality is now more of a priority than ever. Both technological innovations and continuous optimization of existing process flows are essential to the energy-intensive foundry industry to ensure competitiveness, especially in small and medium-sized businesses. This makes it essential to develop processes and solutions that meet demands and prioritize material efficiency and sustainable use of available energy carriers while minimizing cumulative harmful emissions.

UNIFIED SMART FOUNDRY DESIGN

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INNOVATIVE TECHNOLOGY AND OPTIMIZED PROCESSES

The project is intended to deliver a shift solution for a fully movable distributed melt supply system, including development, design engineering and manufacturing engineering. The three partners’ necessary process steps of “melt and transfer metal”, “transfer melt” and “hold metal” will be replaced in the future by a single process step “melt and hold metal in distributed fully movable systems”.

The project will be implemented by developing novel system components that make it possible to combine individual process steps and, thus, reorganize material streams and manufacturing supply chains in foundries completely.

Apart from the enhanced quality of output, digital transformation of the complete process will become the point of departure for the fully automated operation of transfer crucibles aspiring to in the future.