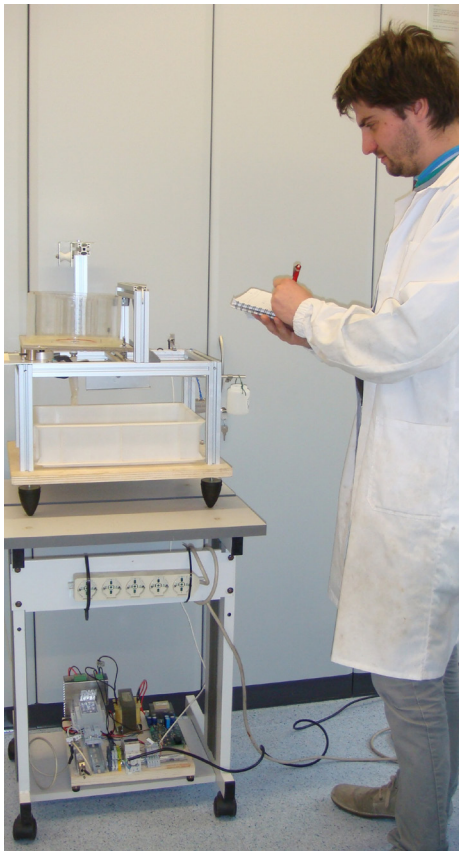
Fortissimo Case Study

FORTISSIMO

HPC-Cloud-based simulation of steel casting

Fortissimo Experiment Facts:
- Segment: Industrial Metals
- Application Domain: CFD
- Application: OpenFOAM



The Company

Ergolines, an SME, is a world leader in the manufacture of a wide range of products specifically designed for the production of speciality steels, including electro-magnetic stirrers and special instrumentation designed around the requirements of a continuous casting facility. Ergolines' goal is the development of equipment supporting the production of flawless steel alloys with metallurgical properties able to satisfy an ever increasingly quality-oriented market. In the development of such equipment, Ergolines routinely simulates the flow of liquid steel, as it becomes a solid mechanical structure, using in-house computational resources. This case study addresses the problem of slag carry-over from the ladle to the tundish which is a serious problem in steel casting and which can lead impurities in steel or poor ladle yield. Slag carry-over is a complex phenomenon which cannot be observed directly. The simulation of slag carry-over requires the use of HPC which has not previously been used by Ergolines.

The Challenge

In the field of continuous casting there is an increasing industrial demand for the development of new technologies for preventing slag transfer from the ladle to the tundish. Such an event may cause a breakout, that is the breaking of the solid skin of the solidifying cast products, which results in hazardous dispersion of liquid steel within the industrial plant. Ladle-slag monitoring is currently performed by operators on an empirical basis. Given the relevance of both safety and the economic implications of a breakout, there is a significant demand for an effective, automated system for ladle-slag monitoring. While passing through the ladle shroud, liquid slag induces characteristic vibrations which can be measured. In order to develop an effective detection system, it is necessary to correlate the vibrational signal with the fluid dynamics of the system. Such a correlation requires a complex, detailed simulation, which can only be carried out on an HPC system.

The Solution

Dedicated HPC-based simulations followed by case experimental validation have provided Ergolines with key insights into the physics of the system and into different ladle-emptying mechanisms. As a result, it has been possible to establish a correlation between the shroud vibrational signal and the fluid dynamics of the system. The results obtained constitute the basis for the development of an innovative slag monitoring technology based on vibrational analysis, which would significantly contribute to both better occupational safety and greater productivity of steel plants. Previously Ergolines was using simulation in its design process. However this case study was their first experience of HPC and the benefits it could bring.

Fortissimo Experiment Partners:
- Ergolines (End User)
- Arctur (HPC Expert and Centre)

More Information:
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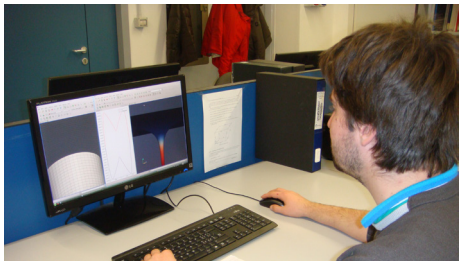

The Benefits

Given the complexity of the phenomenon to be simulated, a very fine discretization in terms of geometry and time is needed in order to obtain accurate results. Such a fine discretization involves a significant computational load and therefore requires adequate computational capabilities. As the company does not possess the necessary computational infrastructure, the possibility of using Cloud-based HPC resources proved fundamental in addressing this specific industrial and scientific challenge. In fact, the availability of a cloud-based HPC system allowed Ergolines to exploit supercomputing resources and reduce computational times without having to sustain the high costs of a dedicated infrastructure, used for only part of the time. The use of such an HPC resource can contribute to a significant reduction in time to market and improved product design. The results attained by the HPC-based fluid-dynamic analysis set the stage for the development of a new product for automatic slag detection in steel continuous casting, a promising technology envisioned to bring significant benefits to the end-users both in terms of occupational safety and productivity of steelworks.

The ability to detect slag while it is passing through the shroud would enable a steel plant to control the closing of the ladle better and so increase the steel yield. For an average ladle size of 100 tons, usually 0.5 to 1% of steel remains in the ladle. Using the proposed slag monitoring technology, 60% of that lost steel can be saved. On an average production of 1 million tonnes of per year, a medium-size factory could then save 6,000 tonnes of steel that do not need to be re-melted.

The re-melting of 6,000 tonnes of steel would cost approximately €70 to €100 per tonne, namely 420,000€ to 600,000€. Additionally the loss of a further 300 tonnes of steel for a cost of 70,000€ could be avoided. This means a total saved amount up to 670,000€ saved per year per medium sized steel plant.

Casting is a high energy-consuming process. It is very easy to see what this means in terms of energy saving for the re-melting of 6,000 tons of steel of each steel plant equipped with the proposed monitoring technology.

The Fortissimo Project

Fortissimo is a collaborative project that enables European SMEs to be more competitive globally through the use of simulation services running on a High Performance Computing cloud infrastructure. The project is coordinated by the University of Edinburgh and involves 123 partners including Manufacturing Companies, Application Developers, Domain Experts, IT Solution Providers and HPC Cloud Service Providers from 14 countries. These partners are engaged in 53 experiments (case studies) where business relevant simulations of industrial processes are implemented and evaluated. The project is funded by the European Commission within the 7th Framework Programme and is part of the I4MS Initiative.

I4MS Fortissimo is part of I4MS ICT Innovation for Manufacturing SMEs: www.i4ms.eu

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