Design of a 52 kW permanent magnet heater for aluminum billets

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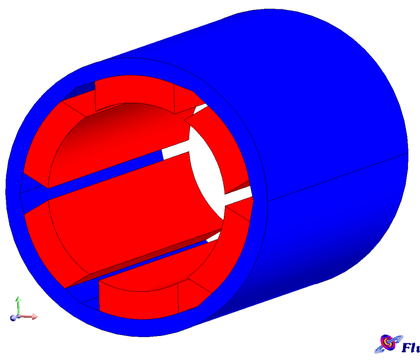
Introduction

The preheating of billets before hot metal forming process plays a major role among industrial induction heating applications, in terms of number of installations, unit rated power of heaters and energy consumption.

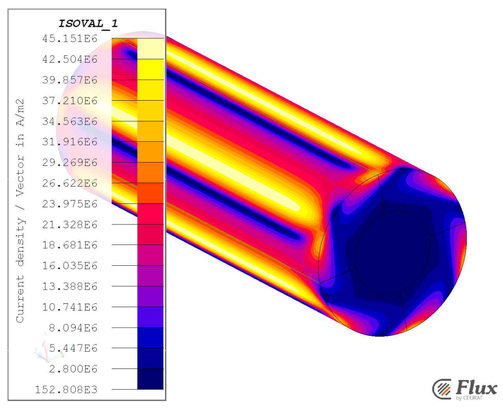
The proposed solution with rotating magnets reaches unmatched heating efficiencies, process integration and product quality.

An industrial scale prototype, designed by using advanced CAE software tools, has been developed. A 200 mm diameter, 500 mm long aluminum billet (42 kg) can be heated uniformly. The motor drive has a rated power of 52 kW at 2500 rpm. The magnetic field is produced by SmCo rare earth permanent magnets.

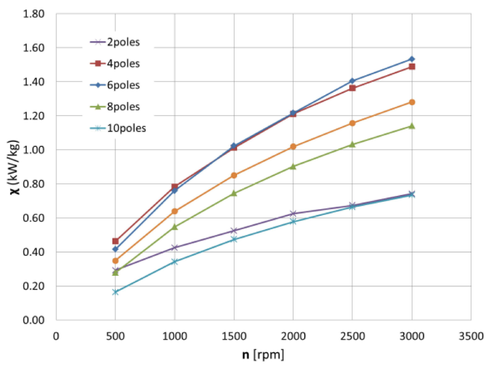
EM - TH Simulations



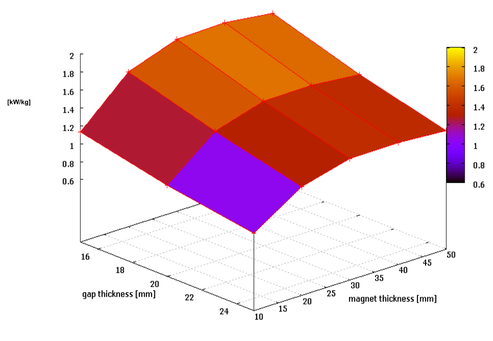
Geometrical Model



Current Density Distribution



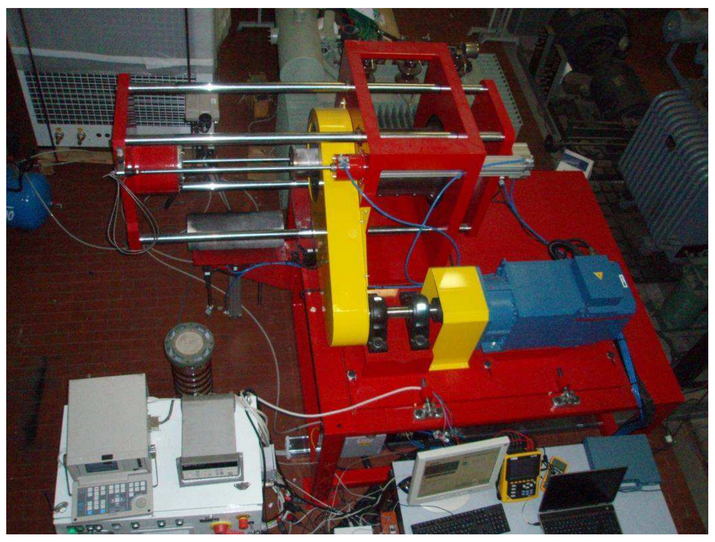
Induced power vs rpm



Induced power vs PM and airgap thickness

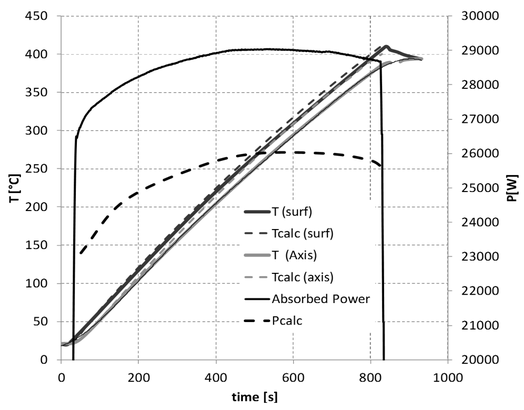
DOE and other parametric analysis have been performed in order to find the best configurations in terms of maximum magnet exploitation.
The solution set is also limited by mechanical and cost constraints.

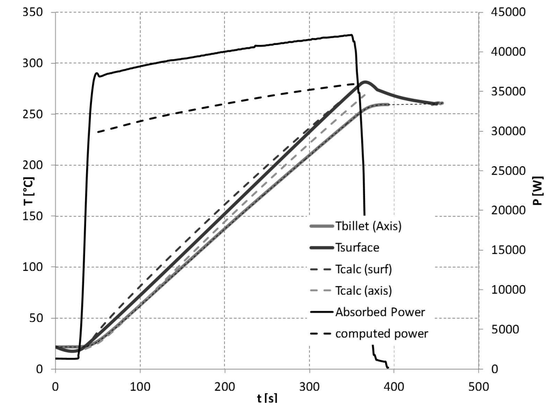
The Prototype



Industrial scale prototype

Permanent Magnets inside the heater





Experimental and numerical results for 2 different velocities: 500 rpm (upper) and 750 rpm (bottom). Measured values, continuous lines. Computed quantities: dashed lines.

Conclusions

Experimental measurements on a pioneering prototype of PM-heater are summarized and compared to numerical simulation results, showing the effectiveness of the innovative design.
The integrated use of simulation and optimization tools will lead to the development of an industrial heating system.