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XII JORNADA DE JÓVENES INVESTIGADORES DEL I3A

Electro-thermal modelling of an induction heating process for industrial applications

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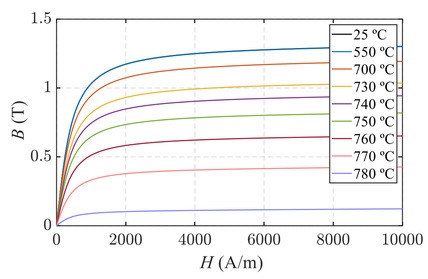
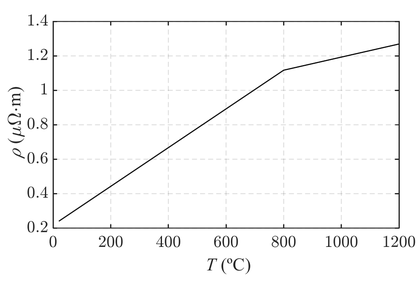
ABSTRACT
This work describes the electromagnetic and thermal modelling procedure of an induction hardening load of 42CrMo4 steel. In addition to the temperature and field level dependent physical properties of the material, the magnetic behaviour of the load is captured by means of some kind of non-linear impedance boundary condition which simplifies the computational cost of the simulation. The numerical results show the critical behaviour around Curie temperature. Finally, a comparison between several simulation results and experimental measurements is provided to assess the usefulness of the proposed electro-thermal simulation.

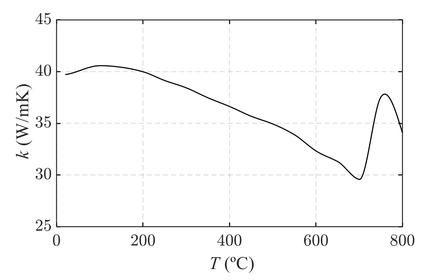
ELECTRO-THERMAL MODEL

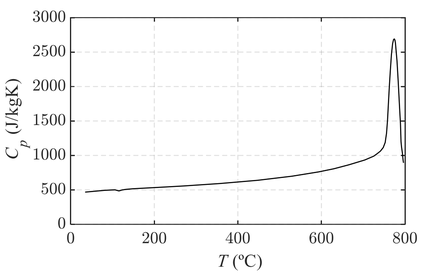
IH process characteristics: geometry and coil's current (left), and 42CrMo4 steel properties (right).

Parameter	Value	Unit
Coil's turn number	6	
Coil mean radius	15	mm
Turn inner diameter	4	mm
Turn outer diameter	6	mm
Distance between turns	9	mm
Billet radius	10	mm
Billet length	75	mm
Operation frequency	12,5	kHz
RMS current	440	A

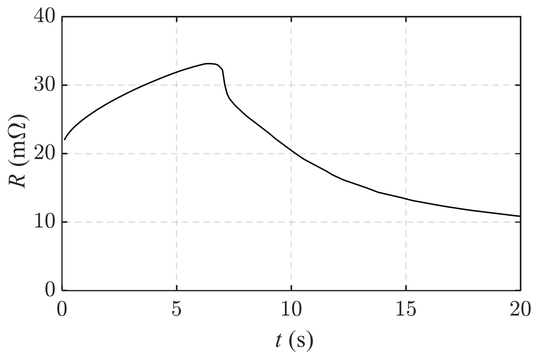


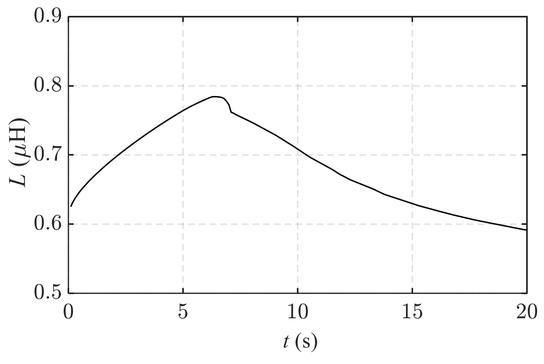




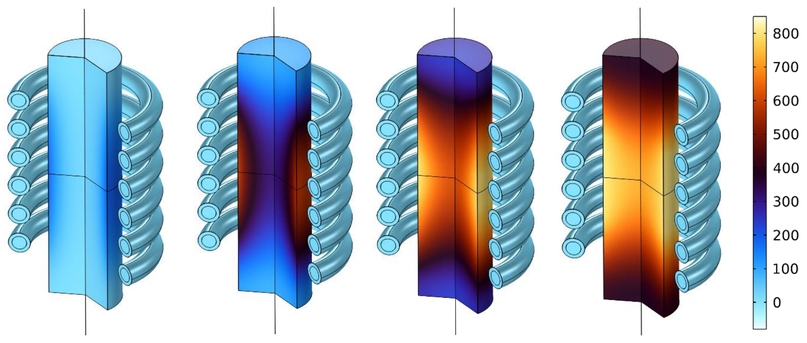


SIMULATION RESULTS

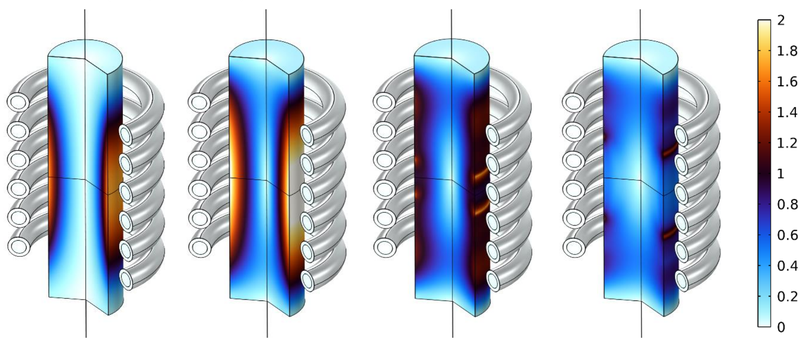




- Temperature distribution (ºC)

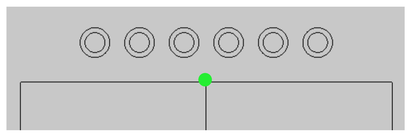


- Heat flux (W/mm²)

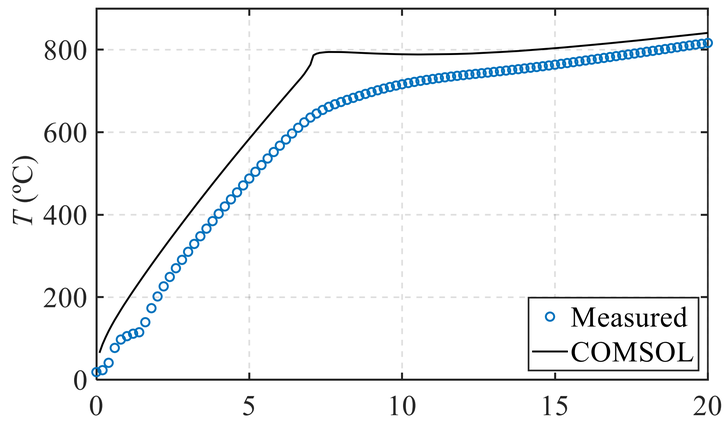


for t = 1, 5, 10, and 15 s

EXPERIMENTAL MEASUREMENTS



- Type-K thermocoouple.
- Curie temperatura at t = 7s:
  -Material saturation
  -Phase transition



CONCLUSIONS

- **Electro-thermal** simulation model of a **42CrMo4** steel billet.
- **Dependence** of the physical properties **of the temperature and field levels**.
- **Accurate characterisation** of the properties → good predictions.
- Equivalent **impedance boundary condition** → substitute electrical and magnetic properties of the load.