Finite Element Analysis of Induction Heating Process Design for SMART Foundry 2020

(SMART=Sustainable Metal casting using Advanced Research and Technology)

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Overview of Presentation

- SMART Foundary 2020
- Module: Melting & Direct Casting
- 3D Scanning for Reverse Engineering
- Induction furnace @VNIT
- CAD Model
- COMSOL Modelling
- Results & Conclusions
Fig. Proposed SMART Foundry
Module: Melting and Direct Casting

Melting + Pouring Unit

Sensing
- Camera
- Temperature

Casting Alloy
- Al / Mg / Ti
- Weight metering

Induction Furnace

Electronics Circuit
- Cooling Circuit

Crucible and Induction Coil
- Mold Block

Attachments

Vacuum
- Chamber
- Vacuum Pump
- Pressure Sensor

Inert Gas
- Chamber
- Gas Supply
- Metering

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3D Scanning for Reverse Engineering

Creation of 3D models without CAD:
Rapid manufacture of spare parts

3D Scanner

Cloud of points

CAD model

Existing objects can be scanned to create a Cloud of Points, which are ‘stitched’ into a CAD model.
This is useful to ‘reverse engineer’ parts for which drawings may not exist, like an old car or valuable equipment.

Tripod-mounted systems scanning rotating objects give less than 0.1% error.
Hand-held and phone based scanning is less accurate, but costs much less, making it widely accessible.

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Steps:
Fig. Low cost rapid manufacturing methodology developed with industry partners

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Area to be Explored

- Melting + Pouring
Induction Furnace @ VNIT Nagpur
Fig. Induction melting with direct pouring and data acquisition

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Induction Furnace CAD Model

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COMSOL

- Numerical model Validation
- Main features of the model
- Geometry & Meshing
- Governing equations and Boundary Conditions
- Numerical results
- Conclusions
It is a high temperature vacuum distillation furnace used for recovery of heavy metals.

**Functions:**

- Melt and consolidate of heavy metals
- Distill the volatile metals and salts
- Operate in inert containment box
- Heat reasonably fast while being capable of holding temperature

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COMSOL Modelling
• Tightly coupled phenomena
• Non-linear
  \( \mu(T, \omega), \sigma(T), C(T), k(T) \)
Geometry in COMSOL
2D Axis Symmetric

Fine Meshing
Temperature Profile
Temperature Profile
Transient Thermal analysis of mock-up induction furnace is being carried out in this study which is highly important for operation and control of the process.

Preliminary model: it will aid in improving the design.

The results of this study have shown that the temperature of the crucible rises to 650 °C in 30 min of heating time at frequency of 60 Hz and current of 22amp. Aluminium is likely to melt under these conditions.

The coil temperatures are above the acceptable temperature of Al material, hence different cooling technique is to be adopted.

These results will be compared with the experimental results which will be obtained during the operation of mock up facility.
Thank You!