

MeltFlow-VAR™

A Comprehensive Simulation Tool for the Vacuum Arc Remelting (VAR) Process

The VAR Process for Ingot Production

Vacuum Arc Remelting is a type of consumable electrode remelting process used for producing ingots of Titanium alloys, superalloys, and steel.

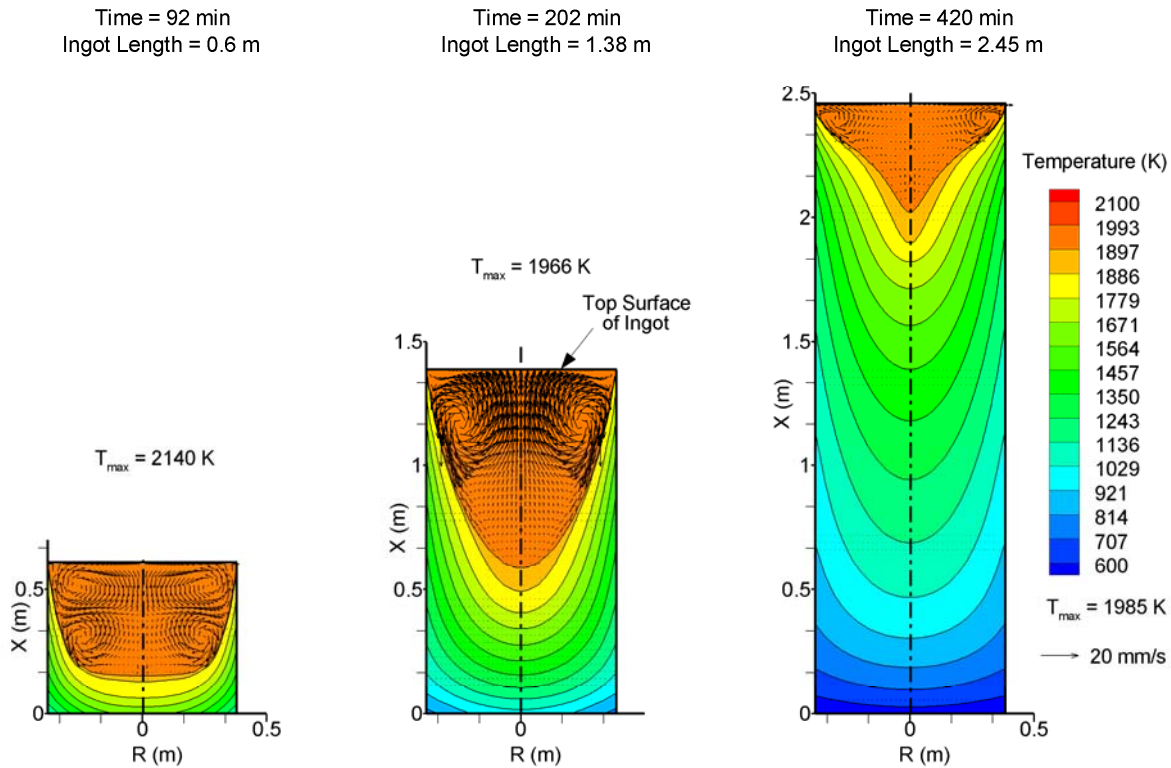
The performance of the VAR process is governed by complex interactions among electromagnetic, flow, heat transfer, and phase change phenomena. Effectiveness of the process in removing inclusions and achieving compositional uniformity is determined by the operating conditions. Due to the process complexity, a trial-and-error approach is ineffective for process optimization.

A Powerful Predictive Capability

MeltFlow-VAR* offers a scientific and cost-effective approach for predicting the effects of process conditions on the quality of the ingot produced.

MeltFlow-VAR considers all the underlying phenomena in a comprehensive and efficient manner for a detailed prediction of the flow, temperature, and electromagnetic field variations in the growing ingot during the entire process, and the distributions of the concentrations of the alloying elements within the final ingot produced.

*MeltFlow-VAR was formerly called COMPACT-VAR



Velocity and Temperature Fields, and Pool Region During a VAR Process for Ti-64 Alloy

Comprehensive Treatment of Process Physics

MeltFlow-VAR performs a rigorous analysis of the process by considering the following phenomena:

- Turbulent Flow in the Molten Pool
- Heat Transfer in the Pool and the Solid
- Effect of Shrinkage on Mold Heat Transfer
- Electromagnetic Fields due to Arc Current
- Effect of Magnetic Stirring
- Macrosegregation of Alloying Elements
- Motion and Dissolution of Inclusions

Efficient Computational Solution

The control volume computational method incorporates many algorithms that address specific aspects of the VAR process. These include:

- Growth of the Ingot in a Fixed Grid
- Automatic Determination of the Time Step
- Nonlinear Heat Transfer from Ingot Surfaces

Therefore, MeltFlow-VAR provides a robust and efficient calculation of the transient behavior of the ingot during the entire process.

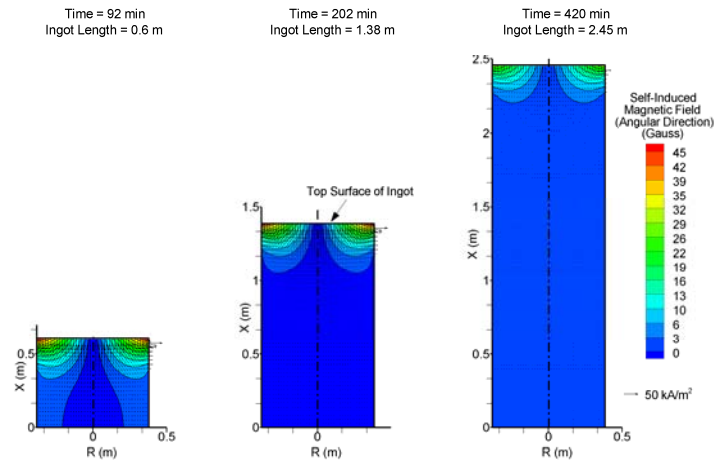
Powerful, Yet Easy-to-Use

MeltFlow-VAR allows easy creation of a process model by specifying ingot geometry, temperature-dependent alloy properties, and melt schedule through a user-friendly graphical interface. Results of analysis are conveniently examined using powerful visualization software.

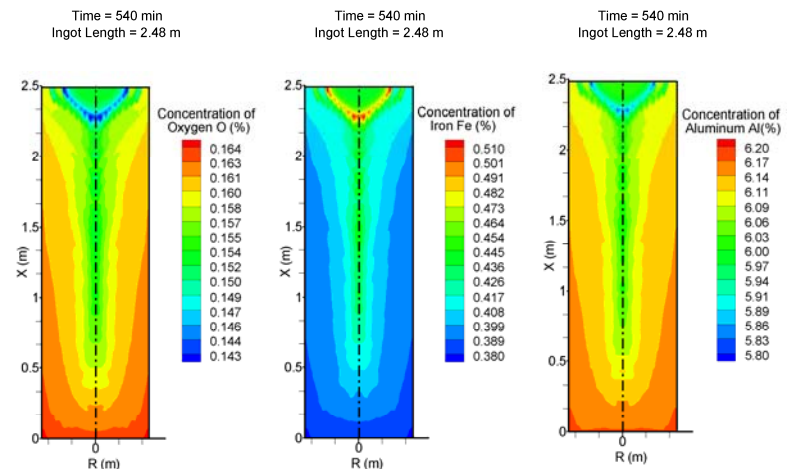
Engineering Benefits

MeltFlow-VAR has been shown to accurately predict the observed pool profiles and alloy concentrations in practical processes. It is being used in the following manner by leading alloy producers to obtain substantial cost-savings in process design:

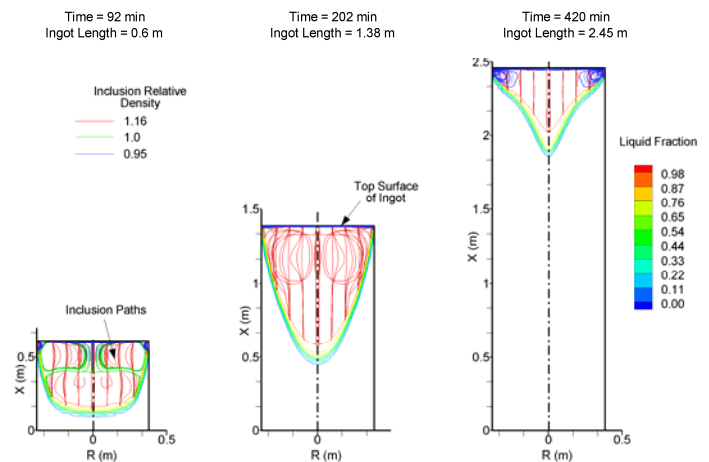
- Optimization of Melt Schedule
- Investigation of Process Anomalies
- Design of Process Variants
- Processing of Ti Alloys, Superalloys, and Steel



Electromagnetic Fields in the Growing Ingot



Concentrations of Alloying Elements in the Final Ingot



Behavior of Inclusions in the Growing Ingot