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| Book Name: | **Proceedings of the 8th International Conference on Solidification and Gravity** |
| Manuscript Number: | **Ms\_BPR\_** **3590.4** |
| Title of the Manuscript:  | **Melt Flow and Macrosegregation Formation Mechanism in VAR Ingot of TC17 Alloy** |
| Type of the Article | **BOOK CHAPTER** |

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| PART 1: Review Comments |
| Compulsory REVISION comments | Reviewer’s comment | Author’s Feedback *(Please correct the manuscript and highlight that part in the manuscript. It is mandatory that authors should write his/her feedback here)* |
| **Please write a few sentences regarding the importance of this manuscript for the scientific community. Why do you like (or dislike) this manuscript? A minimum of 3-4 sentences may be required for this part.** | **The manuscript is a valuable contribution to the scientific community, as it addresses the influence of axial magnetic fields on melt flow and macrosegregation during the vacuum arc remelting (VAR) process of TC17 alloy. This research is highly relevant for improving the quality and consistency of metal production, particularly in industries where alloy purity and uniformity are crucial. The combination of numerical simulations and experimental investigations adds robustness to the findings, offering a more comprehensive understanding of the underlying mechanisms. I appreciate the manuscript's clear approach in investigating the coupling effects of magnetic fields on melt dynamics, which could lead to more controlled remelting processes and better product performance. The research also paves the way for future work on the optimization of the VAR process in other materials.** |  |
| **Is the title of the article suitable?****(If not please suggest an alternative title)** | **The title of the article is informative but can be refined to better emphasize the key aspects of the study, particularly the use of axial magnetic fields (AMFs) to control melt flow and mitigate macrosegregation in VAR processes. Here's a revised title suggestion:**"Numerical and Experimental Investigation of Axial Magnetic Field Effects on Melt Flow and Macrosegregation in TC17 Alloy Vacuum Arc Remelting" |  |
| Is the abstract of the article comprehensive? Do you suggest the addition (or deletion) of some points in this section? Please write your suggestions here. | **The abstract of the article is quite comprehensive as it succinctly covers the key elements of the study, including the application of the axial magnetic field (AMF) in the vacuum arc remelting (VAR) process, the simulation method used (ANSYS Fluent), and the results related to melt flow and macrosegregation. It also highlights the experimental validation and the numerical parameter study to explore the effects of AMF on melt flow and segregation.****Here are a few suggestions for improvement:****1. Clarify the impact of AMF direction: The sentence regarding the AMF direction could be more specific. While it mentions the "effect of the AMF direction," it doesn't explain why this is significant. Adding a brief explanation of how the direction influences the melt flow or macrosegregation would provide a clearer picture.** **2. Results and implications: It would be beneficial to emphasize more on the practical implications of these findings. For instance, how can the reduction in macrosegregation from applying AMF impact the production of TC17 alloy ingots or other alloys? A sentence or two on the potential real-world benefits could make the abstract more compelling.** **3. Terminology: The term "hysteresis" might not be familiar to all readers. A brief clarification of what this means in the context of melt flow could be helpful (e.g., "delayed response" or "lag in flow direction change").****4. Numerical simulation details: The phrase "incorporating the multi-physics coupling of heat transfer, solute transfer, melt flow, and electromagnetic effects" is comprehensive, but perhaps a brief mention of the specific coupling method used (e.g., finite element method, etc.) could add depth for technical readers.****Overall, the abstract is already very well-rounded, but incorporating these suggestions could enhance clarity and impact.** |  |
| **Are subsections and structure of the manuscript appropriate?** | **The structure and subsections of the manuscript appear to be generally well-organized and suitable for a scientific study on the solidification process in VAR ingots. Here's a breakdown of the key sections:****1. Introduction:** **- The introduction is clear and provides an adequate background on the TC17 alloy, the VAR process, and the motivation for the study (macrosegregation and melt flow).** **- It outlines the significance of the problem and existing research, highlighting gaps in understanding macrosegregation and the role of axial magnetic fields.** **- The study's objectives are also clearly defined.****2. Modeling:** **- The modeling section provides detailed information on the computational approach, including the enthalpy-porosity method, governing equations, and assumptions (e.g., Boussinesq approximation).** **- The section also explains the key physics involved, including the forces (buoyancy, self-induced electromagnetic force, and stirring electromagnetic force) that influence melt flow.** **- The boundary conditions and physical properties are clearly described, with appropriate references to simulation parameters and material properties.****3. Results:** **- The results are clearly presented, with appropriate figures (e.g., isotherms, melt pool contours, and force distributions) and detailed descriptions of how the melt flow evolves during the VAR process.** **- The simulation results are linked to the thermal, solutal, and electromagnetic effects on the melt flow and macrosegregation.** **- A quasi-steady state is reached, and the distribution of temperature, forces, and velocity are presented.****4. Model Validation:** **- The validation section compares the simulation results with experimental data, providing confidence in the model's reliability.** **- The overlay of simulation and experimental data (e.g., melt pool traces and solute concentration) offers strong validation of the numerical approach.****5. Discussion:** **- The discussion of the results in terms of the forces influencing melt flow is comprehensive. It provides insights into how different combinations of forces affect flow patterns and macrosegregation.** **- The discussion also provides a detailed breakdown of different simulation cases (Cases I, II, and III) and their influence on melt flow and macrosegregation.** **Suggestions for Improvement:****- Subsection Titles:**  **- Consider making the subsection titles a bit more descriptive. For example, "Results" could be expanded to "Simulation Results and Analysis" to more clearly indicate the nature of the content.** **- For the Discussion section, the structure is good, but clearer subheadings for individual cases (Case I, Case II, and Case III) would make it easier to follow the comparative analysis.****- Model Assumptions:** **- It would be beneficial to have a brief section outlining the key assumptions made in the model (e.g., simplification of the alloy to a binary system) to help readers understand the limitations of the simulation.****Overall, the manuscript structure is logical, with well-defined subsections that guide the reader through the process, simulation, results, and interpretation of findings. With minor adjustments to subsection clarity the manuscript will have a solid structure suitable for publication.** |  |
| **Please write a few sentences regarding the scientific correctness of this manuscript. Why do you think that this manuscript is scientifically robust and technically sound? A minimum of 3-4 sentences may be required for this part.** | **This manuscript is scientifically robust and technically sound due to its comprehensive approach to modeling and simulating the solidification process in the VAR (Vacuum Arc Remelting) process, particularly for TC17 alloy. The authors employ a well-established enthalpy-porosity method to solve the governing equations, ensuring that key physical phenomena, such as melt flow, heat transfer, and solutal effects, are accurately captured. Additionally, the use of both numerical simulations and experimental validation strengthens the credibility of the results, demonstrating that the model accurately reflects real-world behaviors. The inclusion of various electromagnetic forces and their impact on the melt flow further enhances the scientific rigor, providing a detailed understanding of how these forces influence macrosegregation during solidification. Overall, the manuscript's methodology, coupled with thorough validation and in-depth analysis, demonstrates a strong technical foundation for advancing the study of alloy solidification processes.** |  |
| **Are the references sufficient and recent? If you have suggestions of additional references, please mention them in the review form.****-** | **The references in the manuscript are generally sufficient, covering key foundational and recent works relevant to the study of solidification processes and electromagnetic forces in the VAR process. However, there could be some opportunities to enhance the breadth of references to ensure a more comprehensive overview of the current state of the field. Including recent reviews or cutting-edge studies on the numerical modeling of solidification processes in other high-performance alloys, such as those focused on the interaction between electromagnetic fields and alloy properties, could further strengthen the manuscript. Additionally, references to recent advancements in computational techniques, such as the use of machine learning in the optimization of solidification processes, may also offer a contemporary perspective.** **If possible, I recommend including studies published in the past 2-3 years to reflect the latest advancements in the modeling of solidification and melt flow under electromagnetic influences.** |  |
| **Minor REVISION comments****Is the language/English quality of the article suitable for scholarly communications?** | The language and English quality of the manuscript are generally suitable for scholarly communication, but some minor revisions could improve clarity and precision. The manuscript appears well-written, with clear structure and formal tone appropriate for a scientific paper. However, there are instances where technical terms or concepts might benefit from clearer explanations, especially for interdisciplinary readers who may not be as familiar with specific terminology.Additionally, a few sentences could be rephrased to enhance readability and flow, ensuring that complex ideas are expressed concisely. Grammar and punctuation are mostly correct, though a thorough proofreading would help identify any subtle errors or awkward phrasing that could hinder the overall readability. Ensuring consistency in the use of terminology and maintaining proper alignment with standard scientific English will further elevate the manuscript's quality for publication in scholarly journals. |  |
| Optional/General comments | **REVIEW REPORT**The abstract and introduction provided for your manuscript are well-structured, technically detailed, and precise in describing the study's motivation, methods, and findings. Here’s a concise review:  **Strengths:**1. Clarity and Context:  The abstract succinctly outlines the problem (macrosegregation in VAR ingots) and the proposed solution (AMF application), offering an immediate understanding of the study's significance and scope. 2. Technical Rigor:  The introduction provides a solid technical foundation, including details of the VAR process, challenges like macrosegregation, and previous studies. The problem is contextualized within industrial applications, particularly in aviation. 3. Model and Validation:  Emphasis on using a validated numerical model (ANSYS Fluent) adds credibility. The comparison with experimental data further demonstrates reliability.4. Original Contributions:  The study innovatively explores the interplay of electromagnetic forces and buoyancy during solidification, highlighting how AMF mitigates macrosegregation. This makes the research impactful.**Suggestions for Improvement:**1. Abstract:  - The sentence "The trend of melt flow does not immediately change..." could be rephrased for clarity. Consider:  "The melt flow exhibits inertia, causing a delayed response to variations in the AMF direction." - Avoid excessive technical detail in the abstract (e.g., terms like "hysteresis"); focus on broader implications.2. Introduction:  - While comprehensive, the introduction can be slightly condensed to improve readability. For example:  - Combine related sentences to reduce redundancy (e.g., discussion on macrosegregation mechanisms).  - Highlight key findings of prior studies without detailed methodologies unless directly relevant. 3. Figures and Explanations:  - Ensure that figures in the introduction or results section (e.g., Figure 1(a)) are cross-referenced properly. Ensure clarity in captions, as not all readers may be familiar with terms like “Gaussian distribution of electric potential.” 4. Key Phrases:  - Simplify technical jargon for broader accessibility. For example, replace "thermo-solutal buoyancy force" with "combined thermal and solute-driven buoyancy forces."  - For the introduction, clearly state the novelty of the work early on, e.g., \*"Unlike previous studies, this work explicitly establishes a relationship between macrosegregation patterns and flow dynamics during VAR with AMF."**Key Refinement:**The reviewed work demonstrates some valuable experimental efforts, particularly in observing and characterizing fluid behaviors. However, there is a significant gap in mathematical and numerical modeling. A well-structured mathematical framework is crucial for understanding and generalizing the physical phenomena described in the study. The absence of equations or a quantitative analysis undermines the ability to draw robust conclusions or validate findings within a rigorous theoretical context. This lack raises critical questions: Where is the physics in this study? Without the application of fundamental physical laws formalized through mathematical expressions, the work risks being more descriptive than analytical. To elevate the study's impact, a stronger integration of modeling—including the derivation and use of governing equations for the phenomena under investigation is essential. In conclusion, while the experimental observations are noteworthy, addressing the deficiency in mathematical modeling and numerical simulation is imperative to fully explore the underlying physical principles and to ensure the research contributes meaningfully to the field.**1. Clarity and Structure: The manuscript demonstrates good organization but could benefit from more concise and clear explanations in some sections, especially in describing experimental setups and results. Minor revisions for clarity and better flow are recommended.** **2. Experimental Details: While the manuscript outlines the experimental methodology well, it may require additional details or visual aids (e.g., more figures or tables) to enhance understanding, particularly when describing complex phenomena like hydrodynamic instabilities.****3. Relevance and Novelty: The study presents relevant and novel research in the field of Taylor-Couette flows and non-Newtonian fluids. However, additional references to the most recent work and a stronger discussion of how this research builds upon previous studies could improve its overall impact.****Suggested Improvements:****- Revise certain sections for clearer expression.****- Add more figures or experimental results to illustrate key findings.****- Ensure proper citations are included for all relevant literature.****- Add Mathematical Modeling of Melt Flow and Macrosegregation:****Objective: This section would focus on describing the mathematical models that govern the melt flow and macrosegregation mechanisms in TC17 alloy during the VAR process.** **A major revision would address these concerns, improving the overall quality of the manuscript.** |  |

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| **PART 2:**  |
|  | **Reviewer’s comment** | **Author’s comment** *(if agreed with reviewer, correct the manuscript and highlight that part in the manuscript. It is mandatory that authors should write his/her feedback here)* |
| **Are there ethical issues in this manuscript?**  | *(If yes, Kindly please write down the ethical issues here in details)* |  |

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| **Reviewer Details:** |
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