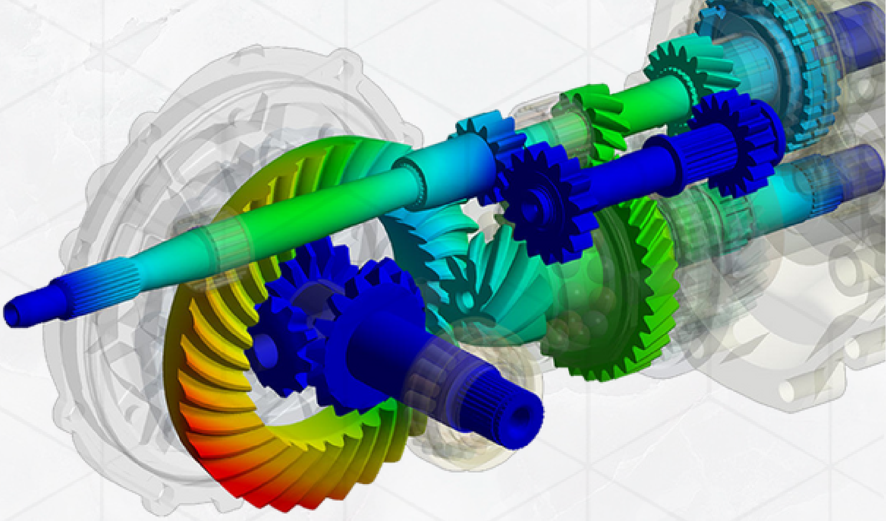

CASE STUDY

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CASE STUDY

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حديد عز

COMPARATIVE ANALYSIS OF INTOCAST AND VESUVIUS SUBMERGED ENTRY NOZZLES (SEN) USING CFD SIMULATION

The case study focuses on the challenges and subsequent CFD solution for submerged entry nozzle (SEN) analysis. The challenges in analyzing SEN include the need to understand the complex mold flow regimes, phenomena, and terminology, as well as the mechanical behavior of the nozzles. Additionally, the validation of CFD results and the prediction of cracks in the nozzles pose significant challenges.

CFD ANALYSIS PLAN

To address these challenges, a comprehensive CFD analysis plan was developed, incorporating oscillatory movement simulation and current flow analysis. The CFD analysis provided insights into the reaction forces, momentum ejection, and flow instabilities of different types of submerged entry nozzles, allowing for a comparison of their performance and probability of failure. The CFD verification process, including the nail board method, further enhanced the accuracy and reliability of the analysis. Overall, the CFD solution offered a robust and effective approach to understanding and addressing the challenges associated with submerged entry nozzle analysis.

CFD Analysis Plan: Oscillatory Movement Simulation:

- Current Flow Analysis Typical Time Step: t-step = 0.01 sec (4 iterations)
- Oscillating Wall Analysis (350 Hz): t-step = 1/350 = 0.002 sec (2 iterations)
- Verification: SSAB- Oxelösund Trial 2015

The CFD solution for submerged entry nozzle analysis proved to be instrumental in overcoming the challenges associated with understanding and predicting the behavior of these critical components in the steelmaking process. By developing a comprehensive CFD analysis plan, valuable insights were gained into the complex mold flow regimes and phenomena, as well as the mechanical behavior of the nozzles. The oscillatory movement simulation and current flow analysis provided a detailed understanding of the flow characteristics and reaction forces, enabling a thorough comparison of different types of submerged entry nozzles.

SUMMARY OF CFD RESULTS

Intocast's submerged entry nozzle (SEN) exhibits stronger reaction forces compared to Vesuvius SEN. This is primarily because Intocast's design leads to accelerated flow and higher momentum ejection at the discharge, resulting in increased reaction forces. Additionally, Intocast's design also causes a greater vertical speed at the discharge, further enhancing the reaction force. The difference in ferrostatic pressure due to design is approximately 710 N for Intocast and around 540 N for Vesuvius.

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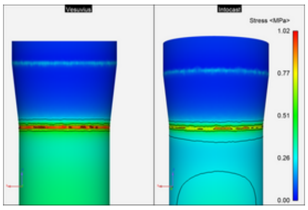
CRACK VERIFICATION

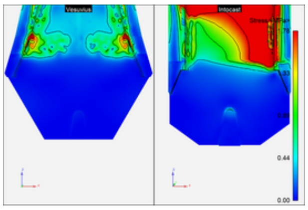
Upper Neck Breakage:

- Vesuvius: 0.9 MPa
- Intocast: 0.5 MPa



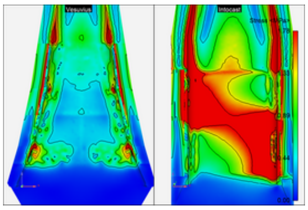
Discharge Divider Upper Crack:

- Vesuvius: 0.44 MPa
- Intocast: 0.85 MPa



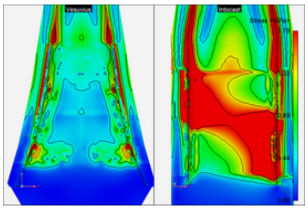
Diffuser Mid-Section Crack:

- Vesuvius: 0.55 MPa
- Intocast: 1.78 MPa



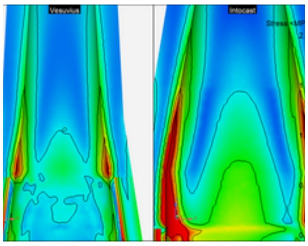
Diffuser Longitudinal Crack:

- Vesuvius: 0.55 MPa
- Intocast: 1.10 MPa



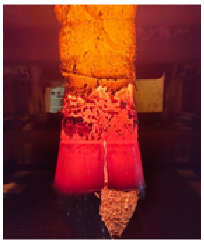
Diffuser Upper-Section Crack:

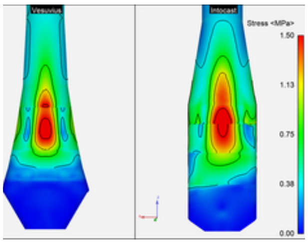
- Vesuvius: 0.75 MPa
- Intocast: 1.70 MPa



Centerline Longitudinal Crack:

- Vesuvius: 0.45 MPa
- Intocast: 0.75 MPa





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CONCLUSION

This comparative analysis provides valuable insights into the performance and potential failure modes of Intocast and Vesuvius submerged entry nozzles, aiding in the optimization of casting processes for enhanced efficiency and reliability. Further studies are recommended to address identified flow instabilities and ensure the integrity of casting operations.

TESTIMONIAL

"The seamless integration of different software within ANSYS Workbench allowed me to create a comprehensive case study. It began with generating a versatile mesh using ICEM CFD, followed by high-fidelity CFD analysis using ANSYS Fluent, and incorporating Fluid-Structure Interaction (FSI) simulations using ANSYS Mechanical. Finally, I combined all these solutions into a comprehensive report using Ensight to manage and present the technical details effectively, making it comprehensible to a wide variety of management levels."

Mustafa M Ezzeldeen
Forming Process Research Engineer
Ezz Steel