ABSTRACT

This thesis explores metal casting, specifically the permanent mould casting of aluminium in steel mould. The advantages of permanent mould casting, including cost-effectiveness and high-quality part production, are discussed. The significance of the solidification process in metal casting is examined, considering factors that affect casting quality, strength, and characteristics. Techniques for predicting and reducing porosity defect in casting are explored. The thesis proposes the use of Ansys Fluent simulation software to enhance the casting process. Computational fluid dynamics (CFD) models are highlighted for their ability to reduce trial-and-error testing and provide insights into mould filling, solidification, cooling, and porosity defect detection. The thesis aims to create a CFD model that comprehensively analyses the solidification process from the start of metal pouring. By optimizing casting parameters and minimizing porosity, the study seeks to improve casting quality. The CFD model predicts porosity location and identifies areas with the highest porosity, enabling better control of the solidification process. The study focuses on permanent mould casting of pure aluminium with a steel mould. One-dimensional casting solidification models estimate solidification time and front, while a three-dimensional model using Ansys Fluent simulates the process more extensively. The model considers air and aluminium as a two-phase system and turbulent flow within the mould cavity. It allows for variations in pouring velocity, pouring temperature, and mould initial temperature. The study explores the importance of parameters related to porosity defects and their impact on casting quality. Optimal pouring velocity and temperature are determined to reduce porosity. The length of fully-filled solid aluminium and the presence of a solid aluminium-air layer are analysed. The findings reveal the influence of pouring parameters on porosity formation and propose strategies to minimize porosity. The thesis concludes by summarizing the research's contributions, identifying areas for further investigation, and acknowledging encountered limitations and challenges. Continued research in aluminium casting with metal mould is encouraged to advance the field