ISETC2025

UNIVERSITI TEKNOLOGI MARA

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2 ND INTERNATIONAL SCIENCE, ENGINEERING AND TECHNOLOGY COLLOQUIUM



THE POWER OF SCIENTIFIC INNOVATION

INTELLIGENT SOLUTIONS FOR A SUSTAINABLE WORLD

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PREFACE

Welcome to the 2nd International Science, Engineering and Technology Colloquium 2025 (ISETC 2025)!

It is with great pleasure that we present this year's colloquium, a distinguished gathering of scholars, researchers, and professionals dedicated to the advancement of applied sciences. Held virtually on 9th July 2025, ISETC 2025 serves as a platform to highlight cutting-edge research, foster meaningful networking, encourage collaborations, and explore innovative solutions to global challenges.

This year's theme, "The Power of Scientific Innovation: Intelligent Solutions for a Sustainable World" highlights our shared goal to solve global challenges through applied science. It celebrates innovation as a key to building a more sustainable and resilient future. We're proud to feature keynote speakers and presenters who bring fresh insights, bold ideas, and breakthroughs shaping tomorrow's world.

We would like to extend our heartfelt appreciation to the Faculty of Applied Sciences, Universiti Teknologi MARA, Perak Branch, Tapah Campus, for their outstanding support and assistance throughout the planning and execution of the event. Their dedication has been instrumental to the success of this colloquium. We would like to sincerely thank all participants and researchers for their valuable contributions. We also appreciate the reviewers for their careful evaluations and helpful feedback. Your hard work and support mean a lot to us.

As editors, we are proud to present this collection of proceedings. It is an honour to bring together the interesting and meaningful work of our speakers and authors. We hope the ideas shared will lead to new discoveries, encourage more research, and help solve global challenges through science and innovation.

Warm regards,

Dr. Emi Norzehan Mohamad Mahbob
Dr. Saiyidah Nafisah Hashim
Ms. Lili Widarti Zainuddin
Ms. Nurul Nazwa Mohammad
Ms. Rozaina Saleh

ISETC 2025 Proceedings Editors

THE EFFECTS OF MULTIPLE GATES ON MECHANICAL AND PHYSICAL PROPERTIES OF ALUMINIUM ALLOY CASTING

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Abstract: This study investigates the effects of multiple gate configurations in sand casting on the mechanical and physical properties of aluminium alloy (Al 6063). Recycled Al 6063 was cast using green sand molds with two, three, and four gate setups. Surface roughness and Vickers hardness were evaluated. The two-gate configuration produced the smoothest surface finish (Ra = 17.370 µm), while the four-gate configuration recorded the highest hardness (304.7 HV at 0.1 kg load). The results demonstrate a trade-off between surface quality and mechanical strength, influenced by gating design. This study offers practical insights for optimising aluminium casting quality through appropriate gate configuration. This study provides valuable insight for manufacturers seeking to optimise casting quality by selecting the appropriate number of gates in the gating system design.

Keywords**:** *Aluminium casting, gating system, surface roughness, hardness, sand casting, mechanical properties*

INTRODUCTION

Casting, especially sand casting, is a widely used process for producing complex metallic components. A crucial factor in casting quality is the gating system, which controls molten metal flow. Single-gate systems often lead to issues such as turbulence, misruns, and porosity. This study focuses on evaluating how multiple gates (two, three, and four) influence the mechanical and physical properties of aluminium alloy castings, especially surface roughness and hardness (Cavallo, 2023; Nimbulkar & Dalu, 2016). Single gates may cause uneven filling and gas entrapment, affect dimensional accuracy and lead to defects. In contrast, multiple gates offer better flow distribution, improved venting, and more design flexibility. However, the effect of multiple gates on casting quality, particularly for aluminium alloys, is still not fully understood. Previous studies mainly examined single or double gates, leaving a gap in knowledge about more complex systems (Bhatt et al., 2014; Nimbulkar & Dalu, 2016). This research aims to evaluate the impact of using 2, 3, and 4 gates on aluminium alloy casting to address this gap and provide useful insight into optimal gating design.

MATERIALS AND METHODS

This study used recycled aluminium 6063 and green sand molds prepared at the Foundry Workshop of UiTM Permatang Pauh. The gating system was designed using SolidWorks with three configurations: two, three, and four gates. Each gate had a cross-sectional dimension of 24mm (width)×15mm (height)×50mm (length) and a taper angle of 3°, resulting in a total gate area of $360mm^2$. The patterns and gates were 3D printed using FDM technology with PLA filament. Green sand composed of 88% sand, 9% clay, and 3% water was used for molding. Aluminium was melted at 660℃ and poured into the mold. After 4 hours of cooling, castings were removed and cleaned. Surface roughness was measured using the Mitutoyo SJ-410 tester based on ISO 4287:1997 standards (ISO, 1997). Hardness was tested using the Mitutoyo HM-200 under 0.1 kg, 0.3 kg, and 0.5 kg loads, averaging three indentations per sample.

RESULTS AND DISCUSSION

Figure 1 shows the results for the surface roughness testing, which indicated that the product using two gates has the lowest average roughness value, which is 17.370 µm. This can be interpreted as the casting product with the best surface quality. The design of two gates is likely to result in a more balanced and streamlined flow of molten metal into the mold cavity. With only two gates, the molten metal may encounter fewer obstacles and less turbulence during its journey, allowing it to fill the mold more evenly and smoothly. This leads to a more uniform solidification process and a smoother surface finish on the final casting product. In contrast, adding more gates (such as three or four) can increase the complexity of the flow path and introduce more points of potential turbulence. Uneven flow distribution and turbulence can disrupt the solidification process and result in surface imperfections.

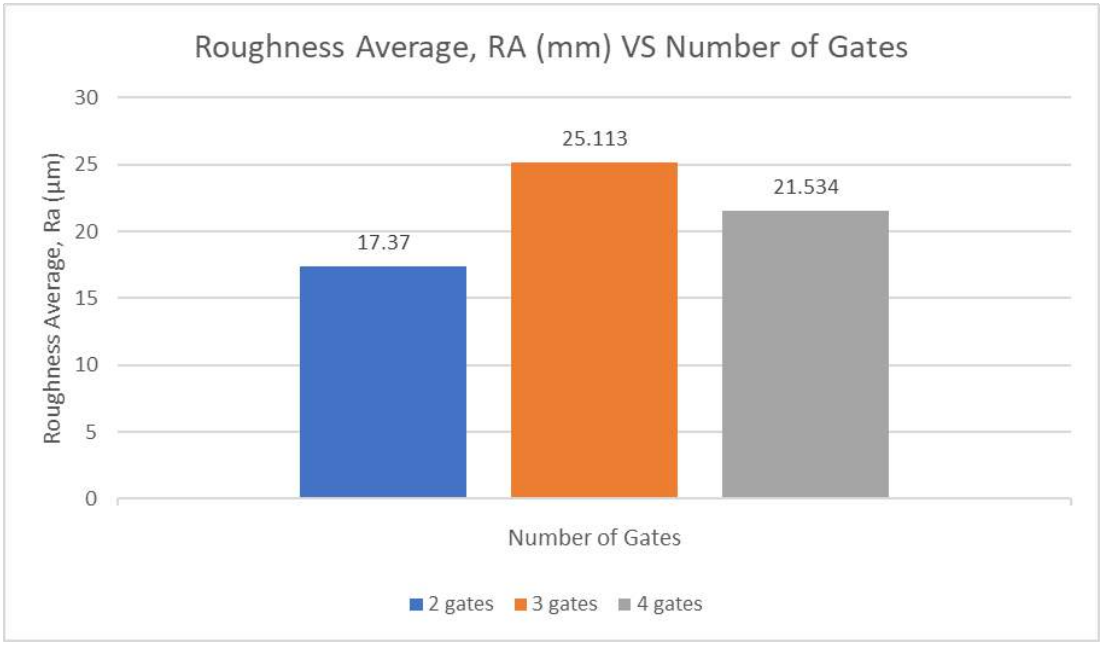


Figure 1. Roughness Average VS Riser Placement

The hardness test results shown in Figure 2 demonstrate that casting using four gates resulted in the highest value of Vickers hardness, which is 304.7 HV for a 0.1 kg load. A high hardness value indicates that the material has a high resistance to plastic deformation. The addition of gates improves metal distribution and solidification, leading to a more homogeneous microstructure with fewer porosity and shrinkage defects. As a result, casting with multiple gates is more likely to achieve higher hardness values. It implies that increasing the number of gates can be a useful method for increasing the mechanical strength and wear resistance of castings. This is in line with the statement by (Raza et al., 2021) that the number of gates influences the microstructure of the final casting and can impact the mechanical properties of the cast component. However, while more gates improve hardness, they also cause a slight increase in surface roughness, as shown by the findings. This implies that the flow complexity and turbulence generated by multiple gates can have both positive and negative consequences depending on the property under consideration.

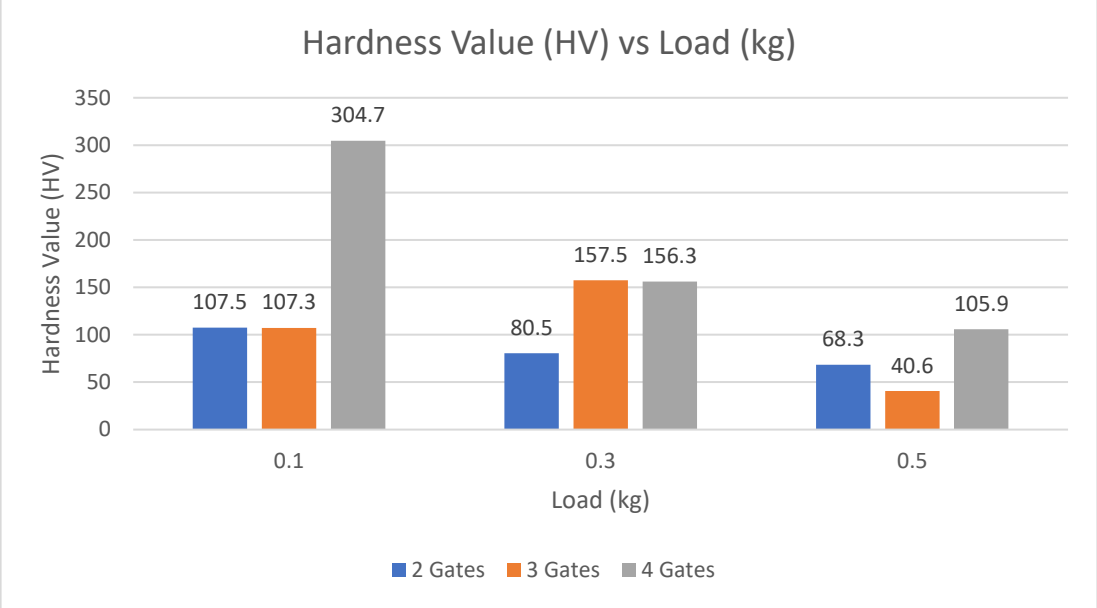


Figure 2. Hardness Value (HV) Vs Load (kg)

CONCLUSIONS

The two-gate configuration achieved the lowest surface roughness, indicating superior surface quality, while the four-gate configuration resulted in the highest hardness value, reflecting enhanced mechanical strength. From a practical perspective, the selection of two, three, or four gates should be guided by the specific requirements of the final product. A two-gate setup is preferable for applications demanding a high-quality surface finish, whereas a four-gate system offers advantages in applications where mechanical strength is a priority. Achieving an optimal balance between surface aesthetics and structural performance is essential in casting design. This study provides valuable insights to support decision-making in gating system design. Among the tested configurations, the four-gate system demonstrated the highest mechanical performance. Further improvements in surface finish may be attained through alternative pattern fabrication methods or by using finer sand during mold preparation.

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