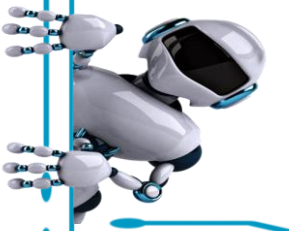
ENHANCING WELD QUALITY THROUGH TIG/MIG HYBRID WELDING: A CFD APPROACH ON THE INVESTIGATION OF CURRENT DENSITY DISTRIBUTION AND HEAT FLUX

Authors: Aisyah Arina Mohammad Shahrazel, Nor Zaiazmin Yahaya, Mohamad Shaiful Ashrul Ishak, Ahmad Nazri Dagang, Mohd Fadzil Abdul Kadir, Sarizam Mamat

Affiliations: Universiti Malaysia Perlis, Universiti Malaysia Terengganu, Universiti Sultan Zainal Abidin, Universiti Malaysia Kelantan

Contents



Introduction

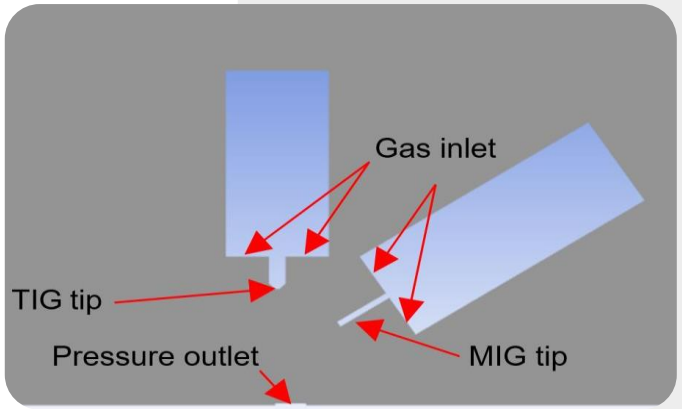
- The importance of welding process optimization
- We investigating current density distribution and heat flux in TIG/MIG hybrid welding using CFD
- ANSYS software has been used for thermal-electric and Fluent analysis

Problem Statement

Traditional Challenges: Costly and extensive real world testing in welding

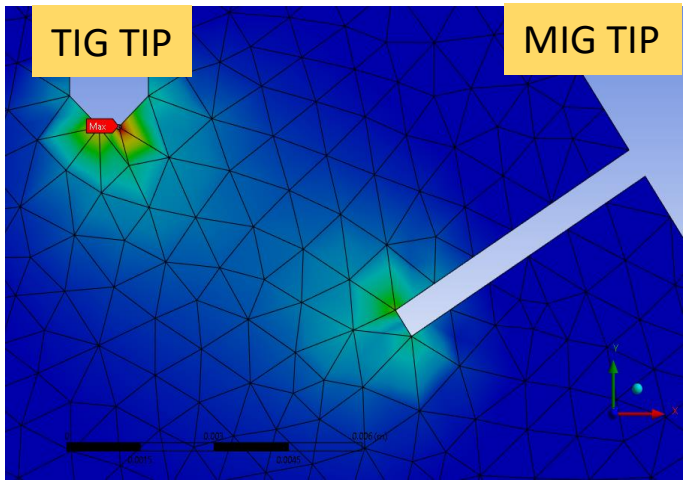
Proposed Solution: Numerical simulation using CFD to optimize welding parameters

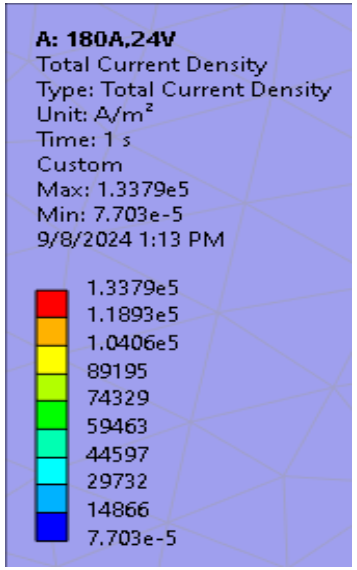
Methodology

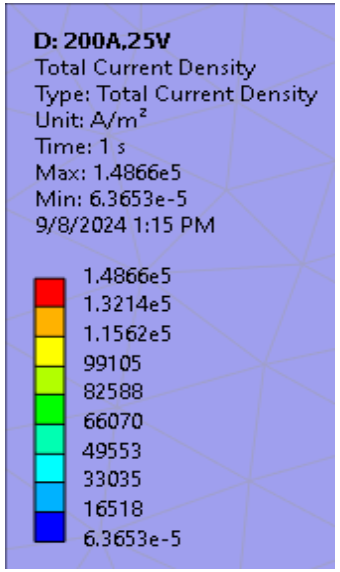


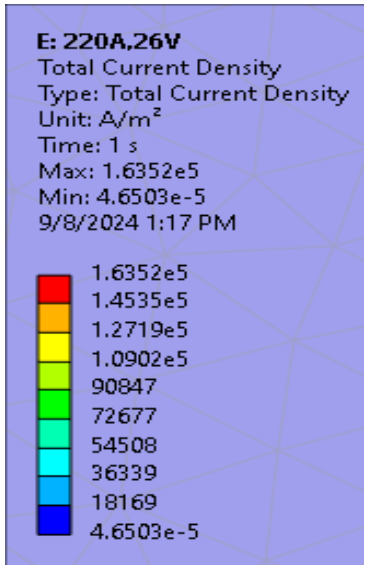
Results: Thermal-Electric Analysis

Current density distribution for 3 sets:









Observations:

Higher current leads to increased current density, especially near the TIG tip

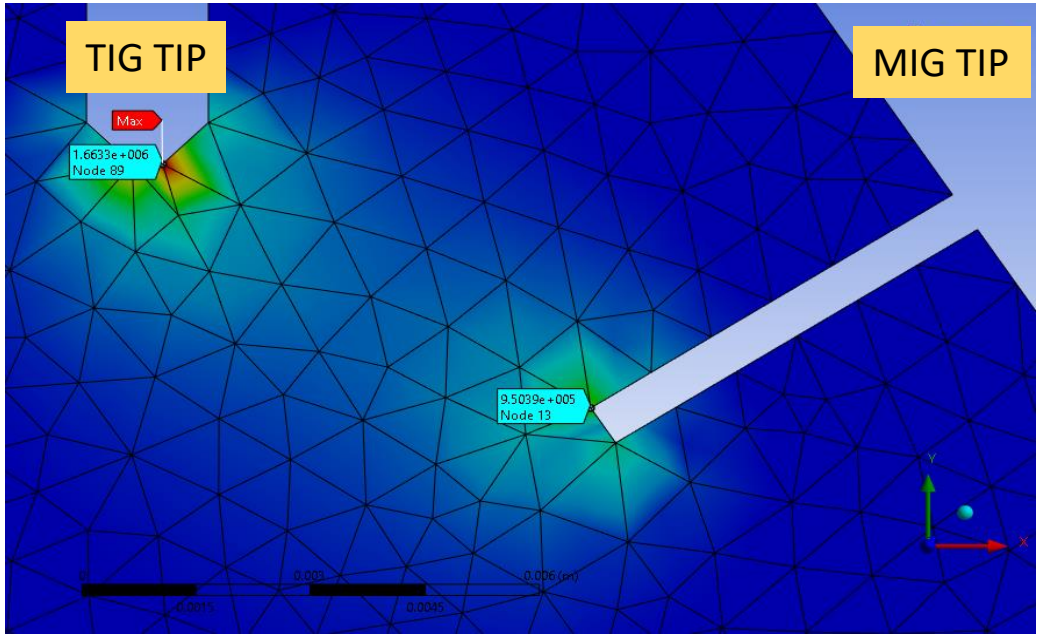
Discussion

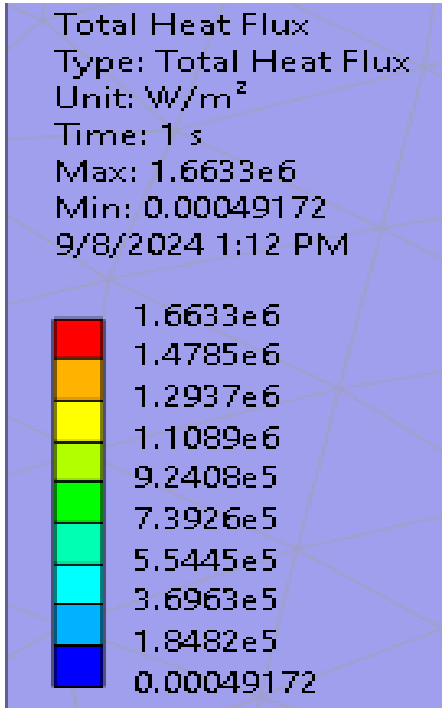
- The impact of current and voltage on welding quality

To produce the **extreme heat** needed to melt the base and the charge components, this current concentration is essential. The most electrically active region, indicated by the **red zone**, indicates the **strongest welding arc** and may have a direct **impact on weld quality**, as **higher current density** can be heated **more intensely**, affecting **penetration depth**. Giving deep penetration and strong fusion of materials can improve the efficiency of the welding process.

Results: Thermal-Electric Analysis

Heat flux at TIG and MIG tip for 3 sets:





Observations:

The heat flux value at each MIG tip and TIG tip did not change even though there have been changes to higher voltages and the current value

Discussion

- <u>The importance of heat flux and it influence the temperature distribution</u>

✓ The **heat flux value** is important in the **heat transfer** process. **Accurate** control of heat flux is essential for **predicting** and **controlling** the **thermal stresses** and **distortions** for **achieving** the **desired thermal distribution.**

✓ This may **influence the microstructure** and **mechanical properties** of the **welded joint**. It ensures that the **energy** from the welding processes is **efficiently utilized**, leading to improved **weld quality** and **reduced defects**

Discussion

- Error variation

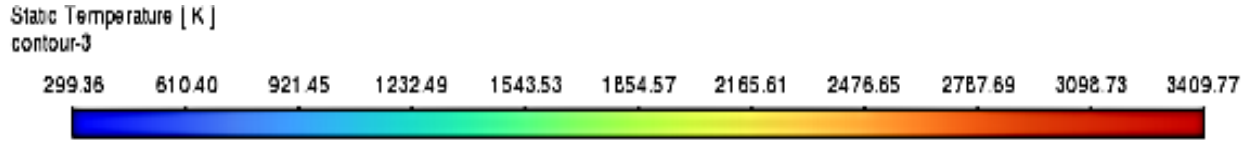
✓ The error of variation calculation against Cui et al.'s work

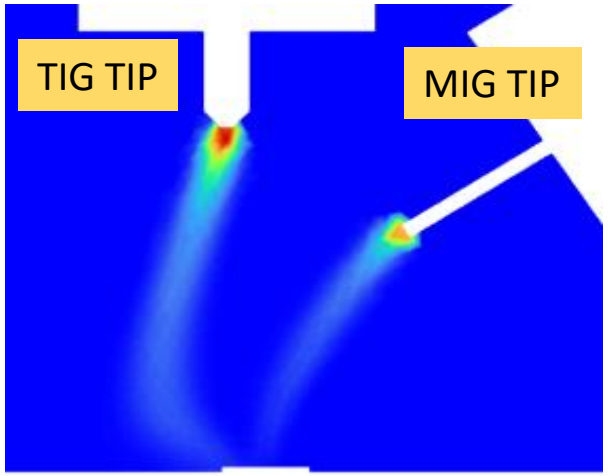
✓ 2.16% for TIG tip and 4.96% for MIG tip in heat flux compared to experimental values

✓ Can be used in Fluent analysis

Results: Fluent Analysis

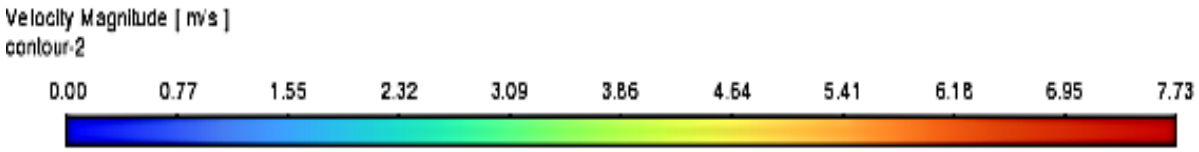
Temperature Distribution:

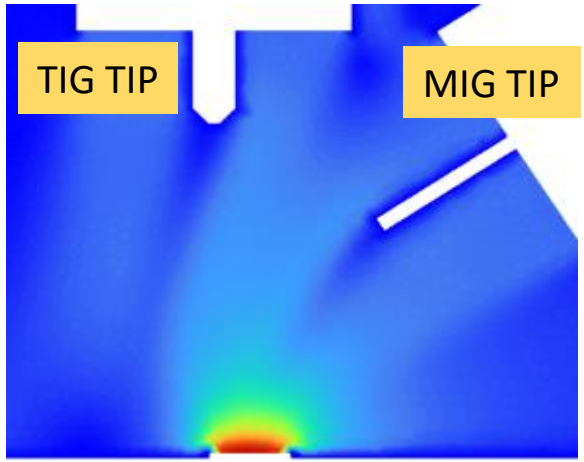




Maximum temperature recorded at 3409.77°C

Velocity Distribution:





Maximum velocity of 7.73 m/s

Discussion

- Temperature distribution

✓ The red zone represents the maximum heat concentration

✓ High temperature critical for ensuring complete fusion of the material (~3500°C)

- Velocity distribution

✓ The velocity represents the molten material velocity.

✓ Higher speeds can result in faster cooling rates, which can affect microstructure formation in the weld.

Conclusion

- Effective modeling of TIG/MIG hybrid welding using CFD
- Key findings on current density and heat flux
- Practical applications for improving welding quality
- Future Work: Further experimental validation and exploration of current density effects on weld strength

THANK YOU