Least Squares Approach To Optimize Electrofusion Welding Parameters of Glass/PE Thermoplastic Composite Pipes

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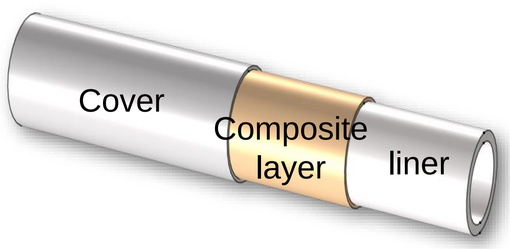
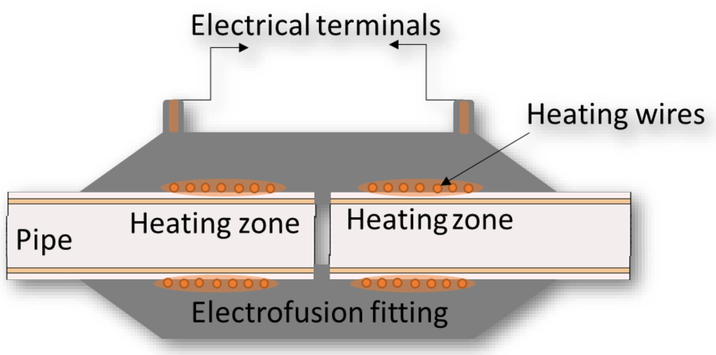
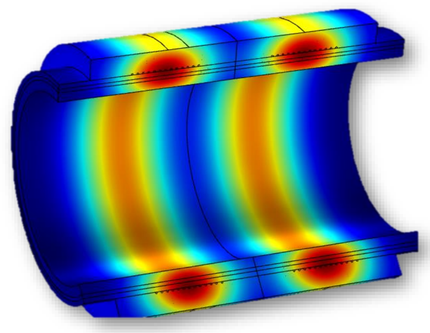
Abstract

Thermoplastic composite pipe





FEA modelling and optimization



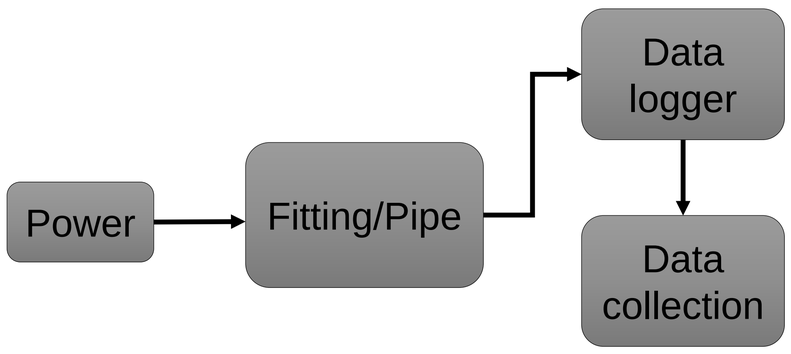
1- Introduction

Electrofusion coupling, a reliable welding method for thermoplastic pipes[1], can be extended to high pressure TCP, offering benefits like a corrosion-free system, improved sealing, and potential cost savings[2]. To ensure effective use, a coupled FEA model with optimization algorithms is needed for the process optimization and understanding the behaviour of the reinforced pipe during welding.

In this study, the least squares approach is used to optimize the welding parameters by matching the temperature profile from a simulated model and experimental data at different locations in the pipe/fitting assembly. The simulated data are generated by a 2D FEA model which focus on the virtual simulation of the heat transfer during electrofusion welding.

2- Method & Results

1. Experimental data collection



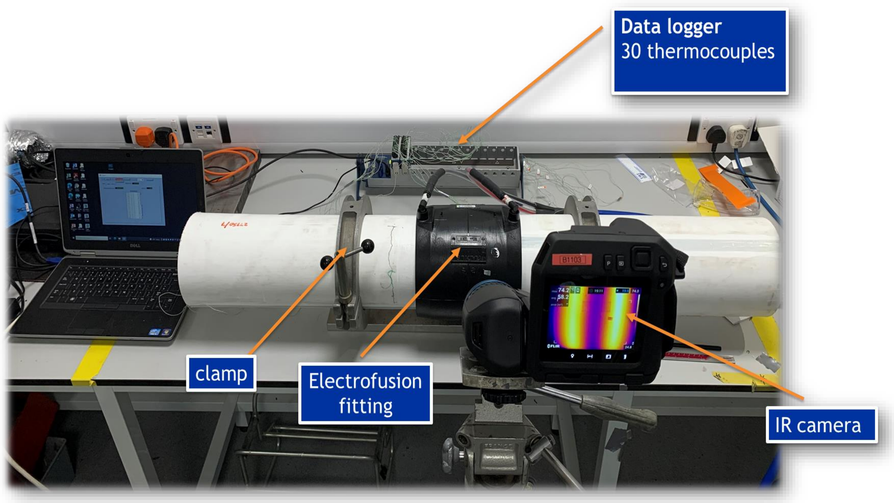


Figure 1. Electrofusion welding setup

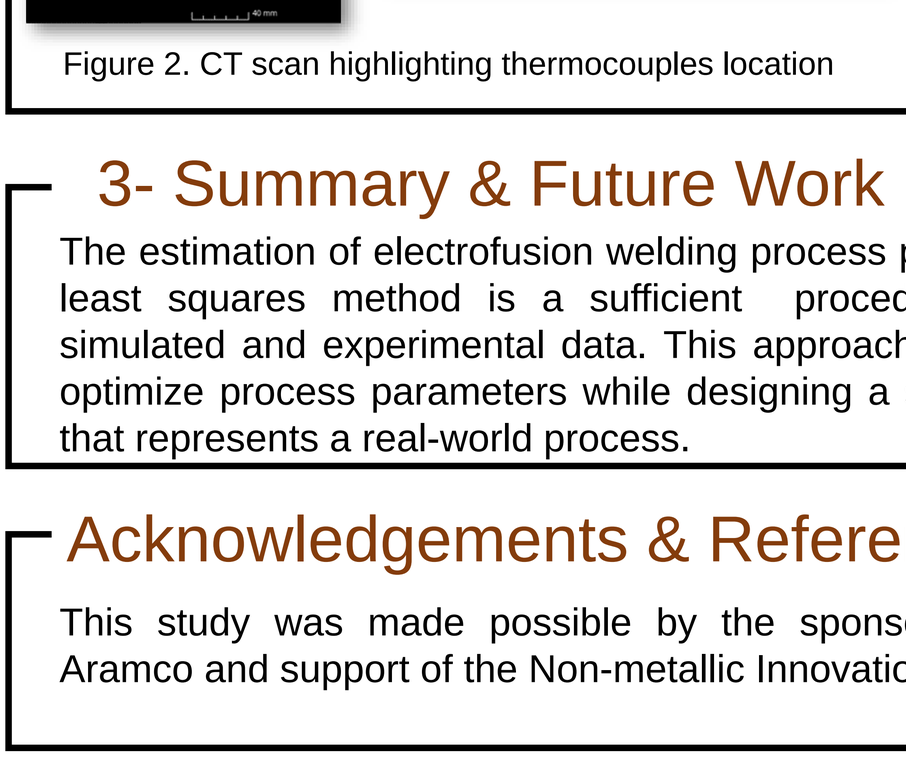


Figure 2. CT scan highlighting thermocouples location

2. FEA Model

Assumptions

- 2D axisymmetric model
- Perfect contact between coupler-pipe
- Material properties are temperature dependent. (ρ, K, Cp)
- Convection heat transfer coefficient set to h = 10 W/m^2.K

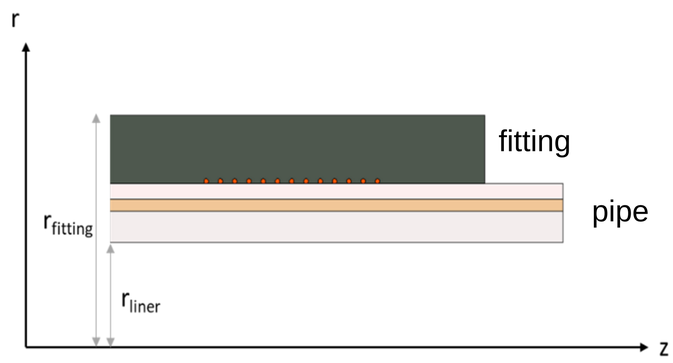


Figure 3. Schematic of the modelled joint

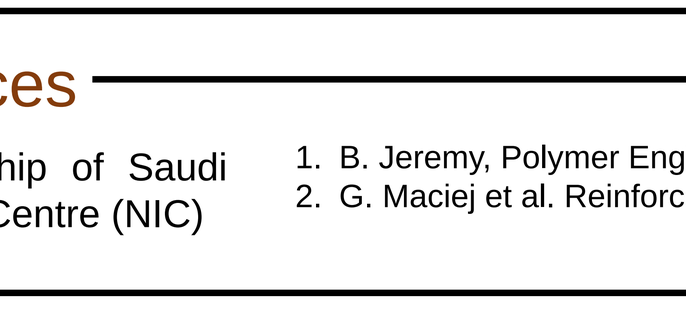
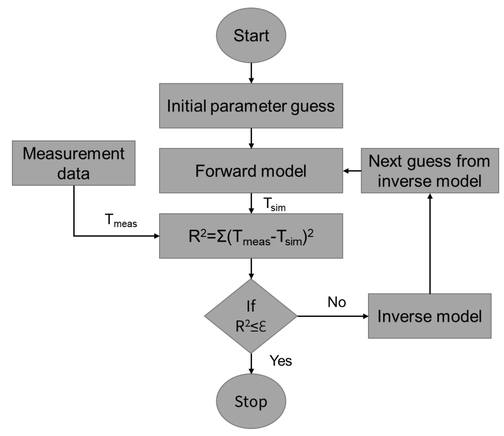


Figure 4. Simulated temperature profile

3. Process Optimization



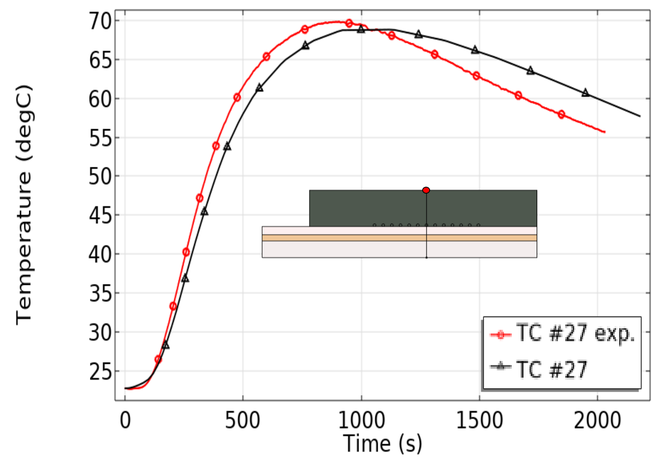


Figure 5. Temperature profile before optimization

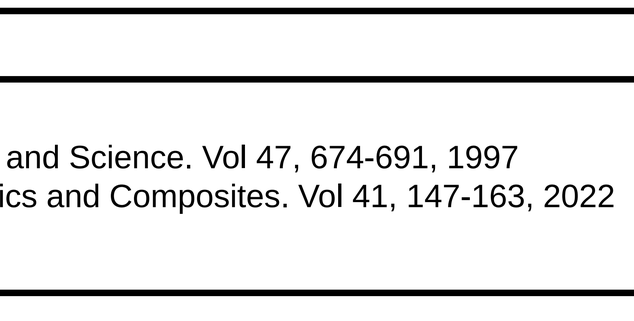


Figure 6. Temperature profile after optimization

3- Summary & Future Work

The estimation of electrofusion welding process parameters using least squares method is a sufficient procedure to calibrate simulated and experimental data. This approach can be used to optimize process parameters while designing a simulation model that represents a real-world process.

The result of this optimization study will be used to investigate different electrofusion fitting designs to achieve a reliable design that matches the required long-term performance from the industry.

Acknowledgements & References

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2. G. Maciej et al. Reinforced Plastics and Composites. Vol 41, 147-163, 2022