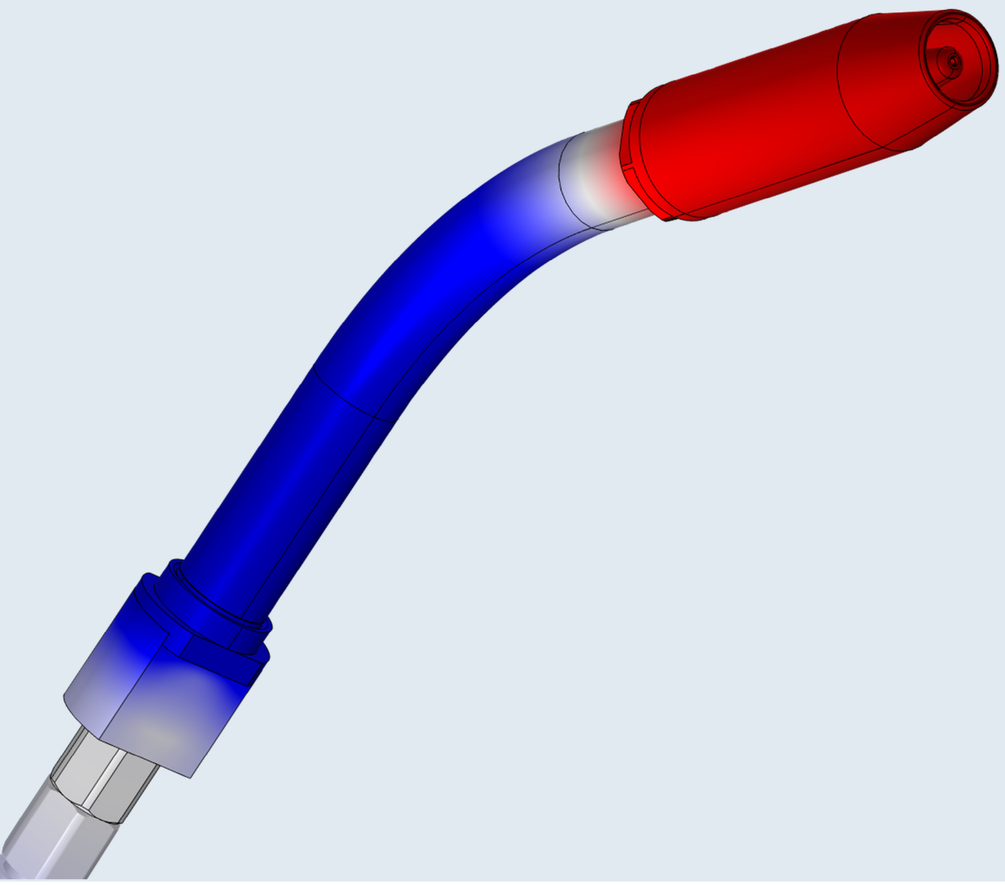

Analysis of Thermal and Electrical Contact Resistance in Welding Torches

A comparison between OpenFOAM® and COMSOL Multiphysics®

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Introduction & Goals

Contact resistance, refers to the resistance encountered when two materials or components come into contact. It arises from the microscopic roughness, impurities or contaminants of surfaces.

The resistance originates from the fact that current or heat flow is constricted to flow through the actual contact spots and due to the presence of any insulating films or layers at the contact interface.

The main objective of the project was to examine and compare the capabilities and performance of OpenFOAM and COMSOL Multiphysics in accurately and efficiently analyzing contact resistance.

In this analysis, the distribution of the electrical potential and the heat development resulting from the Joule heating effect were examined.

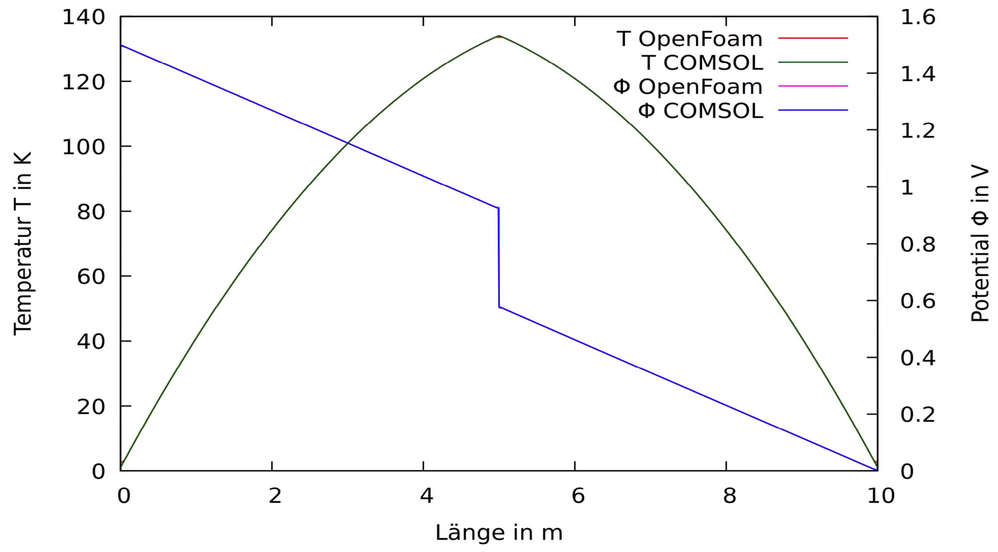

Figure 1. 1D contact test simulation illustrating temperature distribution from Joule heating, with boundary conditions for potential and temperature at the ends and a central contact resistance.

Methodology

Simulations of thermal and electrical contact resistances were conducted with OpenFOAM and COMSOL Multiphysics, evaluating the potential and heat distribution, resulting from contact resistances.

A series of test simulations were performed, encompassing various contact configurations, material properties, simple and complex geometries and boundary conditions.

The different simulations were carried out in both OpenFOAM and COMSOL Multiphysics, and then compared with each other for accuracy, computation speed, and usability.

Results

There are notable differences between OpenFOAM and COMSOL Multiphysics in their performance and user experience.

When simulating contact resistances, COMSOL Multiphysics demonstrated a marginal edge in both speed and accuracy.

The open-source nature of OpenFOAM offers the benefits of community-driven development, flexibility and no licensing costs. Still, development and maintenance costs must be considered.

Beyond the technical performance, what stood out significantly was the superior usability COMSOL Multiphysics, making it the more user-friendly option.

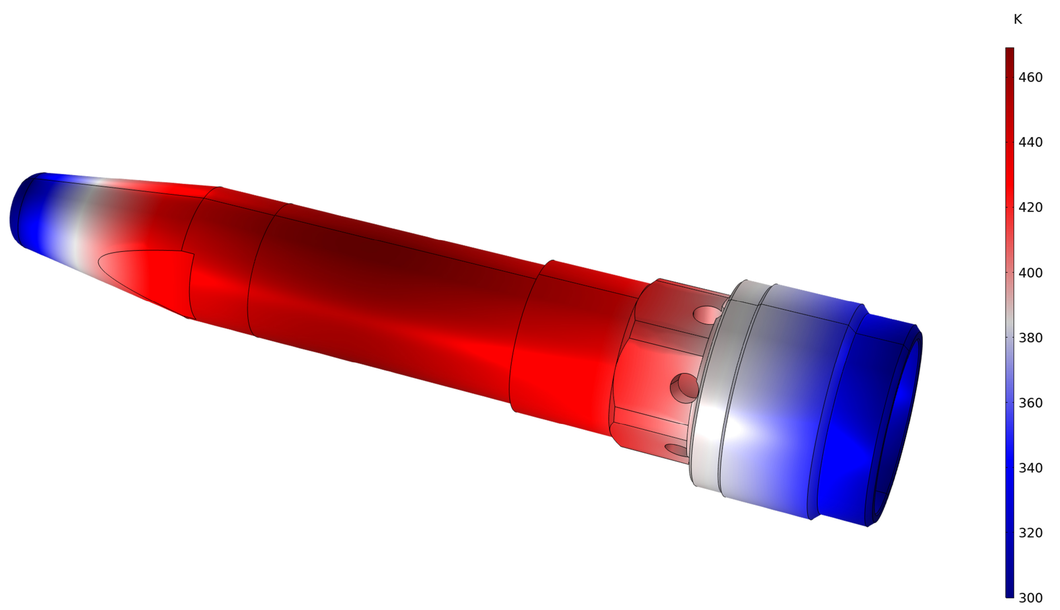

Figure 2. Temperature distribution of a 3D contact test simulation of a part of the examined welding torch nozzle, with boundary conditions for potential and temperature at the ends and a central contact resistance.

REFERENCES

Fronius International GmbH, Wels, Austria.

Leading innovator in the fields of welding technology, photovoltaics, and battery charging technology. https://www.fronius.com/de-at/austria

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