A 2D Model of a DC Plasma Torch

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Abstract

Plasma torches are used in processing of materials and in energy industry for producing plasma. In a non-transferred arc plasma torch, an electric arc can be glowed by applying a direct current (DC) between the cathode and anode, both placed inside the torch. Then, the plasma is obtained by heating, ionizing and expanding a working gas, introduced into the chamber of the torch upstream of the cathode. Under hypothesis of local thermodynamic equilibrium (LTE), the electrons and heavy particles temperatures are approximately equal and the plasma can be modeled by using the magnetohydrodynamics equations.

In this work, we use the Multiphysics interface Equilibrium Discharge of COMSOL Multiphysics® to model a two dimensional DC non- transferred arc plasma torch. The steady state equations of conservation of fluid mechanics, heat transfer and electromagnetics are implemented by using the respective interfaces and the multiphysics couplings options available in COMSOL Multiphysics. The plasma is considered optically thin and a net emission coefficient is used for the heat transferred by radiation mechanisms. Laminar flows with swirl have been simulated for an axisymmetric plasma torch with argon as working gas. To deal with the complex electric boundary values on the anode surface, two different boundary conditions have been used, i.e. specific arc-root position and isopotential surface. Furthermore, the swirling regime at the inlet of the torch has been introduced by using different combinations of free and forced flow. The computational results have been then compared with experimental results of literature available for the temperature and velocity patterns of the plasma torch.

Reference

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Figures used in the abstract

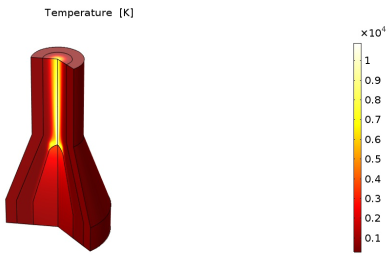

Figure 1: Temperature in the torch.