Development of a Computational Model to Simulate a Plasma Torch Plume for Supersonic Conditions

Abstract

Thermal plasmas are of great technological interest because they exhibit special characteristics such as high energy densities and the ability to use electricity as primary energy source. At the heart of any thermal plasma system is the plasma torch where fluid and electromagnetic forces compete with each other and determine the movement of plasma arc root, column & column-root junction. Complex interactions among the electromagnetic, fluid dynamic and thermal fields inside the torch lead to fluctuations in the plasma column. It is difficult to probe such plasmas experimentally and only macroscopic information can be obtained by standard diagnostic techniques, whereas computer modelling can reveal a lot about processes occurring inside the torch. The primary objective of this project is to develop and validate a computational model using either ANSYS or OpenFoam platform that simulates plasma plumes first at subsonic conditions, and then extending the understanding of plasma plume dynamics to supersonic regime. The work will result in the development of a model that will help understand the processes responsible for the sub-to-supersonic to supersonic transition of the plasma plume and form the foundation of modelling in this regime. This will also help reduce design cycle times for such a plasma torch in view of applications such as spray applications, magneto-plasma dynamic thrusters and re-entry. The simulated data will be validated against experimental data. Scope of work includes: (i) literature review and baseline analysis by conducting a review of existing models and simulations for subsonic and supersonic plasma plumes (ii) build a CFD-based multi-physics model capable of simulating compressible plasma dynamics; attempts will be made to incorporate plasma-specific parameters, such as ionization rates, Debye length etc. (iii) validation of the model against experimental data or published results from reference studies. Student preferably from Aerospace Engg.

Academic Project Requirements:

1) Required No. of student(s) for academic project: 1

2) Name of course with branch/discipline: B.E./B.Tech. Other

3) Academic Project duration:

(a) Total academic project duration: 16 Weeks
(b) Student's presence at IPR for academic project work: 4 Full working Days per week

Email to: gravi@ipr.res.in[Guide's e-mail address] and
project_other@ipr.res.in [Academic Project Coordinator's e-mail address]

Phone Number: 079 -23269039 [Guide's phone number]