Seminar

Institute for Plasma Research

Title : Numerical simulation of nitrogen plasma torch using finite volume techniques

Speaker : Dr. K. C. Meher
FCIPT, Institute for Plasma Research

Date : 05th January 2017 (Thursday)

Time : 2.00 PM

Venue : Committee Room 4, (New Building), IPR

Abstract :

The high temperature, high enthalpy and extremely luminous plasma jet generated by a thermal plasma torch can be used as a source of energy at high temperature as well as a source of high temperature inert or chemically reactive ions and radicals for chemical synthesis [1]. This results in the possibility of using it for a large number of applications including cutting, welding, melting, material processing, plasma spraying, waste treatment, nano-particle generation, re-entry simulation etc. [1-6]. Such a wide range of applications provides the necessary driving force for the development of thermal plasma technology. However, experimental study in thermal plasma devices is restricted because of mechanical obstruction, high core temperature and need for high cost diagnostic systems. Hence, numerical modeling is an important tool for analyzing the device physics and engineering and also for design optimization and development of new devices.

We have developed a finite volume numerical model of the nitrogen dc plasma torch operational at FCIPT. This parametric model has been built on ANSYS/FLUENT platform and incorporates many complex features of the torch including the electrodes and fluid region and has the provision for introducing the plasma generating gas as well as a shroud gas. It can calculate the distribution of temperature, velocity, potential inside the device as well as in an extended domain. We have also been able to successfully configure the high performance cluster (HPC) and post jobs using the remote solve manager. This computational fluid dynamic model makes use of specially built user defined functions (UDFs) along with Navier-Stokes equations and Maxwell’s equations to include the plasma dynamics. The results agree well with experimental results.

In my presentation, I shall discuss the fundamental formalism of the model, methodology and results. I shall also discuss how the model could be improved to include three-dimensional features, self-consistent arc root attachment, influence of external magnetic field and time-varying dynamics.

References

[1]Thermal Plasma Processing, Boulos M I, IEEE Transactions on Plasma Science, VOL. 19 (1991) pp. 1078-1089

[2]Thermal Plasma Processing of Materials: A Review, Taylor P R and Pirzada S A, Advanced Performance Materials, 1 (1994) pp. 35-50

[3]Developments in direct current plasma spraying, Fauchais P, Montavon G, Vardelle M and Cedelle J, Surface & Coatings Technology 201 (2006) pp. 1908–1921

[4]Thermal plasma technology for the treatment of wastes: A critical review, Gomez E, Rania D A, Cheesemanb C R, Deeganc D, Wisec M and Boccaccinia A R, Journal of Hazardous Materials 161 (2009) pp. 614–626

[5]Thermal Plasma Synthesis of Nano-Sized Powders, Seo J H and Hong B G, Nuclear Engineering and Technology, 44 (2012) pp. 9-20

[6]Plasma Generators for Re-Entry Simulation, Kurtz M A, Kurtz H L, and Laure S, Journal of Propulsion And Power, 12 (1996) pp.1053-1061