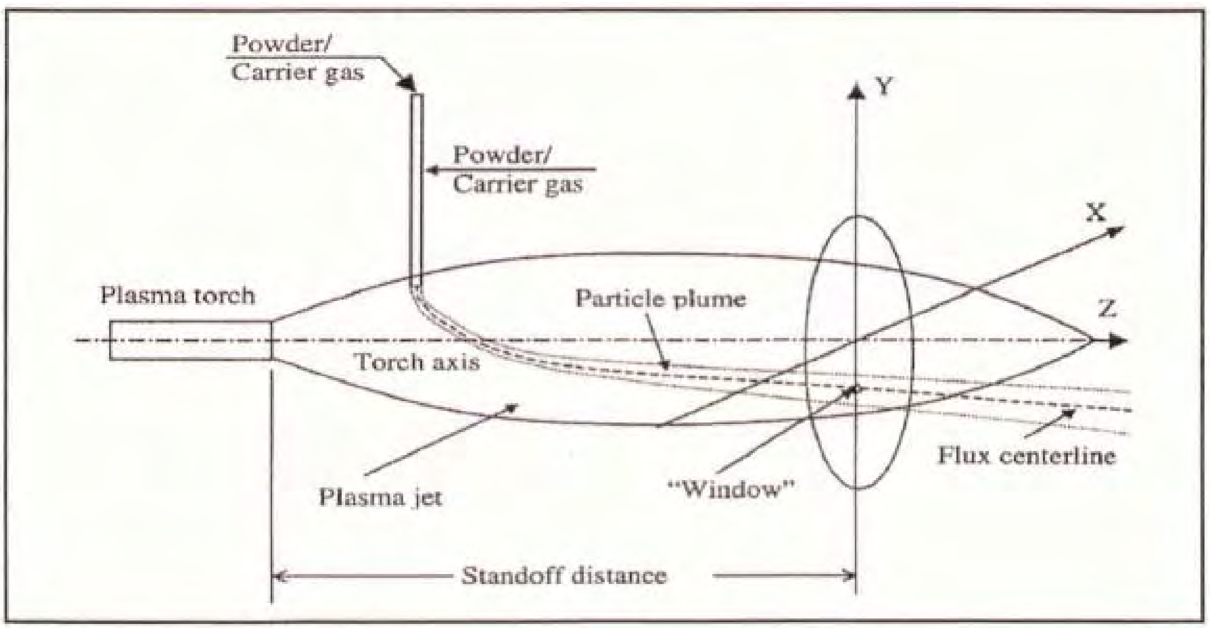
SigmaPlot Whitepaper

In-Flight Particle Behavior for an External Injection Plasma Spray Process

The microstructural characteristics of thermal spray coatings depend strongly on the velocity, temperature, and size of the particles upon impact against the substrate. Generating coatings of good quality or any improvement on spray efficiency requires a detailed understanding of the plasma jet and its interaction with the spray particles.

A three-dimensional computational fluid dynamic (CFD) analysis using Fluent V5.4 was conducted on the in-flight particle behavior during the plasma spraying process with external injection. The spray process was modeled as a steady jet issuing from the torch nozzle via the heating of the arc gas by an electric arc within the nozzle.

The stochastic discrete model was used for the particle distribution. The particle temperature, velocity and size inside the plasma plume at a specified standoff distance have been investigated.



Schematic diagram for the illustration of the "window" in the centerline measurements and simulation

The effects of carrier gas on the plasma jet as well as on the particles are analyzed **using the "contour plot" of SigmaPlot**. The predicted temperature and velocity distributions for two cases S0 and S3 at the plane of symmetry are shown in figure below.

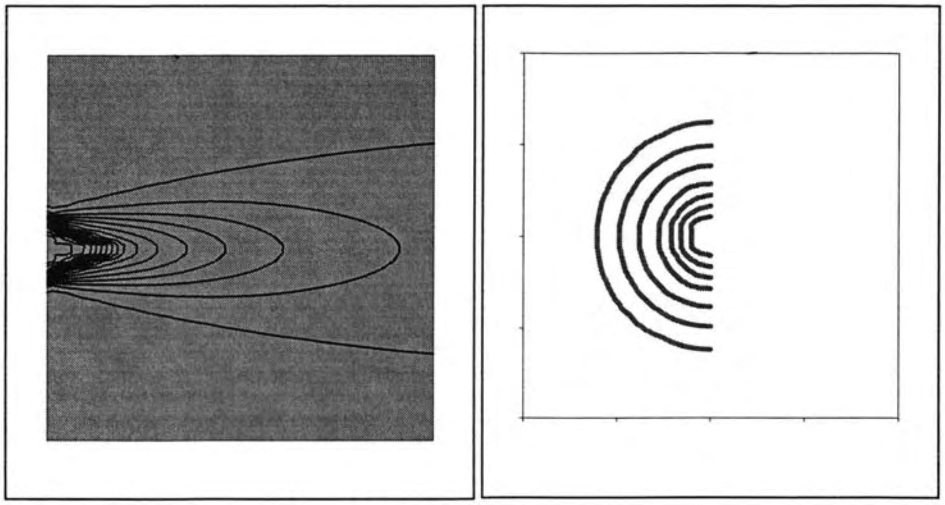
In case S0, there was no carrier gas injection, whereas the carrier gas flow rate was at 6 standard litres per minute for case S3.

These two cases served as reference cases to study the effects of carrier gas flow rate on the plasma jet. The carrier gas affects the plasma plume by cooling down and retarding the plasma jet at the immediate vicinity of the carrier gas injector exit.

Comparing the jet cross sections in figures, the jet symmetry with respect to the x-z plane is affected by the injection of carrier gas that causes the contours to be displaced downwards.

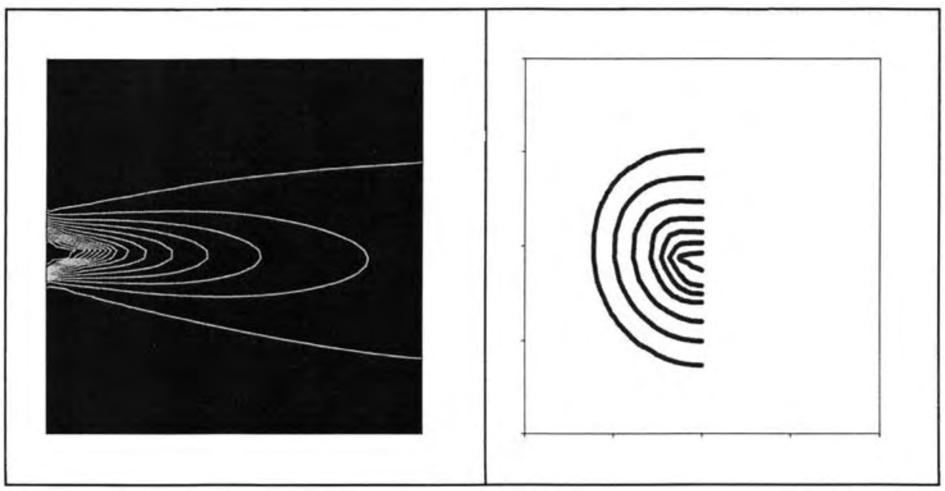
It is, however, noted that the jet core is almost unaffected by the injection of carrier gas. This can be understood by the fact that the momentum of the plasma jet is much higher than that of the carrier gas that prevented penetration of the carrier gas into the jet core.

Part A



The isotherms of plasma plume at the plane of symmetry and at a cross section (A-A'), 3 mm away from the carrier gas port for case S0 (without carrier gas injection).

Part B



The isotherms of plasma plume at the plane of symmetry and at a cross section (A-A'), 3 mm away from the carrier gas port for case S3 (with carrier gas injection of 6 slm).

Credits

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