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**HYBRID EXPERIMENTAL-NUMERICAL APPROACH TO SOLVE**

**INVERSE CONVECTION PROBLEMS**

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# INITIAL ABSTRACT

The inverse convection problem, in which conditions that result in a given solution are to be determined, generally leads to scenarios of infinite and, thus, non-unique solutions. Fortunately, it is possible to reduce the infinite solutions to a finite domain. A practical means to accomplish this task is to use a combined experiment and numerical system. The experiment leads to a simulation set, which in turn, predicts new data points to sample in the experiment. This process may repeat multiple times.

One such inverse convection problem is the plume or jet in a cross-wind. Performing a sensitivity analysis upon the simulated plume shows that the temperature at any point within the domain is proportional to the initial temperature of the source. However, the linear relationship is highly dependent upon location. With *a priori* knowledge of the location of the source and free stream velocity, the plume temperature may be predicted knowing only the temperature at one location. Two simulations could be generated allowing the use of the linear relationship and thus predicting the initial temperature of the plume.

Difficulty arises when the *a priori* knowledge is reduced to the free stream velocity only. Increasing the number of downstream temperature data points allows the use of a least squares error reduction scheme. The problem then involves comparing the predicted temperature for each of the data points and searching for the least discrepancy between the set.

In this study, the plume is generated by a heated copper plate embedded in an aero-gel and ceramic base. The cross wind is provided via a wind tunnel of cross section 254 x 54.5mm. The large aspect ratio of the wind tunnel encourages the flow to be two-dimensional. Stable flow velocities of the wind tunnel are in the range 2.0 - 50.0cm/s. A traversing thermocouple probe is utilized to determine the temperature of the flow at any location within the test section. The simulations are performed as a 2D idealized representation of the experiment utilizing the software package Fluent® from Ansys®.

Initial results have shown it is indeed possible to predict, within acceptable error, both the temperature and the location of the source, which generates the plume, using only limited downstream information. One example of 15 sets of 6 temperature data points each show an initial plume temperature prediction to be in error of no more than 1.4%. The location prediction error was no more than 10.5%. Another example of 15 sets of 33 temperature data points predicts a plume temperature error of less than 1.2% and a location prediction error of less than 6%. Both examples have a free stream velocity of 6.0 cm/s and initial plume temperature of 425 K. Similarly, other results are obtained to demonstrate the approach, its limitations and usefulness in practical situations.