ESTIMATION OF THE TEMPERATURE AND CONCENTRATION PROFILES
OF A HOT COMBUSTION GAS

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Abstract

This work presents a computational and experimental analysis for estimating the stationary two-dimensional temperature \( T(x, y) \) and concentration \( C(x, y) \) profiles in a rectangular domain in the plane \((x, y)\) which is filled by a hot combustion gas. Spectral intensities of radiation coming from the gas are measured at a set of wavelengths \( \lambda_n, n = 1, 2, \ldots, N \) at different points of \( x \) and \( y \) directions (Fig. 1). Then the inverse radiation problem is solved. \( H_2O \) is analyzed.

![Figure 1: Diagram of flame.](image)

The relationship between the intensities measured and simulated numerically is given by the equation of radiation transfer in a semitransparent medium:

\[
\int_{a}^{b} L^0(\lambda_n, T(x, y)) \frac{\partial \tau(\lambda_n, T(x, y), C(x, y))}{\partial x} \, dx = L_{\text{meas}}(X_1, \lambda_n)
\]

\[
\int_{c}^{d} L^0(\lambda_n, T(x, y)) \frac{\partial \tau(\lambda_n, T(Y_j, y), C(Y_j, y))}{\partial x} \, dx = L_{\text{meas}}(Y_j, \lambda_n)
\]

with \( i = 1, 2, \ldots, N_1 \), \( j = 1, 2, \ldots, N_2 \), \( n = 1, 2, \ldots, N_3 \), where \( L^0(\lambda_n, T(x, y)) \) is the Planck function, \( \tau(\lambda_n, T(x, y), C(x, y)) \) is the transmissivity. To compute the transmissivity of \( H_2O \) with given temperature and concentration profiles, a model is used which has been previously developed and validated.

The above equations are the nonlinear Fredholm-type equations of the first kind with respect to \( T(x, y) \) and \( C(x, y) \), and that is a typical ill-posed problem. To solve this inverse problem, an iterative computational algorithm is developed which is based on the iterative regularization method.

This study is to be applied to a jet stream \( H_2/O_2 \). The results of inversion are compared to measurements of temperature profile in a \( H_2/O_2 \) flame.