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NASA TECH BRIEF

Prediction of Thermal Radiation from a Rocket's Exhaust Plume

The absorption coefficients and fine-structure parameters have been measured for water vapor at wavelengths between 1 and 10 μm at temperatures between 1,200° and 3,000°K. The resultant data have been incorporated in a practical analytic procedure that can be used for evaluation of heating by radiation from the exhaust plume of the base of a large rocket.

A uniform volume of high-temperature water vapor was produced above the combustion zone of a specially constructed long, 3-inch-wide, flat burner. Emission and absorption were measured, with path lengths of 2, 5, and 10 feet, at temperatures between 1,200° and 3,000°K. From these measurements mean absorption coefficients and fine-structure parameters (averaged over 25-cm^{-1} intervals) were deduced for the spectral interval between 1,000 and 9,000 cm^{-1}. The resultant data are presented in both graphic and tabular forms, with polynomial representations also.

Combination of these results with earlier data has generated tables of water-vapor absorption coefficients covering the spectral region between 50 and 9,300 cm^{-1} and the temperature range between 300° and 3,000°K; the representation of the fine-structure parameters covers the ranges between 1,150 and 9,300 cm^{-1} and 1,250° and 2,750°K.

Several nonisothermal measurements, with two 5-foot sections at different temperatures, were made to test the nonisothermal-radiance calculation procedure. The following analytic studies were made: (1) extension of the high-pressure-limit calculation for the total engineering emissivity to self-broadened and nitrogen-broadened water vapor, with use of published absorption coefficients and band-averaged fine-structure parameters; (2) study of band models for randomly distributed Doppler lines; (3) an error and sensitivity analysis of the inhomogeneous-radiance calculation technique; and (4) study of an alternative expression for the collision-broadened line width.

Notes:

1. This information may interest personnel concerned with thermal radiation from gases.
2. Documentation is available from:
   Clearinghouse for Federal Scientific and Technical Information
   Springfield, Virginia 22151
   Price $3.00
   Reference: TSP69-10371

Patent status:

No patent action is contemplated by NASA.

Source: C. B. Ludwig et al. of
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