Low-Temperature Vapor Pressures of Some Light Hydrocarbons

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Interpretation of observations and proper modeling of planetary atmospheres are both critically dependent on accurate laboratory data for the properties and processes that give rise to the features and characteristics of those atmospheres. It is important, therefore, that these data be acquired over the appropriate ranges of parameters such as temperature, pressure, and composition. Thermodynamic data at low temperatures are particularly needed for the construction of first-order equilibrium and photochemical models of clouds and hazes in the atmospheres of the outer planets and their satellites. However, this information often does not exist or does not extend to the low temperatures prevalent in those environments. In the absence of the required low-temperature data, modelers must extrapolate high-temperature data to the temperature range of interest which can introduce significant errors.

To address the needs of the space sciences community for information of this nature, we have developed an apparatus specifically designed to provide low-temperature thermodynamic data. The system has been calibrated using propane (C_3H_8) over the temperature range from 84 to 241 K. Besides its role as a constituent in outer planet atmospheres, propane is a good calibration source since its vapor pressure is well determined over most of the temperature range of interest. The vapor pressure of ethylene (C_2H_4), for which there is little data below its triple point (104 K), was then determined from 97 to 147 K. And most recently the apparatus has been used to measure the vapor pressures of the critically important hydrocarbons methane (CH_4) and methane-d_1, i.e,, monodeuterated methane (CH_3D), from 62 to 90 K and 61 to 115 K, respectively. The results of these measurements are presented along with comparisons with existing data sets.

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