A Note on the Composition Dependence of the Thermal Diffusion Factor of Ar–He System

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The thermal diffusion factor α_T, for the Ar—He system is measured for a mixture containing 18.9% He in a two-bulb apparatus with its hot and cold bulbs at temperatures 78.5 and −196.3 °C, respectively. The α_T value referring to −135.8 °C is 0.287. Experimental results are compared with the Chapman–Enskog theory and the exp-six potential.

There is some special interest in the experimental and theoretical studies of the composition dependence of thermal diffusion factor, α_T. The point can be elaborated by casting the expression for α_T in the following familiar form [1]:

$$\alpha_T = (6\,C^* - 5)\,g\,.$$

The "g" factor is a complicated function of different quantities [1] but is very feebly dependent on temperature [2]. Thus, by α_T measurements as a function of temperature one can adjust for a reasonable potential, its parameters such that the temperature dependence is explained. The real test of theory and potential therefore consists in its ability to reproduce the composition dependence. Here also a critical examination reveals that the "g" factor is only weakly dependent on the choice of potential. Consequently α_T variation with composition offers a good check for the test of theory.

Here, we report our study for the Ar—He system on the same apparatus as used by Mathur and Saxena [3]. The hot and cold bulbs were maintained at 78.5 and −196.3 °C, respectively, and the average temperature [4] to which the measurement refers is −135.8 °C. The mixture composition is 18.9% He. The α_T value is found to be 0.287 and is correct within a percent as the thermal diffusion separation is as large as 6.5% and the accuracy of our analysis is 0.025%.

Grew [5] has reported α_T data for this system (51.2% He) as a function of temperature. Our experimental value as well as the interpolated value of Grew [5] are plotted in Fig. 1. The continuous curve is the theoretically calculated one [6, 7] wherein the exponential-six

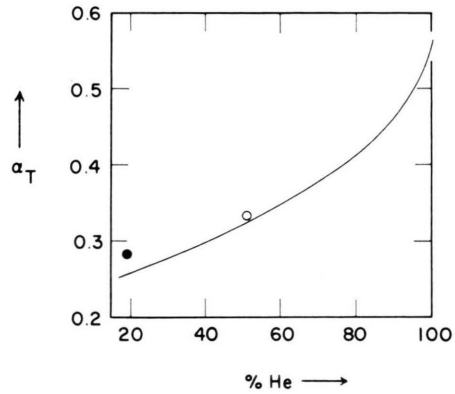

Fig. 1. Composition dependence of α_T for Ar—He mixture at −135.8 °C. Experimental points: ○ Grew, and ● Present work. ——— Theoretical curve for the exp-six potential.

potential with parameters as listed by Saxena and Mathur [8] are used. The theoretical curve is correct to about 2 percent as the second approximation in the worst case differs from the first approximation by about 4 percent. Thus, the agreement between theory and experiment may be regarded as reasonable.

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