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The prediction of the thermal conductivity of xenon

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Abstract. The usefulness of the extended law of corresponding states, the 11–6–8 and Barker–Watts–Lee–Schafer–Lee potentials and a recommended correlation to predict thermal conductivity of xenon has been evaluated by comparison with the recently generated data in the temperature range 800–2000 K. The agreement in all these cases is satisfactory with varying degrees of accuracy.

1. Introduction

Jody *et al* (1976) have recently measured the thermal conductivity k of xenon by the column method. Their data in the temperature range 800–2000 K are represented, within average absolute and maximum deviations of 0·57 and 1·39% respectively, by the following quadratic polynomial in temperature T:

$$k(T)=2{\cdot}294\times10^{-2}+1{\cdot}516\times10^{-4}\,T-1{\cdot}860\times10^{-8}\,T^{2} \tag{1}$$

where k is in mW cm^{-1} K^{-1} and T is in K.

They have also tested the following recently proposed interatomic potentials for their ability to predict the experimental data on thermal conductivity:

(1) Hanley–Klein potential (11–6–8) (Hanley 1973).
(2) Barker–Pompe potential (Neufeld and Aziz 1973).
(3) Gough–Smith–Maitland potential (Gough *et al* 1973).
(4) Thakkar–Smith potential (STP X3) (Thakkar and Smith 1974).
(5) Barker–Watts–Lee–Schafer–Lee potential (X3) (Barker *et al* 1974).
(6) Lee–Henderson–Barker potential (Lee *et al* 1975).

It has been found that all these six potentials predict the $k(T)$ data on xenon well within the experimental limits. But the Barker *et al* (X3) potential has been considered to be the best potential for xenon because of its ability to correctly predict all the transport properties of xenon.

It may be, however, also useful to test the extended law of corresponding states proposed by Kestin *et al* (1972), which has been found by Taylor (1976) to agree with his experimental thermal diffusion data (which provide a sensitive test of the intermolecular forces) on xenon with an uncertainty of the order of the best available measurement.

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2. Comparison with *k* data and discussion

The *k* values of xenon computed by employing the scaling parameters of Kestin *et al* (1972) in the kinetic theory expression (Hirschfelder *et al* 1964) have been compared in figure 1 (curve A) with the *k* data of Jody *et al.* The agreement is very good (the average absolute and maximum deviations being 0·5% and 0·8% respectively) and is

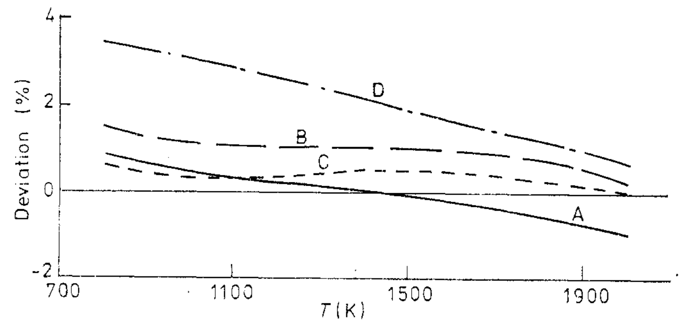

Figure 1. Comparison of *k* data of Jody *et al* (1976) with the predictions of: (A) the extended law of corresponding states (Kestin *et al* 1972), (B) Barker *et al*'s (1974) (X3) potential, (C) the 11–6–8 potential (Hanley 1973) and (D) the correlation of Jain *et al* (1975).

better than that found in the case of the Barker *et al* potential (curve B of figure 1). The average absolute and maximum deviations in the latter case are 0·9% and 1·4% respectively. However, the agreement of the *k* data with the predictions of the 11–6–8 potential (Hanley 1973) appears to be the best (curve C of figure 1), the average absolute and maximum deviations being 0·3 and 0·6% only.

3. Correlation of Jain *et al*

The thermal conductivity correlation recently established by Jain *et al* (1975) by applying the principle of corresponding states to their own thermal conductivity data on noble gases can also be similarly tested for xenon by comparison with the *k* data of Jody *et al.* This comparison is shown in figure 1 by curve D, the average absolute and maximum values of which are 2·0 and 3·4% respectively. This disagreement, being within the maximum uncertainty of the correlation, can be considered to be satisfactory. It is also seen from figure 1 that the deviations are decreasing monotonically with increasing temperatures and lie between 0·7 to 2·5% in the range 1200–2000 K.

4. Conclusions

The 11–6–8 potential provides the best fit to the *k* data of Jody *et al.* The extended law of corresponding states of Kestin *et al* and the Barker *et al* potential are successful in predicting the thermal conductivity of xenon and the corresponding states correlation of Jain *et al* is not so accurate but still quite satisfactory particularly in the high temperature range 1200–2000 K.

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