

INTRODUCTION

A complete review of the thermophysical properties of sodium was published in 1985 in the IUPAC Handbook of Thermodynamic and Transport Properties of Alkali Metals.⁽¹⁾ In that handbook, separate research groups reviewed data on each property for all the alkali metals. Consequently, resulting recommendations of related thermodynamic and transport properties were not necessarily consistent. Consistent assessments of sodium properties were completed by Thurnay in 1981⁽²⁾ and by ourselves in 1979.^(3,4) We have performed the present thermodynamically consistent assessment to include new information available since these past reviews.^(2,3,4) Russian recommendations which include new Russian experimental data and theoretical calculations are now available in the open literature.⁽⁵⁾ Data on sodium enthalpy and heat capacity have been recently evaluated and new equations developed.^(6,7) New data on vapor pressure,⁽⁸⁾ critical parameters,^(8,9) and surface tension⁽¹⁰⁾ and new theoretical research relating to the thermal conductivity of alkali metals⁽¹¹⁾ have been included in this assessment.

The goals of this review were: (1) to obtain consistent equations for the thermodynamic and transport properties of sodium liquid and vapor that have proper physical behavior throughout the temperature range from the melting point to the critical point and (2) to assess the uncertainty of these equations as a function of temperature. With the exception of data related to the thermal conductivity, previously assessed data have not been reanalyzed. We have relied on existing statistical fits to experimental data and have examined new data and theories with respect to existing assessments. New equations that give correct physical behavior at limits such as the critical point have been derived to replace polynomial fits that are appropriate only for the limited temperature range of the experimental data. Care has been taken in deriving more than one equation for the entire temperature range so that there is continuity not only for the property being represented but also for the derivatives that are required for calculations off the saturation curve to subcooled or superheated properties.

This report has been organized according property. Thermodynamic properties of sodium liquid and vapor are given in Section 1. Transport properties of sodium liquid are in Section 2. Six subsections under thermodynamic properties cover: (1) enthalpy and heat

capacity, (2) vapor pressure, boiling point, and enthalpy of vaporization, (3) density and thermal expansion, (4) compressibility and speed of sound, (5) critical parameters, and (6) surface tension. Thermal conductivity and viscosity are the two subsections under transport properties. For ease of use as a reference report, each subsection is complete. All equations, graphs, tables, and references needed for each property are given in the subsection on that property so that the reader only interested in one property (e.g. compressibility) need only read the subsection on that property (compressibility). The subsections for each property are divided into three parts: summary, discussion, and uncertainty. The summary consists of the recommended equations and tabulated values. It is given first for each property so that the reader interested only in this information does not need to read the entire subsection on the property. Next, a detailed discussion of the analysis and comparisons with other assessments is given. The uncertainty part gives the basis for determining the uncertainties in the recommended property values.

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