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THERMOPHYSICAL PROPERTIES OF ALKALI METALS

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Owing to several of their properties, alkali metals have found many applications in various branches of modern technology. Information about their thermophysical properties is sought by many scientists and engineers. The latest monographs on alkali metals have appeared rather a long time ago and their content is quite limited, therefore, while knowledge which has been gained in recent years is scattered throughout the USSR and foreign periodical literature unknown to many individuals. For this reason, the appearance of the book reviewed here is very timely and necessary.

In the book we find a summary of data pertaining to many thermophysical properties of all alkali metals (except francium) in both phases. The authors have performed a tremendous task in systematizing and analyzing the results of numerous studies, evaluating their accuracy, and in extracting the most reliable data on the thermophysical properties of alkali metals and tabulating them for practical use.

The book consists of three parts. In Part One the authors thoroughly describe and critically analyze the methods and the results of experimental studies concerning the thermophysical properties of five alkali metals. Chapter I contains data on density, enthalpy, specific heat, heat of fusion, thermal conductivity, as well as on viscosity and surface tension of the liquid phase. Chapter II contains data on saturated-vapor pressure, Chapter III on the thermal conductivity of Na, K, Rb, and Cs vapors and on the viscosity of Na, K, and Cs vapors. In view of the poor accuracy of test data on the transfer properties of alkali metal vapors (no diffusion data are available at all), results of theoretical research on this subject are surveyed here instead.

Part Two deals with methods of evaluating test data and calculating tables. In Chapter IV are given the thermophysical properties of the condensate phase, in Chapter V are given the thermodynamic properties of the gaseous phase, also the methods of calculating corrections for the departure of the atomic component from an ideal gas, in Charpter VI we find a description of methods used for calculating the thermal conductivity and the viscosity of alkali metal vapors.

Part Three contains tables and diagram of thermophysical properties for both phases, calculated on the basis of test data given in the survey (Part one of the book).

Thus, the book presents a rather thorough summary of the thermophysical properties of alkali metals, needed by many scientists, engineers, and students. Credit must, therefore, be given to the team of authors for having done this big and difficult job with so much diverse and often contradictory material.

Naturally, in such a large volume (1,400,000 characters) it is difficult to avoid a few omissions and some of them will be pointed out here.

Working within editorial guidelines, the authors of the book were compelled to restrict their survey to material published till 1968. Material published since then should have been mentioned at least in the bibliography. The bibliography is a very important part of any handbook, as everyone knows, but in this particular one it is obviously inadequate with only 353 cited references – far below the expected number.

There is nothing in the book about the critical parameters of alkali metals, except for a few references and values recommended on the basis of one source.

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Both the survey and the bibliography concerning thermochemical properties, namely the dissociation energy and the heat of sublimation, are inadequate. The values of these parameters recommended in the book are far from indisputable. Meanwhile, their proper choice is crucial in the calculation of the thermodynamic properties of alkali metal vapors, especially along the saturation line and near it.

This has to do with the erroneous recommended values of the second virial coefficient and of the corrections for the nonideality of the gaseous phase of alkali metals. These corrections are too large here, especially at low temperatures: at $P = 5 \cdot 10^{-5}$ atm and T = 600°K, for example, the correction to the specific volume of sodium vapor is 5.5%. A similar situation is observed also in the case of other alkali metals. The second virial coefficient has been calculated by the authors on the basis of a comparison between the test values of saturated-vapor pressure P_{test} and the values for an ideal gas P_{ideal}. The error in this calculation of the second virial coefficient appears here proportional to $\log(P_{test}/P_{ideal})^{-1}$. This error is particularly large at low temperatures, when $P_{test} \approx P_{ideal}$. If P_{ideal} is calculated on the basis of thermochemical constants recommended by other authors, then the values of the second virial coefficient become lower than those given in this book by almost one order of magnitude at high temperatures and by a few orders of magnitude at low temperatures.

Prior to the publication of this book, several authors have published thermodynamic tables for alkali metals. Some authors have taken into account thermal ionization, the effect of which is quite appreciable even at moderate temperatures under a low pressure. Unfortunately, no reference to those tables is found in the book. A special feature of the thermodynamic tables in this book is the inclusion of corrections for the nonideality of alkali metal vapors. As the authors themselves note, these corrections are approximate and we assume that they apply only to pressures above 1 atm. A great drawback of these tables is the lack of data on the specific heat of the gaseous phase.

A positive feature of the book are the detailed thermal conductivity and viscosity tables for alkali metal vapors; the values are given here with wide tolerances, unfortunately nothing better than that could be done at the time.

The tables in this book do not include any data on diffusivity, which would be quite useful even if not very accurate.

The authors should be reproached for questioning the accuracy of certain experiments without adequately justifying their doubts. Other, less important comments concern the insufficiently precise headings in Part Three; the datum from which the enthalpy and the entropy are counted is not shown. All this does not, however, in any way detract from the merits of the tremendous and most useful work done by the authors. Specialists in the field have been given a book they needed for a long time already and, by making it available, the Izd. GSSD has made an important contribution to its handbook publishing program.