CONDUCTIVITIES AND EMISSIVITIES OF METALS AT HIGH TEMPERATURES

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PREFACE

Thermal and electrical conductivities and spectral and total emissivities of metals at high temperatures have attracted recently a great deal of interest on account of their considerable practical and theoretical interest. Scientists at Thermophysical Properties Research Centre, Purdue University, Indiana, U.S.A., have compiled the available data on thermal conductivity of materials and have emphasized the need for more accurate data, particularly at high temperatures. Many years ago, Jain and Krishnan developed a simple and practically convenient method of determining thermal conductivity of metals at high temperatures. New methods for determining the thermal conductivity of metals at high temperatures have been developed recently. However, the Jain and Krishnan method still seems to be a good method for the measurement of thermal conductivity of metals at high temperatures. It is simpler than other methods and also offers the possibility of concurrent determinations of a number of physical properties on the same specimen.

In the present work, the author has reviewed the theory of the method and derived rigorous conditions under which equations developed by Jain and Krishnan are valid. The author has also suggested some modifications in the experimental technique to secure these conditions. With these improvements in the theory and experimental techniques,

and with the use of Tinsley AC/DC coordinate potentiometer to measure A.C. current and voltage, the accuracy of the method has become high The thermal and electrical conductivities and total and spectral emissivities of nickel, cobalt and platinum have been measured with the improved technique. A comparison of the experimental values of thermal conductivity and electrical resistivity at different high temperatures with the available theoretical expressions show that our theoretical understanding of transport properties of magnetic metals at high temperatures is inadequate at the present time.

The thesis is divided into five chapters. A brief survey of the earlier work on conductivities and emissivities of metals at high temperatures is given in the first chapter. The design and fabrication of the vacuum system to heat the specimen at high temperatures and other experimental details are given in the second chapter. Chapter 3 consists of a critical review of the theory of the Jain and Krishnan method and the improvements made in the theory and the technique. Experimental results of spectral and total emittances for nickel, cobalt and platinum in the temperature ranges 1200 - 1400°K, 1200 - 1500°K and 1200 - 1700°K are discussed in Chapter 4. Chapter 5 deals with the experimental results of the thermal conductivity and electrical resistivity of nickel, cobalt and platinum in the same respective temperature ranges. The last three chapters constitute the main contribution by the author. An abstract of each of these chapters is given at the beginning of each chapter.

Five papers (one in Physics Letters, three in British Journal of Applied Physics and one in Cobalt, Belgium) have already been published on this work. The work on nickel was done entirely by the author. Miss V. Narayan helped in taking some of the observations on cobalt and platinum.

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CHAPTER 1

INTRODUCTION AND BRIEF SURVEY OF EARLIER WORK

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