AIN SHAMS UNIVERSITY
FACULTY OF GIRLS FOR ART,
SCIENCE AND EDUCATION
PHYSICS DEPARTMENT

STUDY OF THERMAL PROPERTIES FOR SOME LIQUIDS

Thesis Submitted in Partial Fulfillment of the
Requirement for M. Sc. Degree in Physics

Presented By
Tarik Ahmed Mohamed El-Sayed (B. Sc.)

Supervising committee

Prof.Dr. M.A. Kenawy
Physics Department
College of Girls
Ain Shams University

Prof.Dr. S.R. Atalla
Physics Department
Faculty of Education
Fayoum Branch, Cairo University

Dr. G. Attia
Physics Department
Faculty of Education
Fayoum Branch, Cairo University

1995

Name of Student: Tarik Ahmed Mohamed El-Sayed

Title of Thesis: Study of Thermal Properties for
Some Liquids

Name of Faculty: Faculty of Science

University: Helwan University

BSc. Graduation date: November 1988

M.Sc. Graduation date:

بسم الله الرحمن الرحيم

ACKNOWLEDGMENT

The author is greatly indebted to Prof. Dr. M.A. Kenawy, Faculty of Girls for Art, Science & Education, Ain Shams University and to Prof. Dr. S.R. Atalla, Dr. G.A. Attia, Faculty of Education, Fayoum Branch, Cairo University for supervision and continuous help throughout the period of this work.

He wishes also to acknowledge Dr. N.Kamel, Faculty of Science, Ain Shams University for encouragement, Dr.M. El-Rabiei and Dr. H. Hassan for their help.

TO MY PARENTS,
MY WIFE,
AND MY CHILDREN

بسم الله الرحمن الرحيم

"و قل رب أدخلنى مدخل صدق و أخرجنى مخرج صدق و اجعل لى من لدنك سلطانا نصيرا"

صدق الله العظيم

(الاسراء:٨٠)

CONTENTS

Page

Chapter 3

Theory of the AC-Heated Strip (Wire) Technique for the Determination of Thermal Properties of Solids and Liquids

Chapter 4

The Experimental Set-Up

Page

SUMMARY

SUMMARY

Thermal properties are material properties of great importance when transfer of heat is involved. In recent years, because of the increase in new materials technology and increasing temperaure ranges of operation, there has been a corresponding increase of interest in the measurement of these properties.

For this purpose an experimental set-up was built in a quite modified form in the Department of Physics, Faculty of Education, Fayoum Branch, Cairo University, for the simultaneous measurement of thermal activity, thermal diffusivity, thermal conductivity and heat capacity of solids and liquids. This set-up is based upon the AC-heated wire(strip) technique.

The set-up was then calibrated with distilled water and toluene which are considered as standard substances. Then it was used for the measurement of thermal properties of cobalt nitrate salt and acetamide in the solid and liquid states in the temperature range 300-400 K. Also DSC investigations were carried out for these materials.

The obtained DSC results for cobalt nitrate showed that this substance melts at 59.2 °C. The thermal properties of $Co(NO_3)_2$ were measured up to 115 °C. The obtained results

for the volumetric heat capacity show that the investigated temperature range is above the Debye temperarure for this substance. The obtained results for the thermal conductivity coefficient show that heat conduction in this salt takes place mainly due to phonons.

For acetamide (CH_3CONH_2),the DSC results show that it melts with its peak at 89.9 °C. The thermal properties of this material were measured up to ~120 °C. The obtained results for the volumetric heat capacity show that the investigated temperature range is above the Debye temperature for this substance. The thermal conductivity results show that the heat conduction mechanism is again mainly due to phonons as expected.

The upper limit of the investigated temperature range was dictated by the fact that at 115 °C for $Co(NO_3)_2$ and 120 °C for acetamide, no balance of the AC-bridge was achieved above the mentioned temperatures. This fact needs to be further investigated to find out the reason behind this phenomenon. This is specially important because the same phenomenon was observed by us for other nitrate salts like $NaNO_3$ $AgNO_3$ and $Zn(NO_3)_2$.

It is our objective to modify the experimental set-up to improve its accuracy, and investigate the thermal properties, at higher range of temperature, of other nitrate salts and combinations of organic materials with some additions of metallic nitrates. These materials are very important for energy technology and seem to be quite good heat storage candidate materials.

INTRODUCTION

INTRODUCTION

The development of new materials and new technologies needs more information on thermophysical property data of different substances. Thermophysics plays therefore a leading role in the characterization of materials, contributing definitely for the advancement of material science and technology. In recent years, molten salts have been attracting attention as heat transfer media or thermal storage materials at high temperatures.

Due to the lack of a complete theory of the liquid state in general, and the theory of thermal properties in particular, accumulation of experimental data about the physical properties of nitrate salts will help the better technical use of these materials. From the sceintific point of view, knowledge of the thermophysical properties helps the understanding of the structure, and the nature of thermal motion in this important class of chemical compounds.

Numerous methods have been devised and modified for the measurment of thermal properties of melts. These methods are divided into two main categories;classical and non-classical. By classical were designated all the methods that measure directly temperature gradients generated by heat flow, while the remaining methods involve indirect ways to access the temperature gradients and high power sources [1].