

## TABLE OF CONTENTS

LIST OF ABBREVIATIONS . . . . .	v
FOREWORD . . . . .	vii
INTRODUCTION . . . . .	1
 Chapter I. HEAT TRANSFER BY CONDUCTION IN INSULATION . . . . .	 3
Heat transfer by gas conduction . . . . .	4
Heat transfer in dispersed media . . . . .	7
Heat transfer in insulants . . . . .	15
Contact heat transfer in dispersed materials . . . . .	18
 Chapter II. RADIATIVE HEAT TRANSFER IN INSULATION . . . . .	 26
The fundamental laws of radiation . . . . .	26
The optical properties of metals . . . . .	27
Heat transfer by radiation between solid bodies in a nonabsorptive and nonscattering medium . . . . .	32
Radiation shielding . . . . .	33
Heat transfer by radiation in an absorptive and scattering medium . . . . .	35
 Chapter III. THERMAL INSULANTS AND THEIR PROPERTIES . . . . .	 50
Characteristics and applications . . . . .	50
Thermophysical properties . . . . .	57
Moisture permeability . . . . .	64
Mechanical properties . . . . .	66
Structure . . . . .	67
 Chapter IV. EVACUATED POWDER AND FIBROUS INSULATION . . . . .	 70
Heat transfer by conduction in gases . . . . .	70
Heat transfer by radiation . . . . .	77
Heat transfer by conduction in solids . . . . .	85
The materials in use and their characteristics . . . . .	86
Evacuated powder insulation with radiation shielding . . . . .	90
 Chapter V. HIGH-VACUUM AND EVACUATED MULTILAYER INSULATION . . . . .	 101
High-vacuum insulation . . . . .	101
Heat transfer in multilayer insulation . . . . .	104

The materials used in multilayer insulation and their characteristics . . . . .	117
The technology of mounting multilayer insulation . . . . .	121
Chapter VI. EVACUATED MULTILAYER-POWDER INSULATION . . . . .	124
Chapter VII. METHODS OF INVESTIGATION OF CRYOGENIC INSULATION	127
Determination of the thermal conductivity and diffusivity . . . . .	127
Methods of determining the emissivity, absorptivity, and transmissivity . . . . .	134
Methods of structure investigation . . . . .	135
Chapter VIII. "THERMAL BRIDGES" IN INSULATION SYSTEMS . . . . .	142
Suspensions . . . . .	142
Supports . . . . .	144
Piping . . . . .	149
Chapter IX. CALCULATIONS AND TESTING OF INSULATION SYSTEMS . .	152
Calculation of the heat flux through insulation under steady-state conditions . . . . .	152
Calculation of the cool-down and warm-up of insulation . . . . .	155
Measurement of the thermal flux in steady-state conditions . . . . .	158
Measurement of the thermal flux in unsteady-state conditions . . . . .	164
Chapter X. THE GENERATION AND MAINTENANCE OF VACUUM IN INSULATION SYSTEMS . . . . .	168
Leak testing . . . . .	168
Evacuation of the insulation . . . . .	170
Improvement and maintenance of the vacuum by means of adsorbents . . . . .	174
Chapter XI. DESIGN OF CRYOGENIC INSULATION SYSTEMS . . . . .	184
Insulation of cryogenic systems . . . . .	184
Basic design of tanks for liquefied gases . . . . .	188
Tanks for liquefied gases . . . . .	195
Piping for liquefied gases . . . . .	209
BIBLIOGRAPHY . . . . .	212