THERMAL INSULATION
Materials and Systems

Powell/Matthews editors

STP 922
ASTM
In Memoriam

This volume is dedicated to the memory of Stan Matthews, coeditor of this book, who passed away before the book was in print. Stan was for many years a tireless worker for ASTM and, particularly, for ASTM Committee C-16 on Thermal Insulation. In Committee C-16, he was constantly involved at every level, from task group commitment to serving as a leading officer. His dedication to ASTM and to professional associations, the government, and the entire thermal insulation industry was admired and respected by all who actively worked with him. Stan's whole life was one of vigor, from his days as a Harvard M.B.A. graduate student, through his career as a U.S. Army colonel, and for the past 25 years as a champion for the thermal insulation industry, including eleven terms as president of the Mineral Insulation Manufacturers Association. The honors accorded Stan have been numerous, including ASTM's highest recognition, the Award of Merit. He will be missed.
Foreword

The conference on Thermal Insulation: Materials and Systems was held in Dallas, Texas, on 2–6 Dec. 1984. ASTM Committee C-16 on Thermal Insulation was sponsor of the event. Frank J. Powell, National Bureau of Standards, and Stanley L. Matthews, consultant, presided as chairmen of the conference and also served as editors of this publication.
Related
ASTM Publications

Guarded Hot Plate and Heat Flow Meter Methodology, STP 879 (1985), 04-879000-10

Building Applications of Heat Flux Transducers, STP 885 (1985), 04-885000-10

Corrosion of Metals Under Thermal Insulation, STP 880 (1985), 04-880000-27

Thermal Insulations, Materials, and Systems for Energy Conservation in the '80s, STP 789 (1983), 04-789000-10

Thermal Insulation Performance, STP 718 (1980), 04-718000-10

Thermal Transmission Measurements of Insulation, STP 660 (1979), 04-660000-10

Thermal Insulations in the Petrochemical Industry, STP 581 (1975), 04-581000-10

A Note of Appreciation to Reviewers

The quality of the papers that appear in this publication reflects not only the obvious efforts of the authors but also the unheralded, though essential, work of the reviewers. On behalf of ASTM we acknowledge with appreciation their dedication to high professional standards and their sacrifice of time and effort.

ASTM Committee on Publications
ASTM Editorial Staff

Helen Mahy
Janet R. Schroeder
Kathleen A. Greene
William T. Benzing
Contents

Introduction 1

CONTROLLING FUEL COSTS

Thermal Envelope Case History for a School District—
WILBUR T. COYLE 5

Utilization of Energy Code Compliance Procedures for the Prediction
of Commercial Building Annual Fuel Consumption—
HELMUTH E. WORBS 8

Recommendations for the Development of a Residential Energy
Standard—T. J. CARDENAS, MERLE MCBRIDE,
GEORGE BARNEY, BRUCE WILCOX, AND ARTHUR JOHNSON 21

INDUSTRIAL APPLICATIONS

Design Criteria for Underground Insulated Piping Systems—
FRANCIS A. GOVAN AND NICHOLAS M. DEMETROULIS 43

A Method for Measuring Heat Loss from Underground Heat
Distribution Systems—TAMAMI KUSUDA, JIN B. FANG, AND
WALTER M. ELLIS 52

Foamed-In-Place Polyurethane Foam Insulation System Design and
Application for Low-Temperature Storage Tanks—
MICHAEL P. DUFF 69

Prevention of Common Pitfalls Through Engineered Specifications
and On-Site Review—WARTAN J. WARTAN 82

THERMAL PERFORMANCE

In Situ Measurement of Wall Thermal Performance: Data
Interpretation and Apparatus Design Recommendations—
MARK P. MODERA, MAX H. SHERMAN, AND
SANTIAGO G. DE VINUESA 91
Field Measurement of the Thermal Resistance of Office Buildings—
JIN B. FANG AND RICHARD A. GROT 107

Air Movements and the Thermal Performance of the Building
Envelope—CLAES G. BANKVALL 124

Design Heat Loss Factors for Basement and Slab Floors—
TAMAMI KUSUDA AND JOHN W. BEAN 132

Thermal Efficiency of Counterflow Insulation Systems: Possible
Applications—CATHERINE LANGLAIS AND ERIC ARQUIS 153

Thermographic Measurements

Infrared Inspection Techniques for Assessing the Exterior Envelopes
of Office Buildings—Y. MAY CHANG, RICHARD A. GROT, AND
LAWRENCE S. GALOWIN 175

Thermographic Inspection of the Installation Quality of Retrofitted
Wall Insulation—GEORGE A. TSONGAS AND TIMOTHY J. BALL 196

Measured Insulation Improvement Potential for Ten U.S. Army
Buildings—STEPHEN N. FLANDERS 202

Materials

Formaldehyde Emissions from Selected Fibrous Glass Insulation
Products—THOMAS G. MATTHEWS AND RITA R. WESTLEY 223

The Thermal Properties of Wood—Data Base—T. J. CARDENAS AND
G. THOMAS BIBLE 238

Heat Transfer Through a Still Air Layer—JEAN-LAURENT JAOUEN
AND SORÎN KLARSFELD 283

Hot Boxes

A Detailed Verification Procedure for a Guarded Hot Box—
ALAN G. GUY AND JEFFREY A. NIXON 297

Experiences in Identification of Thermal Bridging and Elimination of
the Thermal Short—DAVID J. MCCAA, EDWARD D. PENTZ,
JOHN CARRE, AND LESTER J. INFANTE 310
Heat Transfer Characteristics of a Masonry Cavity Wall—
MARTHA G. VAN GEEM 318

Moisture

Design Considerations on Guarded and Calibrated Hot Box Apparatus—FRANCESCO DE PONTE 345

Effects of Moisture on the Thermal Performance of Spray-Applied Insulation Systems—STEVEN M. BENNER, DEBENDRA MODI, AND DONALD C. LARSON 360

Field Study on Moisture Problems in Exterior Walls of a Masonry Housing Development on the Coast of the Gulf of Mexico—HEINZ R. TRECHSEL, PAUL R. ACHENBACH, AND SPENCER CONKLIN 371

Thermal Resistance of a Wet Mineral Fiber Insulation—PER INGVAR SANDBERG 394

Condensation Potential in Wood-Frame Walls—GERALD E. SHERWOOD 405

Roofs

Wetting of Polystyrene and Urethane Roof Insulations in the Laboratory and on a Protected Membrane Roof—WAYNE TOBIASSON, ALAN GREATOREX, AND DORIS VAN PELT 421

Risk of Blistering of Built-Up Roofing Membranes Applied to Polyurethane Foam Insulation—WALTER J. ROSSITER, JR., AND ROBERT G. MATHEY 431

An Apparatus for Thermal Performance Measurements of Insulated Roof Systems—GEORGE E. COURVILLE, KENNETH W. CHILDS, DONALD J. WALUKAS, PHILIP W. CHILDS, AND EDWIN I. GRIGGS 449

Industrial Applications

Anomalous Behavior of Water Vapor Retarders Applied to Spray-Applied Polyurethane Foam Insulation on Low-Temperature Outdoor Storage Tanks—VERNON BATDORF 463
MATERIALS

Material Degradation of Thermal Insulating Mineral Fibers—
NORMAN M. P. LOW 477

Thickness and Density of Loose-Fill Insulations After Installation in Residential Attics—DAVID L. MCELROY,
DAVID W. YARBROUGH, AND RONALD S. GRAVES 493

Thermal Testing of Reflective Insulations—
MARION HOLLINGSWORTH, JR. 506

Development of Experimental Data on Cellular Plastic Insulations Under Simulated Winter Exposure Conditions—
R. P. TYE AND C. F. BAKER 518

WALLS AND WINDOWS

Effect of Wall Mass on the Annual Heating and Cooling Loads of Single-Family Residences for Five Selected Climates—
DOUGLAS M. BURCH, GEORGE N. WALTON, KEVIN CAVANAUGH, AND BETTY A. LICITRA 541


Thermal Resistances of Various Concrete Masonry Wall Constructions Incorporating Rigid Plastic Foam Insulation—
WILLIAM R. STRZEPEK 582

Performance of a Group of Well-Insulated Solar Houses in the United Kingdom—JOHN V. ALDERSON, ALAN GUY,
BARRY JUSTIN, AND GERALD SHAW 599

AIR AND MOISTURE

Case Histories of Moisture Monitoring in Residential Walls—
ROBERT KANE AND GUY TITLEY 615

A Method to Predict the Hour-by-Hour Humidity Ratio of Attic Air—PETER CLEARY AND ROBERT SONDEREGGER 630

Measurement of Air Leakage Properties of Common Residential Insulating Materials—DAVID JACOBSON, DAVID T. HARRIE,
AND GAUTAM S. DUTT 639
RESEARCH

Historical Development of Large Heat Flow Meter Apparatus for Measurements of Thermal Resistance of Insulations—
RONALD P. TYE, KARL G. COUMOU, ANDRÉ O. DESJARLAIS, AND DAVID M. HAINES 651

Thermal Conductivity of Insulants at High Temperature: Reference Materials and Standards—SORIN KLARSFELD, JEAN BOULANT, AND CATHERINE LANGLAIS 665

REPORTS

Thermal Performance of the Building Envelope as Influenced by Workmanship—CLAES G. BANKVALL 679

Final Report of ASTM Committee C-8 Thermal Conductivity Ceramic Fiber Round Robin—DAVID OBER 685

Human Protection from Burns by Heated Surfaces—The Problem and Solution—JOHN R. MUMAW 704

Building Component Test Development Using Module Simulators—CHARLES C. ROBERTS, JR. 713

Thermal Performance of Metal Furred/Foam Board Insulated Wall Systems—R. GERRY MILLER, JAMES A. BERRY, AND MORTON SHERMAN 720

INDEXES

Author Index 731

Subject Index 733