# PREFACE

All around us exists the constant transfer of energy, heat, air, and moisture. And yet human beings, in a pervasive attempt to obtain thermal comfort, are always trying to stop nature from doing what it has always done, is doing now, and will continue to do. Thermal energy will always "move" from a hot source to a cold source. The predominant building constituent that is intended to retard this process is thermal insulation. This is a seemingly daunting challenge for a material that possesses the duality of being so modest but so indispensable, all too often anonymous yet so essential. Simply put, thermal insulation is the intrinsic component in construction that determines the nonsuperficial, experiential success and elemental enjoyment of a home.

Etymologic experts trace the origins of the English word insulate back to the Latin word *insula*, meaning "isle." Historical references suggest this was attributed to the fact that an isle was "insulated" by water. In the same way that water was a barrier to nomadic warriors invading an isle, insulation is a barrier to the "invaders" of thermal or acoustical energy.

Functioning as the barrier between the conditioned volume of a building and the exterior, insulation materials are designed primarily to resist heat flow, whether the energy is moving from outside to inside or inside to outside (or, in some applications, inside to inside). The function of mass insulations and reflective insulations, although designed to address the thermal transfer in two ways, remain basically the same:

1. Control temperature of inside surfaces that affect the comfort of occupants and aid or deter condensation

2. Conserve energy by reducing heat transmission through building sections that determine the energy requirements for both heating and cooling

Physical properties and envelope design also may allow thermal insulations to perform additional functions. These include

1. Adding structural strength to a wall, ceiling, or floor section
2. Providing support for a surface finish
3. Impeding water vapor transmission
4. Preventing or reducing damage to equipment and structure from exposure to fire and freezing conditions
5. Reducing noise and vibration[1]

It is not just the thirtieth anniversary of Earth Day, celebrated on April 22 of this year (2000), that has given the noble cause of saving energy such prominence. It is because rising energy costs, especially heating oil, have begun to affect homeowners in their purses. "Spend a dollar on insulation, save $12 in energy costs" is a quote from a technical paper reporting on the impact of global climate change.[2]

Insulation has become big business. Statistics published by the Department of Energy indicate that these trends will continue. Total energy consumption is projected to increase from 94.9 to 120.9 quadrillion Btu between 1998 and 2020, an average annual increase of 1.1 percent. The energy end use in U.S. residential and commercial buildings for space heating and cooling was 9.5 quadrillion Btu in 1990 and will be over 11 quadrillion Btu in the year 2010.[3]

Electric bills, gas bills, oil bills, HVAC repair bills, etc. are an everyday part of homeownership. As most homeowners, contractors, designers, and architects already know, there is no magic pill to swallow to avoid the monetary realities of obtaining thermal comfort. However, there is joy to be found in knowing that the homeowner's most precious commodity is constructed using the most efficient, most environmentally responsible, most vermin resistant, or maybe even the least expensive method available.

This book, it is hoped, will provide readers with the necessary tools to evaluate the many different types of insulation materials. Each insulation product discussed herein possesses properties that are suitable for certain applications while being unsuitable for others. Even the old faithful R-value is no longer the only consideration when choosing residential insulation. Other properties that now demand and deserve proper review are the material's

cost, fire resistance, mold resistance, insect resistance, vermin and moisture transmission, environmental benefits, health impact, and the ease and appropriateness of its application.

Not only are contemporary insulation materials discussed in this book, but historical products are reviewed as an aid to the renovator or preservationist. Future technologies and products that may one day be used as conventionally as the mass insulation products sold today in home improvement stores are also examined.

In addition to a review of solitary insulation materials, insulation systems are also addressed in this book. These hybrid, composite, or engineered products work in unison with other elements. For example, adjacent airspaces are necessary for the proper performance of radiant barriers. New systems serve as envelope components for the building shell, such as structural insulated panels (SIPs) or insulated concrete formwork (ICF). Unconventional materials such as straw bales or rammed earth also demonstrate effectiveness within certain parameters.

It is important to point out that the specific use of trade names in this book is solely for the purpose of providing specific information. References made in this book do not signify unconditional approval, nor does the exclusion of other products signify disapproval. Mention of a company name does not imply endorsement, nor does failure to mention an organization imply criticism.

Although this work is designed as a reference book, the reader is encouraged to read the entire book to be able to make educated decisions based on either the insulation material type or the installation method preferred. Product data and installation guidelines are presented in this book for general information only. For additional research, a specific manufacturer's product literature is always a good place to start when evaluating thermal insulation; however, it should be balanced with other information sources such as independent testing, contrary perspectives, and when possible, qualified first-hand opinions by actual users or installers.

The 1990s saw a housing boom that may have established an unintended legacy: Residential building predominantly has become a production-oriented process. All too often design decisions are based on the short-run implications of initial cost, without respect or consideration for actual long-term, life-cycle costs. Failure to consider the most appropriate material for a specific application or in response to a specific climate is equally irresponsible.[4]

Residential architects repeatedly work with clients who wish to renovate their homes, remodel a kitchen, or maybe just add on a few

rooms and a bath. Rare is the client who chooses to or is able to "remodel" his or her existing home's insulation. It may be impractical, too expensive, or not even considered, yet the proper selection of a home's thermal insulation is essential to the holistic success of the design, functionality, and enjoyment of the home. It is anticipated that this book will edify the homebuilder, designer, architect and homeowner who are in the pursuit of good design. Unlike the brick, the glass, or the shingle, it is sometimes the "stuff" that is unseen that makes the difference.

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## References

1. CD-ROM: Architectural GRAPHIC Standards, (New York: John Wiley & Sons, 1998).
2. Glen Wilkinson, "Beyond R-Value: Insulating for the Environment," *Environmental Design and Construction Magazine*, January–February, 1999, p. 26.
3. Joseph C. McCabe, "The Thermal Resistivity of Straw Bales for Construction," available at *http://solstice.crest.org/efficiency/straw_insulation/straw_insul.html.*
4. This observation is independently discussed and supported in Report SR/OIAF/98-03, published by the Department of Energy, available at *http://www.eia.doe.gov/oiaf/kyoto/enduse.html*