APPLICATION OF PHASE CHANGING MATERIALS IN RESIDENTIAL BUILDINGS INNER ENVELOPE

By

Rabab Fikry Taher Fareed

A Thesis Submitted to the
Faculty of Engineering at Cairo University
in Partial Fulfillment of the
Requirements for the Degree of
MASTER OF SCIENCE
In
Architectural Engineering

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
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Under the Supervision of

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FACULTY OF ENGINEERING, CAIRO UNIVERSITY
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Title of Thesis:

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Key Words:
Thermal Energy Storage, Phase Changing Materials, Residential Building applications, Passive Application, Dynamic Simulation of energy.

Summary:

The thesis submits an information on the developments of Phase Changing Materials incorporation in buildings for energy saving, as well as demonstrating the energy performance of a passive building conventional structure materials integrated with phase change materials by simulating an experimental residential building in EnergyPlus program.

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DEDICATION

To my family and beloved husband Fady Sherif.

NOMENCLATURE

AC	Active Carbon
AFT	Advanced Fiber Technologies
AHSRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
BASF	Badische Aalin und Soda-Fabric
BLAST	Building Loads Analysis and System Thermodynamics
CFD	Computational Fluid Dynamics
CIBSE	Chartered Institute of Building Services Engineers
CO2	Carbon dioxide
COMIS	Conjunction of Multizone Infiltration Specialists
cp	Specific Heat capacity (kJ kg^{-1} K^{-1})
CSM	Compact Storage Module
DOE	United States Department of Energy
DSC	Differential Scanning Calorimetry
EBBs	Eco Building Boards
EG	Extended Graphite
Epoxy resin	EP
EPW	EnergyPlus Weather data
ES	Energy Storage
EU E2B	European Union Energy Efficient Buildings
GP	Graphite additives
H	Enthalpy (kJ kg^{-1})
HAP	Hourly Analysis Program
HDPE	Paraffin/high density polyethylene
HVAC	Heating, Ventilation, and Air-Condintiong
IDF	Input Data File
IEA ECES	International Energy Agency Energy Conservation through Energy Storage
IHG	Internal Heat Gain
K	Thermal conductivity (Wm^{-1} K^{-1})
L	Latent heat of fusion (kJ kg-1)
LA–PA	Lauric acid and palmitic acid
MPCM	Microencapsulated Phase Changing Material
ORNL	Oak Ridge National Laboratory
OPEC	Organization of Petroleum Exporting Countries
PCMs	Phase Changing Materials
PEG	Polyethylene Glycol
PIR	Polyisocyanurate
PMMA	Polymethyl methacrylate
PU	Polyurethane
PVC	Poly Vinyl Chloride
RACUS	Reducing Air Conditioning Units and Systems

SAS	Société par Actions Simplifiée'
SHGC	Solar Heat Gain Coefficient
SIP	Structural Insulated Panel
SPARK	Simulation Problem Analysis and Research Kernel
SSPCM	Shape Stabilized Phase Changing Material
T	Temperature (°C or K)
TES	Thermal Energy Storage
TIM	Transparent Insulation Material
TRACE	TRAnsient Climate Evolution
TRNSYS	Transient Systems Simulation Program
Ts	Enthalpy of fusion
U	Overall heat transfer coefficient
UPG	Unified Power Generation
USAID	United States Agency for International Development
V	Volume (m^3)
ZDH	Zone-Degree-Hours

Greek Symbols

α	Thermal diffusivity (m^2/s)
ρ	Density
μ	Water vapor diffusion resistance factor
λ	Thermal conductivity
μm	Micrometer

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