ENERGY SAVING IN RESIDENTIAL BUILDINGS

By

Eng. Ahmad Sabry Abdel-Aleem Ali An-Naggar

A Thesis Submitted to the Faculty of Engineering at Cairo University in Partial Fulfilment of the Requirements for the Degree of Master of Science

In

MECHANICAL POWER ENGINEERING

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Approved by the Examining Committee

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**FACULTY OF ENGINEERING, CAIRO UNIVERSITY
GIZA, EGYPT
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Title of Thesis:

ENERGY SAVING IN RESIDENTIAL BUILDINGS

Key Words: **(**Energy Saving – Energy Efficiency – Sustainability**)**

Summary:

The research in this thesis addresses the topic of energy consumption in residential buildings in Egypt. This topic represents a considerable section of the total electric energy generated by the electric power stations. A residential building consists of three floors and six apartments of 100 m^2floor area for each apartment; this building has been drawn by software called "**Design-builder**" that also calculate the cooling load and the heating load for the left house on the 3rd floor (typical floor) on two cases; one with thermal insulation in the walls and the roof and the other without thermal insulation. This research illustrates by using "**Design-builder**" software three comparisons between the sensible cooling load, air-conditioner energy consumption rate, cost of the energy consumed and the CO_2 produced by power plant, due to the energy consumed on the two cases (with thermal insulation and without), at three different room temperatures.

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Symbols and Abbreviations

Nomenclature

Symbol

A	area, m2
A_L	building effective leakage area (including flue) at 4 Pa, assuming
CD	1, cm2
C_l	air latent heat factor, 3010 W/(L·s) at sea level
C_s	air sensible heat factor, 23 W/(L·s·K) at sea level
C_t	air total heat factor, 1.2 W/(L·s) (kJ/kg) at sea level
CF	cooling load factor, W/m^2
D_{oh}	depth of overhang (from plane of fenestration), m
DR	daily range of outdoor dry-bulb temperature, K
E	peak irradiance for exposure, W/m^2
F_{shd}	shaded fraction
FF	coefficient for CF_{fen}
G	internal gain coefficient
Δh	indoor/outdoor enthalpy difference, kJ/kg
H	height, m
HF	heating (load) factor, W/m^2
I	infiltration coefficient
IAC	interior shading attenuation coefficient
IDF	infiltration driving force, L/(s·cm^2)
k	conductivity, W/(m·K)
LF	load factor, W/m^2
OF	coefficient for CF_{opq}
p	perimeter or exposed edge of floor, m
PXI	peak exterior irradiance, including shading modifications
q	heating or cooling load, W
Q	air volumetric flow rate, L/s
R	insulation thermal resistance, (m^2 ·K)/W
SHGC	fenestration rated or estimated NFRC solar heat gain coefficient

SLF	shade line factor
t	temperature, °C
T_x	solar transmission of exterior attachment
Δt	design dry-bulb temperature difference (cooling or heating), K
U	construction U-factor, W/(m2 ·K) (for fenestration, NFRC rated heating U-factor)
w	width, m
ΔW	indoor-outdoor humidity ratio difference, kg_w /kg_{da}
V	building volume, m^3
X_{oh}	vertical distance from top of fenestration to overhang, m
z	depth below grade, m
α_{roof}	roof solar absorptance
db	Dry-bulb temperature
rh	Relative humidity

List of Abbreviations

ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
C.O.P	Coefficient of Performance
KWh	Kilowatt hour
BP	British Petroleum
OTTV	Overall Thermal Transfer Value
WWR	Window-to-wall ratio
CFD	Computational Fluid Dynamics
PMV	Predicted Mean Vote
PPD	Percentage Predicted Dissatisfied
SBEM	Simplified Building Energy Model
ECMs	Energy Conservation Measures
GW	Glass Wool
LEED	Leadership in Energy and Environmental Design
OECD	Organization for Economic, Co-operation & Development
NFRC	National Fenestration Rating Council
CSA	Canadian Standards Association
ceil	Ceiling
cf	conditioned floor
cl	Closed
es	exposed surface
exh	Exhaust
fen	Fenestration
i	Infiltration
in	Indoor
ig	internal gain
l	Latent
o	Outdoor
oc	Occupant
oh	Overhang
opq	Opaque
shd	Shaded