



شبكة المعلومات الجامعية
التوثيق الإلكتروني والميكرو فيلم

بسم الله الرحمن الرحيم



MONA MAGHRABY



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شبكة المعلومات الجامعية التوثيق الإلكتروني والميكروفيلم



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جامعة عين شمس

التوثيق الإلكتروني والميكروفيلم

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MONA MAGHRABY



**NUMERICAL STUDY OF SMOKE MOVEMENT
AND BEHAVIOUR AT AUDITORIUM HALL**

By

Eng. Islam Gaber Mohamed Gaber

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
MECHANICAL POWER ENGINEERING

**FACULTY OF ENGINEERING, CAIRO UNIVERSITY
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Title of Thesis

NUMERICAL STUDY OF SMOKE MOVEMENT AND BEHAVIOUR AT AUDITORIUM

Key Words: Smoke- CFD – Fire – temperature distribution – Egress

Summary: This research shows the approach for the smoke layer interface at particular distance above the highest walking surface in an auditorium, The associated smoke exhaust capacity required to provide a large clear height is substantial. Further concerns about the make-up air requirements, especially given that the maximum velocity of 6.0 m/s for the make-up air in case utilizing mechanical ventilation and 4 m/s in case none forced ventilation as in this study utilizing ANSYS Fluent V.18.2 CFD software. Based on that this thesis will discuss how much smoke air should be extracted to enable people escaping from that auditorium in safe way.

DISCLAIMER

I hereby declare that this thesis is my own original work and that no part of it has been

Submitted for a degree of qualification at any other university or institute.

I further declare that I have appropriately acknowledged all sources used and have cited them in the references section.

Name:

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ACKNOWLEDGEMENT

I hereby would like to express my deep gratitude and thanks to **Prof.Dr. Essam E. Khalil, Dr. Gamal A El Hariry** for their support, continuous encouragement and distinctive supervision throughout the course of this work. They helped providing me with up to date technical references that are of great help in the present work.

In addition, I would like to express my thanks and gratitude to my family and friends for their great and continuous help and support they provided me to finish this work in final form

In addition, I need to thank my colleagues in mechanical power engineering department, Cairo University for their support and help.

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Nomenclature

Symbol	Description
a	Constant
C	Solid material specific heat
C	Constant pressure specific heat
D	Density Persons/m ²
D	Diffusion coefficient, Dilution parameter
F	External force vector (excluding gravity)
F _c	External force vector (excluding gravity)
F _s	Specific flow Persons per seconds per meter of effective width (Persons/seconds/m of effective width)
F _{sm}	Maximum specific flow Persons per seconds per meter of effective width
G	Acceleration of gravity
H	Acceleration of gravity
I	Radiation intensity
I	Radiation black body intensity
k	Thermal conductivity; suppression decay factor
K	Constant
K _g	Grad factor
M	Mass production rate of species a by evaporating droplets/particles
m,	Fuel mass flux
P	Population of the assembly area users
Pr	Prandtl number
Q	Total heat release rate Kw
q	Convective flux to a solid surface Kw
Q*	Convective flux to a solid surface Kw
R	Universal gas constant
R	Riser (for stairway) Meters (m) and millimeters (mm)
Re	Riser (for stairway) Meters (m) and millimeters (mm)
S	Riser (for stairway) Meters (m) and millimeters (mm)
S	Visibility, m
S	Speed meters per second (m/s)
T	Thread (for stairway) Meters (m) and millimeters (mm)
t	Temperature °C
T ₀	Ambient temperature
t _d	time to detection from fire initiation (minutes)
t _{pm}	time to detection from fire initiation (minutes)
t _t	time to detection from fire initiation (minutes)
t _u	time to untenable conditions (minutes)
W	Molecular weight of the gas mixture
W	Molecular weight of the gas Species
W	Width Meters (m)
We	Effective width Meters (m)

(x,y,z)	Position vector
ΔH	Heat of combustion kJ/kg

GREEK LETTERS

α	Thermal diffusivity mm^2/s
δ	Delta function
Γ	Diffusivity
ρ	Density, kg/m^3
ε	Turbulence dissipation rate
Φ	Relative humidity
τ	Shear Stress, Pa
ψ	Gaussian random number
μ	Dynamic viscosity, $\text{N.s}/\text{m}^2$
ν	Kinematic viscosity, m^2/s
ω	Vorticity
κ	Von Kármán constant
ε	Emissivity

ABBREVIATIONS

2D	Two-dimensional configuration
3D	Three-dimensional configuration
AJV	Authority having jurisdiction
ASET	Available safe egress time
ASHRAE	American Society of Heating Ventilation and Air Conditioning Engineers
CFD	Computational Fluid Dynamics under ANSYS V.18.2
HVAC	Heating, Ventilation and Air Conditioning
NFPA	National Fire Protection Association.
p	Pressure
Ppm	Population of the assembly area users
RSET	Required safe egress time
SFPE	SFPE, Society of Fire Protection Engineering, Fire and smoke Handbook. 5 th Edition
T	Temperature
V	Velocity