



**NUMERICAL INVESTIGATION OF
THERMAL COMFORT AND INDOOR AIR QUALITY INSIDE
BAGHDAD INTERNATIONAL AIRPORT**

By

Eng. Manar Kadhem Jaafar Ahmed

**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

**FACULTY OF ENGINEERING, CAIRO UNIVERSITY
GIZA, EGYPT
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Title of Thesis: NUMERICAL INVESTIGATION OF THERMAL COMFORT AND INDOOR AIR QUALITY INSIDE BAGHDAD INTERNATIONAL AIRPORT IN IRAQ

Key Words: (CFD, Thermal comfort, indoor air quality, Airport, air distribution)

Summary:

This thesis focuses on analyzing indoor air quality and thermal comfort inside departure hall in an airport through numerical investigation. Six suggested cases were studied and in each case the location, dimensions and even number of air supply and air extract grilles to discuss the effect of changing these parameters on thermal comfort levels for occupants using ANSYS 19. .Mesh sizes used in present work exceeded 5 million approximately.

The result had shown the best case among the other cases when four supply grilles at the middle and two extract grilles at the ends of the building.

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:

Date:

Signature:

ACKNOWLEDGEMENT

With the name of ALLAH, I started this research hoping that it accelerates the wheel of progress in this field.

I would like to express my sincere appreciation and infinite thanks to **Professor Dr. Essam E. Khalil**, professor of mechanical power- faculty of engineering–Cairo University, who gave me a great scientific support and guidance to make a progress in my research. Besides, having severe admiration of his gigantic experience and unlimited co-operation and efforts of helping me to introduce this research in the best. I would also like to acknowledge the help rendered to me by, **Dr. Gamal El-Hariry and Dr. Taher Abuddeif** as advisors, they provided me valuable suggestions and guidance during my study. I appreciate their encouragement, guidance and cooperation through my whole thesis work.

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Last, but not least, I dedicate this research to my home country, Iraq.

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SYMBOLS AND ABBREVIATIONS

NOMENECLATURE

SYMBOL	QUANTITY
a	Acceleration vector, m/s^2 – Speed of sound, m/s
cp	Specific heat at constant pressure, $J/kg.K$
C	Constant – Convective heat loss from skin surface, W/m^2
e	Internal energy, J/kg
E	Total energy of a fluid element, J
g	Gravitational acceleration, m/s^2
G_b	Generation of turbulent kinetic energy, k , due to buoyancy
G_k	Turbulence kinetic energy n
h	Enthalpy, J/kg – Hour
H	Height, m
I	Overall turbulence intensity
k	Turbulent kinetic energy, m^2/s^2 – Thermal conductivity coefficient, $W/m\ oC$
L	Length, m
M	Mach number – Metabolic rate, W/m^2
P	Pressure, Pa
Pr	Prandtl Number, $Pr = cp\mu / k$
Q	Heat flux, W/m^2
Q	Volumetric air flow rate, m^3/s – Total heat added to a fluid element, J
R	Gas constant, $kJ/kg.K$ – Radiative heat loss from skin surface, W/m^2
Re	Reynolds Number, $Re = \rho U L / \mu$
RH	Relative humidity, %
S	Source term – Modulus of the mean rate-of-strain tensor

SF_6	Sulfur hexafluoride
t	Time, s
T	Temperature, K
T'	Temperature fluctuation, K
u	Instantaneous velocity component in x-direction, m/s
U	mean velocity components, m/s
u'	Fluctuating velocity components. m/s
U	Axial velocity, m/s – Average velocity near the wall region, m/s
U_i	Inlet jet velocity, m/s
v	Instantaneous velocity component in y-direction, m/s
V	Room volume, m ³ – Velocity vector, m/s
w	Instantaneous velocity component in z-direction, m/s
W	Total work done on a fluid element, J–Width, m– Mechanical work, W/m ²
x, y, z	Cartesian coordinate components

GREEK LETTERS

β	Thermal expansion coefficient, K-1
Δ	Element interval –Change interval of any property
δ	Boundary layer thickness
∇	Gradient
ϵ	Turbulence dissipation rate m ² /s ³
κ	Von Kármán constant
μ	Molecular viscosity, kg/m.s
τ	Shear Stress, kg/m.s ²
Γ	Diffusion coefficient
ρ	Density, kg/m ³
φ	Dissipation function
Φ	Donates scalar property (i.e. density, temperature, etc.)
ω	Vorticity