NUMERICAL INVESTIGATIONS OF FLOW PATTERNS AND THERMAL COMFORT IN HEAVY TRUCK CABIN

By

Eng. Ahmed Fathy Ibrahim Omran

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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Under Supervision of

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Title of Thesis: Numerical Investigation Of Flow Patterns And Thermal Comfort In Heavy Truck

Key Words:
(Thermal Comfort; Truck Cabin; Transient Simulation; Transportation)

Summary:

Thermal comfort in heavy truck cabins is a prime concern for designers, owners and passengers. Interior climate is one of the main comfort factors during a trip. Besides, it is also very important for intrerior safty because air temperature, air velocity and humidity affect the driver's well-being ,concern and alertness. Air conditioning and ventelation system is also responsible for providing a well occupied envieronment for both the driver and the passenger. Recently, there has been a major development in the area of HVAC systems using thermal comfort to insure that the passengers are comfortable staying in the truck cabin. More investigations of the design parameters space is conducted to bring the final design closer to the optimum.

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Thanks are due to Dr. Esmail M. Elbialy and Eng. Osama Abdel Khalek for their support. I am very grateful to my wife Dr. Maha Magrabi and my father Mr. Fathy Omran for their support, understanding and encouragement as faithful companions.

I extend my gratitude to my dear managers and colleagues in Arab Contractors – Road Sector for their great support in both work and study through the last five years.

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NOMENECLATURE

Symbol	Quantity
Br	Brinkman number, $\mathrm{Br} = \frac{\mu U_e^2}{k \Delta T}$
C	Constant
C_p	Constant pressure specific heat, kJ/kg.K
d	Distance, m
D_{im}	diffusion coefficient for species i in mixture m
D	Fluid Domain
E	Total energy of a fluid particle, J Dimension Less term describing the turbulent dissipation rate, ε
$\vec{F}$	External body forces, N
g	Gravitational acceleration, m/s2
G	Filter function
G_b	Generation of turbulent kinetic energy, k, due to boyancy
G_k	Turbulence kinetic energy production
Gr	Grashohf number, $Gr_L = \frac{g\beta\left(T_s - T_\infty\right)L^3}{\nu^2}$
h	Enthalpy, kJ/kg
h_j^0	enthalpy of formation of species j
H	Height, m
I	Unit tensor Fluctuation intensity
$\vec{J}_j$	Diffusion flux of species j

k	Turbulent Kinetic energy, m^2/s^2 Thermal conductivity coefficient, W/m ^oC
K	Dimensionless group describing the the turbulent kinetic energy, *k*.
L_s	Mixing length, m
Le	Lewis number, $Le_i = \frac{k}{\rho\ c_p D_{i,m}}$
m	Mass, kg
Nu	Nusselt number, $Nu_L = \frac{hL}{k_f}$
p	Pressure, Pa
Pr	Prandtl Number, $Pr = C_p\ \mu\ /\ k$
Ra	Rayleigh number, Ra = Gr × Pr
Re	Reynolds Number, Re = ρ U l / μ
RH	Relative humidity, %
R_i	Net rate of production of species *i*
$\Re_j$	Volumetric rate of creation of species *j*
S	Source term modulus of the mean rate-of-strain tensor
Sc	Schmidt number, $Sc = \nu / D_{im}$
t	Time, s
T	Temperature, K
T'	Temperature fluctuation, K
$\bar{u}_i$	Mean velocity components, m/s
u_i'	Fluctuating velocity components. m/s