Design Consideration of Armored Vehicle Heat Ventilation and Air-conditioned System using Computational Fluid Dynamics

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Abstract— This study showed how the Computational Fluid Dynamics (CFD) help understanding and optimizing the flow field in a trooper compartment of armored vehicle in order to achieve an optimum of thermal comfort for the troopers. The flow field and temperature distributions in a trooper compartment were calculated using the commercial CFD program. In combination with a thermophysiological model, for the troopers, the computational results were used to evaluate the thermal comfort of the troopers and compare different geometrical modifications.

The objective is to determine the optimal air condition system. To ensure that the designed system serve enough air and ventilation system to the trooper compartment, for the safety and comfort for all troopers.

***Index Terms*— Heating ventilation and air condition (HVAC), Computational Fluid Dynamics (CFD), Thermal comfort, armored vehicles, Thermal comfort.**

I. INTRODUCTION

In the development of armored vehicles used in military applications, comfortable and safety conditions are the factors that must be taken into consideration in the design process. The insufficiency of heat ventilation and air conditioning system can cause not only the uncomfortable situation but also the danger to the trooper such as heat stroke from the vehicle thermal warming. This research then focused on the analysis of the air conditioning and ventilation system for the trooper compartment that access to critical areas.

Things to consider in development a prototype armored vehicle for transporting troops are the ability to protect themselves from external attacks. This may be due to mechanical weapons such as bombs or ammunition There are also weapons in the form of biological chemistry as well. Therefore, it is essential to design a transport vehicle as a closed model to protect biological weapons. The convenience and safety of the inside passengers is essential to be considered. This research was studied about how to make the air system design for this prototype efficient, by using computational fluid dynamics for simulate air conditioning system design inside the vehicle.

The research started with designed all alternative of laying out the evaporator system in the compartment. Then use the numerical simulation method to analyze the optimal pattern flow in compartment. The design was in two type of air conditional system with the same inlet air flow called type A and B, respectively. Both types of design have different advantages and disadvantages. However, this study will focus on the comfort of the troopers inside the compartment.

II. THERMAL COMFORT IN VEHICLE COMPARTMENT

Based on ASHRAE Standard 55, thermal comfort is defined as “that state of mind which expresses satisfaction with the thermal environment” [1]. Thermal comfort reflects human being’s subjective sensation to surrounding thermal environment. In ASHRAE handbook of fundamentals [2], the heat balance equation (1) is described as:

$$S = M \pm W \pm R \pm C \pm K - E - RES \ [W/m2] \tag{1}$$

S – rate of heat storage
M – rate of metabolic heat production
W – rate of mechanical work accomplished
R – rate of heat exchange by radiation
C– rate of heat exchange by convection
K– rate of heat exchange by conduction
E – rate of heat exchange by evaporation
RES – rate of heat exchange by respiration

Here Respiration [2] :

$$RES = Cres + Eres \tag{2}$$

$$Cres = 0.0014\, M\, (34 - ta)$$

$$Eres = 0.0173\, M\, (5.87 - Pa)$$

Cres - is sensible heat loss by convection

Eres - is latent heat loss by evaporation of heat and water vapour

Pa- is ambient water vapour pressure (in kPa)

ta - is ambient air temperature

People produce heat during metabolism, and then heat will be exchanged with the surrounding by conduction, convection, radiation and evaporation. When the heat produced balance with heat loss, people feel comfortable and then body temperature keep at 36.5 degree.