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Thermal Comfort Analysis in Vehicle Cabin

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Abstract- Thermal comfort is an important factor for vehicle passenger and especially for driver. Thermal comfort is defined as the state of mind that expresses satisfaction with surrounding environment. The objective of this project is to improve thermal comfort by calculating the predictive mean vote in vehicle cabin by using MATLAB coading.Their are many theories on thermal comfort one of the most famous and trusted is theory proposed by P.O.Fanger using this theory PMV will be calculated

Key Words- *Thermal comfort,PMV,PPD.*

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I. INTRODUCTION

Thermal comfort is very important factor in an automobile cabin as decreased thermal comfort causes adverse effects on driver's health and its decision making capability hence it should be calculated properly in the designing step itself.According to Fanger thermal comfort is determined by calculating Predictive Mean Vote(PMV) and thermal discomfort by calculating Predicted percentage dissatisfied(PPD).Thermal comfort can also be determined by using Equivalent temperature(T_{eq}).

II. LITERATURE SURVEY-

John P. Rugh et al.[1] developed a thermal comfort predicting Manikin .The model first determined temperature on surface of body and measures heat loss by sensors and then this is input to physiological model developed with ANSYS . The model was then validated with previously developed model .The objective of this paper was to reduce the air conditioning load on automobile by predicting the thermal comfort. Michaela Simion et al.[2] in his paper Factors which influence the thermal comfort inside of vehicles discussed briefly factors affecting thermal comfort. He classified them into two categories measurable factors and personal factors. Measurable factors include Air Temperature, Air velocity, Radiant temperature, Relative humidity .Personal factors include clothing insulation and activity level. RaymoundAmbs[3] developed a model for prediction of thermal comfort in preprototying phase by CFD analysis. Firstly geometric Modeling was done then automatic mesh generation was done solar load calculation and boundary conditions was defined transient CFD analysis was done through which temperature and velocity contours were obtained this temperatures and velocity was imported to VISTEONS thermal comfort model to calculate thermal comfort.

Joachim Currle[4] developed a model in which the flow field and temperature distribution was calculated in STAR CD and this was linked with thermo physical Model. It is a multilayer model which allows computation of thermal state of any occupant under given heat load both of them were connected together in iterative loop if the temperature was not suitable the Boundary conditions or the geometry was changed results for two modifications are only shown in paper. Comparing the diagrams of driver side which has 3 outlets and passenger side which has 2 outlets show that driver side has better thermal comfort. Also velocity fields and temperature distribution results was shown. M.OzgunKorukcu et al.[5] in their paper the effect of velocity was observed. 3 different velocity values were taken and their effect on temperature, relative humidity was plotted increase in velocity increases inside temperature due to heating period low air velocity have more relative humidity values during heating period. Equations for predicting temperature and relative humidity values with respect to time and air velocity levels were obtained. HitomiTsutsumi et al[6] 4 cases with variation in relative humidity and velocity were conducted in which they conducted 3 different task .Results were Skin moisture was high when relative humidity was high fan has effect on moisture. Break up time became shorter in environment with local air velocity, there was difficulty of concentration when there was high humid air.H K. Narahari et.al[7]in his paper studied the effect of vent shape in order to save computational effect convective heat transfer was solved in fluent and conduction and radiation in RADTHERM .Five different geometries and combination of vent shape of same opening area were analyzed. The designing was done in catia and meshing in hypermesh .First the base line case was analyzed .The different shaped vents were of Circular ,Elliptical and squared centered with circle side .Circular vents gave the best results. It gave 5% reduction in overall shape compared to baseline case.

III. SUMMARY

From the above literature survey it was found that thermal comfort depends on six parameters which are Air temperature,Mean radiant temperature,Airvelocity,relativehumidity,Metabolic activity and clothing insulation.

Air temperature:Air temperature is defined as the average temperature of air surrounding the body with respect to location and time.The optimal value for the inside temperature is a function of season time.During winter the optimal temperature is 22^0C during summertime different value for inside temperature are their.

Mean Radiant Temperature:The mean radiant temperature is the uniform surface temperature of an imaginary black enclosure in which an occupant would exchange the same amount of radiant heat as in the actual non-uniform space.MRT represents the mean temperature of all objects surrounding the body.

Air Velocity:It is defined as the average speed of the air to which the body is exposed with respect the location and time.Air velocity inside vehicle usually has reduced values ranging between 0.1 and 0.4 m/s.

Relative Humidity:Relative humidity is defined as the ratio of water vapour in air to the amount of water vapour that the air could hold at specific temperature and pressure.Thermal comfort sensation is optimal when the relative humidity value is about 50%.

Metabolic activity:Metabolic rate is chemical reaction that occurs in living organism in order to maintain life.In standard metabolic rate is expressed in Met unit. 1Met =58.2W/m^2. Which is energy produced per unit surface area of an average person seated at rest.

Clothing Insulation:Amount of thermal insulation worn by person has a substantial effect on thermal comfort.Because it influence the heat loss and thermal balance.The standard amount of insulation required to keep a resting person warm in a windless room at 70^0F

This topic was selected because of the increase of demand of people in comfort sector as well as its impact on drivers health and decision making capability. We will be generating a code in MATLAB this code will calculate PMV, PPD taking various inputs from the user. Thermal comfort in various cities with extreme climate conditions will be calculated using this code.

IV. CONCLUSION

Thermal comfort is a key factor and should be studied properly before designing a car.A review on thermal comfort in vehicle cabin briefly explaining the factors affecting thermal comfort have been discussed in the paper.

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