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TECHNICAL NOTE

A New Approach in Developing Optimal Defrost/Demist Performance in a Passenger Car

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ABSTRACT

The objective of this paper is to optimize defrost/demist performance in a vehicle. However, to initiate the problem, it is necessary to have a thorough understanding of flow behavior within the compartment. So a full-scale model of passenger compartment has been modeled and the air stream from very near to the windshield up to back of the compartment has been analyzed applying computational fluid dynamics. A computational C++ code is developed to calculate vapor film thickness glass temperature and some other parameters in different time steps. The code inputs are the air flow parameters resulted from the CFD simulation. Some different flow arrangements are prepared by changing locations of demist panels and outlet pores to evaluate defrost and demist performance. Ultimately, between 6 different cases suggested, the optimum location of demist panels and exit vents is determined. For the case in which warm air enters through left A-Pillar in addition to the bottom panel, and exits through right A-Pillar, the windshield clearance time is minimum for the same initial conditions.

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NOMENCLATURE

A	Windshield area, [m^2]
c_p	Specific heat capacity, [J/kg.K]
d_f	Thickness of water film
D	Factor of mass transfer
E	Energy, [J/kg]
g	Gravitational acceleration, [m/s^2]
$\hat{g}$	Density of moisture flow, [kg/m^{2}s]
h	Convective heat transfer, [W/m^{2}K]
$\hat{h}$	Sensible enthalpy, [J/kg]
I	Unit tensor
K	Thermal conductivity, [W/mK]
m	Mass, [kg]
p	Static pressure, [Pa]
Q	Heat flux, [W/m^2]
T	Temperature, [K]
$\vec{V}$	Velocity vector
Greek Symbols	
φ	Relative humidity
μ	Molecular viscosity, [Pa.s]
ν	Humidity by volume, [kg/m^3]
θ	Evaporation factor, [kg/m^{2}h]
ρ	Density, [kg/m^3]
τ	Stress tensor
Indices	
a	Air
e	Equivalent
g	Glass
wo	Outward surface of windshield
f	Vapor film

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1. INTRODUCTION

One of the vital performances in vehicles HVAC systems is demist/defrost. In addition to safety associated with improved defrost and demist performance, occupants thermal comfort is the other important issue to be considered. Due to humans comfort standard, semi-static air around the occupants, surely surpasses air flow of relatively high velocity. Applying high temperatures for defogging is usually avoided as it may reduce the driver's alert.

The presence of fog on the windshield glass reduces or sometimes blocks the driver vision which may endanger the driver as well as other drivers in the road. Windshield fogging is also a frequent problem occurring in the car due to condensation of water vapor on the glass and would be the result of two phenomena:
1- Decreasing the glass temperature below the dew-point temperature.
2- Increasing the humidity ratio in the vehicle compartment. This is always due to more humidity inside the car than outside, as the human occupants emit humidity via perspiration and respiration (breathing). In the small confines of an automobile, especially in case of maximum occupancy, the relative humidity inside can quickly reach 100%.

There have been several experimental as well as CFD works regarding demist/defrost problems in passenger cars. Aroussi et al. [1] have suggested a new approach to improve vehicle windshield defrosting and demisting. They have used Fluent CFD code to examine their 3D model of passenger car. They have validated their results by experiments in a similar condition as that of computational model.

Wang et al. [2] described an automatic system for demist and defog performance. Their system was based on prevention of misting in glass controlled by an IDGT sensor. Karamjit [3] proposed a new design for the defrost system of Jaguar Land Rover with one inlet panel at the bottom of the windshield. His aims in his study were to achieve the correct air flow distribution of about 1.5-2 m/s across the windscreen.

Skea et al. [4] made a comparison of CFD simulation methods and thermal imaging with windscreen defrost pattern. Their objective was to compare CFD and experimental results. Consequently their CFD method was shown to be suitable for fault finding of HVAC system performance.

Arroussi and Aghil [5] characterized the flow field in passenger car model, using CFD code. PIV method and CFD code were applied to determine the velocity field due to both windshield defroster and instrument panel registers.

Zolet [6] demonstrated the defogging simulation methodology developed by FIAT Brazil and Multicorpos Engineering. They used CFD simulations with Star CCM+ software. Experimental data obtained from climatic chamber was used to compare their numerical data and validate the methodology.

Croce et al. [7] simulated defogging procedure in the windshield. In their simulation, the water layer was considered as a collection of closely packed tiny droplets, leaving a portion of dry area. They considered the effect of the contact angle.

There are some researches in the literature concerning simulation and prevention of mist formation phenomenon in other fields like supermarket refrigerators [8].

Tchertovskaia [9] developed a simulation model for evaluation of energy balance at the inside of motorcar windshield including evaporation and condensation of humid air. The windshiels geometry was simplified to a flat plate in his study and condensed mass of vapor on the windshield was reported at each time step.

Most of the works in the mentioned field deal with achieving velocity field in the compartment while simultaneous consideration of both velocity and temperature fields, is little accomplished in the literature. As mentioned before air moisture content is the main issue for the mist/frost formation on the windscreen. Heating acts to lower the relative humidity of the air, but as long as the glass remains cool there will still be condensation forming. To halt the condensation, heating must be applied long enough to warm up the glass itself above the dew point of the interior air. Furthermore, heating the glass causes the interior of the car to be overheated and consequently the passengers come up with uncomfortable conditions.

Since the convective heat transfer increases by increasing air flow velocity and temperature, it is worth to find a method to improve demist/defrost performance while providing occupants comfort. Improving defrost/demist performance requires high heat transfer between windshield and its adjacent warm air. Increasing heat transfer effects is usually followed by increasing air velocity and temperature; this may somehow disturb occupant's comfort. Here in this article a new approach would be considered to manage air flow and achieve an effective method for improving defrost/demist performance. In this respect, we are going to find the best geometry and location of input panels and output pores. All suggested cases are exerted on a 3D model of real scale vehicle, analyzed in a commercial CFD software, FLUENT, to achieve temperature and velocity profiles through the vehicle compartment. By post processing the results, velocity and temperature distribution adjacent to the windshield is obtained to be applied as the inputs for the computational code developed in C++ programming environment, to calculate film thickness on the glass at each time step. The best case among the considered ones is the one in which mostly provides passengers comfort and also clears the fog at the shortest time.

2. METHODOLOGY

The objective of the present study is to find the film thickness distribution at different time steps on the windshield interior. This is achievable through a computational program developed in C++, which gets velocity and temperature profiles adjacent to windshield as inputs. Note that velocity and temperature profiles will be found through analyzing a real scale model of an Iranian made vehicle, namely SAMAND, by finite volume CFD software, FLUENT using SIMPLE method. The flow is considered steady, incompressible, viscous, Newtonian, isotropic and laminar.

The computational model consists of an exact geometry of car interior, simulated 3D in Catia software, with the exact location of inlet and outlet panels. Three panels, in addition to the existing bottom panel, have been introduced to manage the air flow. The aforementioned panels are two in both A-Pillars and one on the ceiling adjacent to windshield (Figure 1). Back outlet vents are located behind back seats, similar to the most passenger cars.

Total 600,000 unstructured tetra-hederal elements are generated by GAMBIT 2.3 as demonstrated in Figure 2. The following six different cases have been investigated and compared:

1. Warm air enters through panel A and exits passively through E1, E2 vents. (The present case in most vehicles)
2. Warm air enters through panel A, B, C and exits through D as a vent.
3. Warm air enters through panel A, B, C and passively exits through E1, E2 vents.
4. Warm air enters through panel A, B and exits through C as a vent.
5. Warm air enters through panel A, C and exits through B as a vent.
6. Warm air enters through panel A, B, C, D and exits passively through E1, E2 vents.

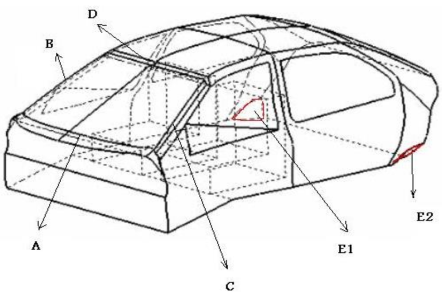


Figure 1. Location of panels (A: bottom panel, B: panel in the left A-Pillar, C: panel in the right A-pillar, D: panel added to the ceiling adjacent to windshield and E1, E2: back outlet vents)

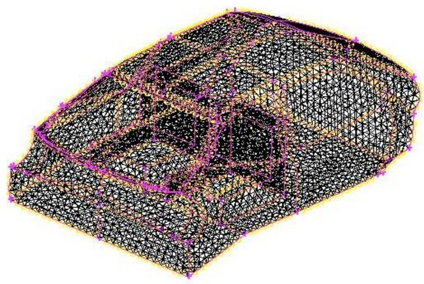


Figure 2. Whole compartment meshing

There is a constant 40CFM of mass flow rate assumed for inlet air. Heater of demist/defrost system makes the air temperature rises to 300K. (Very usual mode of demist system performance(It should be noted that providing such a flow condition is of the present HVAC capabilities of almost all vehicles; as the applied fans in automotive HVAC systems can provide 40-60 CFM of air flow [7])). Outdoor temperature is assumed to be 270K.

Pressure outlet boundary condition with the zero gauge pressure is applied at the outlets. The convection boundary condition is assumed for the side and back walls of the compartment.

After analyzing each of six mentioned cases in FLUENT, velocity and temperature distribution through the compartment is achieved. The essential data for proceeding the solution is the velocity and temperature distribution adjacent to the windshield which are obtained by post processing the achieved data from the FLUENT and applied as inputs for the developed computational code written in C++ programming environment. Results of temperature distribution within the compartment as well as velocity and temperature distribution near the windshield are presented just for two cases (Figures 3-8). One for the present case existed in most of vehicles (case No.1) and the other, the best suggested case (case No.5).

3. DESCRIPTION OF THE MODEL (HYBRID METHOD)

According to the automotive standards, the acceptable film thickness to have a clear vision is about 10-9 mm while the boundary layer thickness varies from zero to about 22 mm. Because of significant difference among the order of thicknesses, it is not rational to solve flow and energy equations on the windshield therefore a computational approach is surpassed to compute vapor film thickness at each time step.

The hybrid method is an innovative approach, introduced in this study, to simulate defrost/demist performance. It employs CFD results along with numerical/empirical correlations to calculate vapour film variations on the windshield.

The method can be divided into two principle parts, the first part is CFD simulation of the flow in the vehicle compartment to achieve the velocity and temperature distribution adjacent the windshield and to evaluate the temperature distribution all over the compartment to see whether passengers comfort has been reached; and the second part is the computational code which employs results of CFD simulation to give vapour film variations on the windshield.

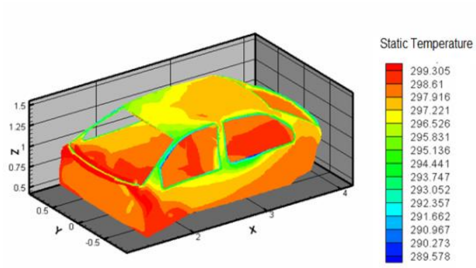


Figure 3. Temperature distribution in the compartment (case No.1)

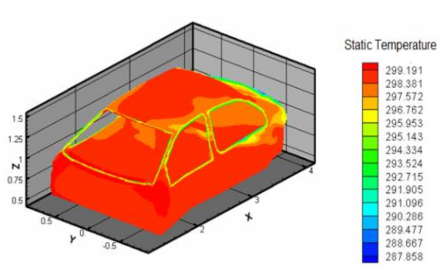


Figure 4. Temperature distribution in the compartment (case No.5)

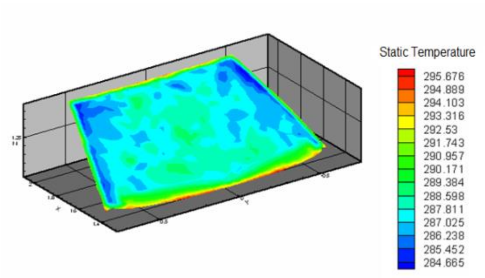


Figure 5. Temperature distribution adjacent to windshield (case No.1)

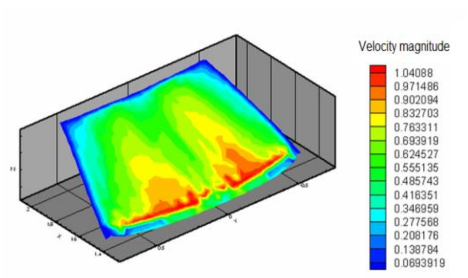


Figure 6. Velocity distribution adjacent to windshield (case No.1)

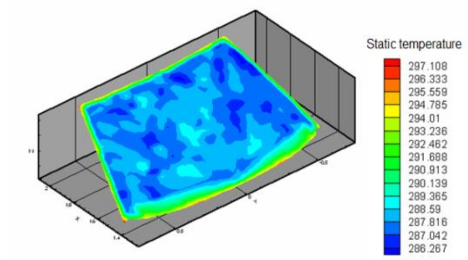


Figure 7. Temperature distribution adjacent to windshield (case No.5)

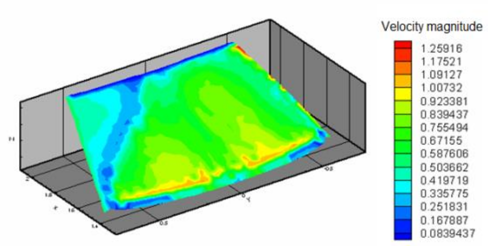


Figure 8. Velocity distribution adjacent to windshield (case No.5)

To accomplish the first part, mass and momentum conservation equations are solved. The flow is considered steady, incompressible, viscous, Newtonian, isotropic and laminar.

The equation for conservation of mass, or continuity equation can be written as follows:

$$\nabla.\left(\rho\vec{V}\right)=0 \tag{1}$$

Conservation of momentum for the present problem is described by:

$$\nabla.\left(\rho\vec{V}\vec{V}\right)=-\nabla p+\nabla.(\tau)+\rho\vec{g} \tag{2}$$

where p is the static pressure, τ is the stress tensor (described below), and $\rho\vec{g}$ is the gravitational body force. The stress tensor τ is given by [10]:

$$\tau=\mu\left[\nabla\vec{V}-\frac{2}{3}\nabla.\vec{V}I\right] \tag{3}$$

where μ is the molecular viscosity, I is the unit tensor.

After solving the mass and momentum conservations in the above forms by the SIMPLE method, the pressure and velocity distribution are achieved through the compartment which is applied into the energy equation to achieve temperature distribution. Conservation of energy for the present problem is described by:

$$\nabla.\left(\vec{V}(\rho E+p)\right)=\nabla.\left(k\nabla T+\left(\tau.\vec{V}\right)\right) \tag{4}$$

The terms on the right-hand side of Equation (3) represent energy transfer due to conduction and viscous dissipation, respectively. In Equation (3):

$$E = \hat{h} - \frac{P}{\rho} + \frac{V^2}{2} \tag{5}$$

Sensible enthalpy , $\hat{h}$ for incompressible flows of air as ideal gas is of following form:

$$\hat{h} = \int_{T_{ref}}^{T} c_p dT + \frac{p}{\rho} \tag{6}$$

where T_{ref} is 298.15 K.

Solving Equations (1), (2) and (4) reveals the velocity, presure and temperature distribution within the vehicle compartment. Velocity and temperature distributions represent wether thermal comfort is provided in the compartment. To proceed the next step magnitudes of these values adjacent to the windshield should be used as inputs for the computational code.

The computational code is based on the mass transfer law to calculate the quantity of water evaporation from the windshield or the condensation of water vapor on the windscreen as well. It is important to note that a 3D real scale model is considered for the windshield with the same curvature and slope. The model is meshed as shown in Figure 9.

There are two principle sources for the vapour contents in the vehicle compartment: occupants' perspiration/respiration and the outside air humidity.

Moisture transfer through the air takes place through diffusion and convection. The first process can be simulated by Fick's law [9]:

$$\hat{g} = -D\frac{d\nu}{dx} \tag{7}$$

while the second as the dominant mechanism of moisture transfer is formulated as following [9]:

$$\begin{aligned} &\hat{g} = \theta.A.(\nu_s(T_s) - \nu_a) \\ &\theta = 25 + 19V \end{aligned} \tag{8}$$

where $\theta(Kg/m^2.h)$, accounts for evaporation factor, V and A denote the air velocity on the windshield and the wet area of the windshield, respectively.

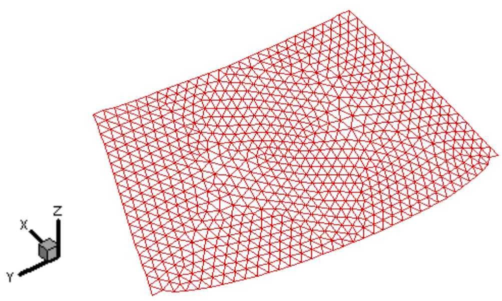


Figure 9. Windshield meshing

As can be found from Equation (8) if the humidity of the ambient air is lower than saturation humidity of the windshield with determined temperature then evaporation will take place and g will be negative, otherwise condensation happens with the positive g. At the beginning of time steps of the model, the humidity transfer rate, g, is assumed to be zero and the equivalent temperature close to the windshield is calculated.

Equivalent temperature T_e is the temperature in which effects of condensation and evaporation are considered. As a portion of air vapor content is condensed on the windshield, it transfers some energy to the air around which causes its temperature to increase and vice versa. The influenced increased/decreased temperature is known as equivalent temperature which is calculated by [9]:

$$T_e = T_a + \hat{g}.h_{fg} / h_{air} \tag{9}$$

If the mass of water film condensed on the windscreen is zero, surface temperature at the inside of windshield is calculated by:

$$T_s = \frac{k_g.T_{wo} + h_{air}.A.T_e}{k_g + h_{air}.A} \tag{10}$$

At such condition, T_f, is equivalent to T_s, surface temperature.

The heat transfer problem for each considered element on the windshield can be simplified as shown in Figure 10. The hatching part is representative of condensed vapor film on the windscreen.

$R_{convec.}$, R_f, R_g in the equivalent electric circuit, are respectively representative of convection resistance of air adjacent the windshield, conduction resistance of vapor film and conduction resistance of the glass. While Q, accounts for the total heat transfer.

$$\begin{aligned} R_g &= \frac{d_g}{k_g A} \\ R_f &= \frac{d_f}{k_f A} \\ R_{convec.} &= \frac{1}{h_a A} \end{aligned} \tag{11}$$

A, in the above equation, denotes the area of each considered element on the windshield.

Applying the electric analogy, total amount of heat transfer from the compartment to the windshield can be calculated:

$$Q = \frac{T_e - T_w}{R_g + R_f + R_{convec.}} \tag{12}$$

By the use of electric analogy for the box shown on Figure 10b, the vapor film temperature can be obtained:

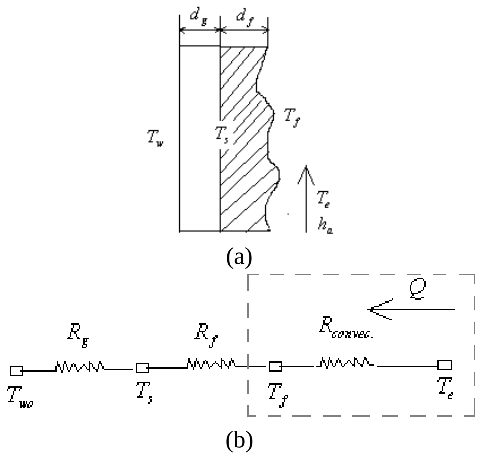


Figure 10. a) Cross view of the windscreen and b) the equivalent electric circuit

$$T_f = T_e - Q.R_{convec.} \tag{13}$$

At this stage, the moisture transfer rate can be calculated, knowing equivalent temperature T_e and T_g. Therefore new amount of condensed vapor mass on the windscreen can be calculated.

$$\Delta m_f = g \times A \tag{14}$$

Condensed vapor mass is then employed to obtain vapor film thickness:

$$d_f = \frac{m_f}{\rho_f} \tag{15}$$

For the film temperatures of above 0°C, water will appear on the glass surface. While film temperatures below 0.1°C may cause ice formation and for the film temperatures in the range of −0.1 to 0°C, it is assumed that either freezing or thawing occurs and thermo-physical properties at this temperature range is achieved by interpolation between values of ice and water.

Heat transfer rate from the compartment to the windshield is significantly influenced by thickness of the condensed film which in turn is a function of evaporation and condensation rates.

4. RESULTS AND DISCUSSION

Relative humidity at the onset of activation of the HVAC system is assumed $\varphi = 95\%$ and the initial film thickness all over the windshield is assumed 0.18 mm. Velocity and temperature distribution adjacent the windshield is obtained by the FLUENT model while the outdoors temperature is assumed −2°C. The windshield is assumed 1400 mm×720 mm with the real curvature.

Results of CFD analysis and the computer program, based on the time interval in which the critical zone of windshield being completely clear are shown for all of the discussed cases in Figures 12-17. The best optimal case is the one in which the critical zone of the windshield will be cleared in the minimum time. Based on the safety standard in the automotive engineering, 100 percent of area C and 80 percent of area A, shown in Figure 11 should be cleared in the minimum possible time. As can be observed in Figure 12, the clear portion of the windshield for case 1 after 400 and even 600 seconds of starting demist system is below the critical vision zone and the demist system performance is not proper.

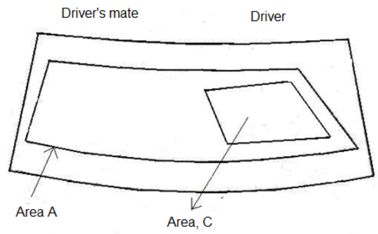


Figure 11. Critical zones of the windshield that should be demisted immediately [11]

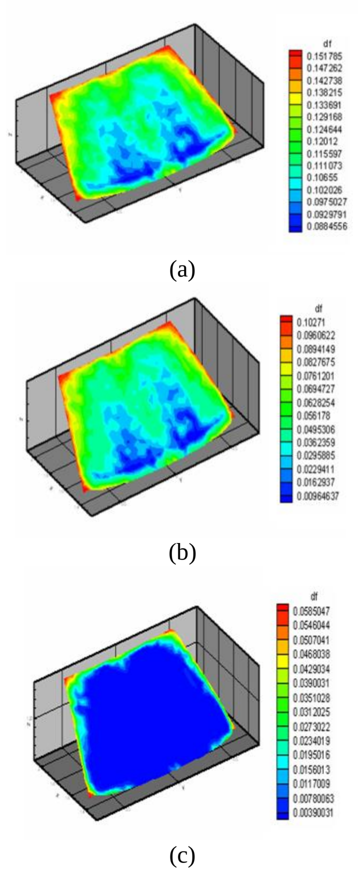
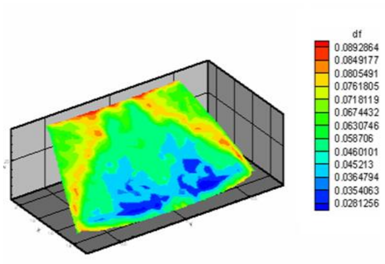


Figure 12. Distribution of vapor film thickness a) after 400s, b) after 600s and c) after 800s of starting demist system (Case 1)

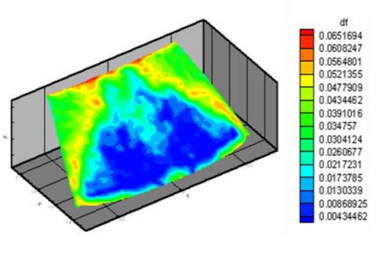
This condition is commonly experienced in medium-quality passenger cars.

In the suggested case 2 both side pillars as well as the bottom panel are applied as flow inputs and the air ventilation is located at the top panel. As can be seen in Figure 13 after 500 seconds performance of the demist system the critical vision has been cleared and after 600 seconds the windshield has been cleared up. This is due to air direct contact with the windshield. When the ventilation pores are located in the rear of the compartment the air flow deviates from the windshield to reach the outlet. This reduces the air flow contact with the windshield and therefore decreases the heat transfer which in turn results in longer time for the windshield clearance.

Figure 14 demonstrates the vapor film distribution on the windshield for case 3 in which warm air enters through panel A,B,C and passively exits through rear vents. As can be found from the figure too, this case provides better cleaning conditions in comparison with the two previous cases in a way that after 500 seconds almost 70% of the windshield has been demisted although the critical vision zone has not been cleaned up till then.



(a)



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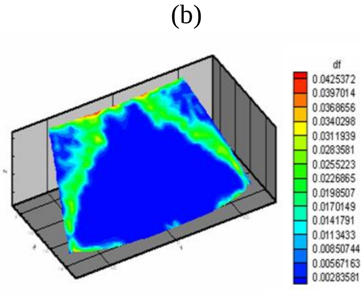
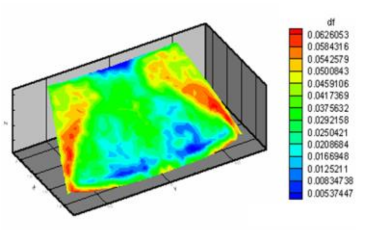


(c)

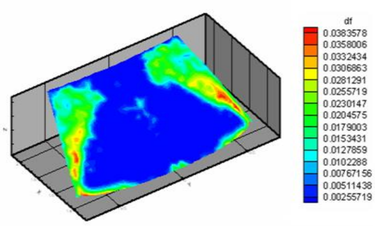
Figure 13. Distribution of vapor film thickness a) after 400s, b) after 500s and c) after 600s of starting demist system (Case 2)

In case 4 it was suggested to enter the warm air through panels A and B suction it by panel C. Results of vapor film distribution are shown in Figure 15. In this case after 600 s the windshield has been entirely cleaned up.

Figure 16 shows the mist distribution on the windshield for case 5 in which the air enters through panels A, C and exits through panel B.



(a)



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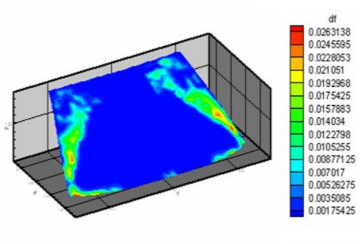
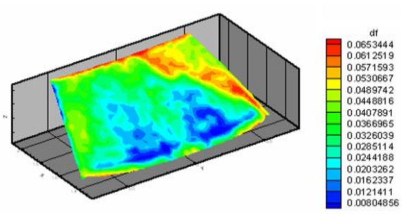
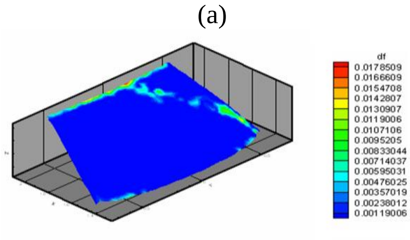


(c)

Figure 14. Distribution of vapor film thickness a) after 400s, b) after 500s and c) after 550s of starting demist system (Case 3)



(a)



(b)

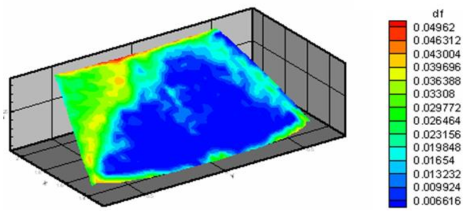
Figure 15. Distribution of vapor film thickness a) after 400s and b) after 600s of starting demist system (Case 4)

This case shows the best performance of the demist system, as after 350 seconds the critical vision zone has been cleaned up and after 450 seconds the windshield has been entirely cleared up.

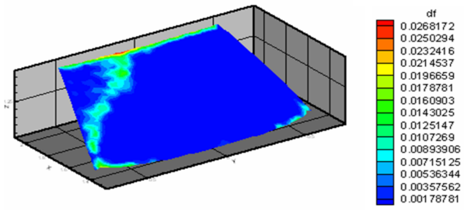
When the ventilation panels are around the windshield, the air flow embraces the windshield and results in optimum heat transfer. Adding a panel along with the bottom panel as inlet increases the warm air contact with windshield and so the heat transfer.

In case 6 it was suggested to exert the warm air through all of the panels around the windshield and to suction the air by the rear panels, E1, E2. Results show that this method of flow arrangement is not as effective as the previous one. Since after 450s, when in case 5 the windshield is entirely cleaned up, the windshield of this case is not still safe and clear. This may be due to the air flow deviation from the windshield.

The required period for the windshield to be completely cleaned up is shown for different cases in Figure 18. The clearance time of the critical zone for different cases is compared in Table 1. Case 5 in different flow and initial conditions provides the best demist performance.

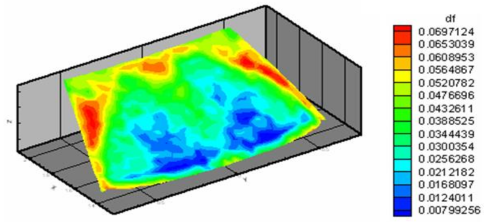


(a)

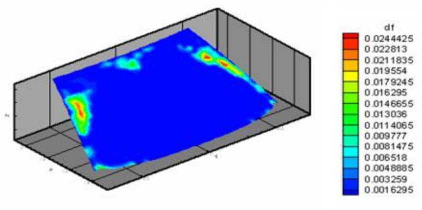


(b)

Figure 16. Distribution of vapor film thickness a) after 350s and b) after 450s of starting demist system (Case 5)



(a)



(b)

Figure 17. Distribution of vapor film thickness a) after 400s and b) after 600s of starting demist system (Case 6)

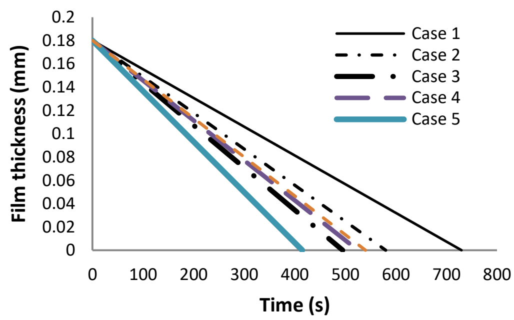


Figure 18. Film thickness changes with time (for all cases)

TABLE 1. Time needed for the windshield critical zone to be completely clear(s)

Thermal characteristics of HVAC sys. Relative humidity and initial film thickness	**Clearing time, case**					
	1	**2**	**3**	**4**	**5**	**6**
$Q = 40\,CFM$ $T = 295\,K,\ \varphi = 95\%$ $d_{f,i} = 0.25$	950	740	670	690	520	720
$Q = 60\,CFM$ $T = 300\,K,\ \varphi = 95\%$ $d_{f,i} = 0.25$	850	650	600	610	490	640
$Q = 60\,CFM$ $T = 300\,K,\ \varphi = 85\%$ $d_{f,i} = 0.18$	720	600	480	560	420	580
$Q = 60\,CFM$ $T = 300\,K,\ \varphi = 95\%$ $d_{f,i} = 0.18$	750	610	500	570	440	600

5. CONCLUSION

Effects of location of the ventilation panels on optimal deforst/demist performance was investigated in this study. In this regard a real-scale compartment was simulated in FLUENT software to obtain distribution of the air flow and temperature. The air thermal and flow characteristics near the windshield were then applied to the computational code to calculate evaporation and condensation of humid air as energy balance and ultimately obtain mist thickness on the windshield. Six different cases were evaluated from the viewpoint of required time for demist performance. The cases differ in location of ventilation pannels. It was found that, case 5, for which warm air enters through panel “A, C” and exits through “B”, provides the best demist/defrost performance among the considered cases.

The windshield clearance time decreased by more than 40% in case 5 relative to the present case used in the passenger cars (case 1).

6. REFERENCES

1. Aroussi, A., Hassan, A., Clayton, B., AbdulNour, B. and Rice, E., "Improving vehicle windshield defrosting and demisting", (2000), SAE Technical Paper.
2. Wang, M., Urbank, T.M. and Sangwan, K.V., “Clear vision” automatic windshield defogging system", (2004), SAE Technical Paper.
3. Karamjit, S., "Simulation of the windscreen defrost performance", in Star European User Conference., (2011).
4. Skea, A.F., Harrison, R., Baxendale, A. and Fletcher, D., "Comparison of CFD simulation methods and thermal imaging with windscreen defrost pattern", (2001), SAE Technical Paper.
5. Aroussi, A. and Aghil, S., "Characterisation of the flow field in a passenger car model", ***Optical Diagnostics in Engineering***, Vol. 4, No. 1, (2000), 1-15.
6. Zolet, A., "CFD and experimental correlation of the defrost flow and vehicle windshield defogging", in 21 thBrazilian Congress of Mechanical Engineering, Natal, RN, Brazi., (2011).
7. Croce, G., D'Agaro, P., De Angelis, A. and Mattiello, F., "Numerical simulation of windshield defogging process", ***Proceedings of the Institution of Mechanical Engineers, Part D: Journal of Automobile Engineering***, Vol. 221, No. 10, (2007), 1241-1250.
8. Himanshu, K., Upadhyay, N., Sehgal, M., Jaraut, P., Gautam, S. and Kalra, S.K., "Feasibility study and development of refrigerator cum air conditioner", ***International Journal of Scientific and Research Publications***, Vol. 4, No. 12, (2014), 1-6.
9. Tehertovskaia, N., "Simulation model for the climate at the windshield of a passenger car compartment", (2004).
10. Guide, F.U., "Fluent 6.3 documentation", ***Fluent Inc***, (2007).

A New Approach in Developing Optimal Defrost/Demist Performance in a Passenger Car

TECHNICAL NOTE

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چکیده

هدف از انجام این تحقیق ، بهینه سازی فرایند بخارزدایی شیشه جلو خودرو می باشد. برای شروع کار شناخت درستی از رفتار جریان هوای داخل اتاقک خودرو نیاز است. لذا یک اتاقک با ابعاد واقعی از یک خودروی سواری مدلسازی شده و جریان هوا از مجاورت شیشه جلوی خودرو تا انتهای پشتی اتاقک با استفاده از دینامیک سیالات محاسباتی مورد تحلیل قرار گرفته است. یک کد محاسباتی نیز در محیط برنامه نویسی C++ جهت محاسبه ضخامت فیلم بخار در گامهای متفاوت زمانی تدوین شده است. ورودی این کد پارامترهای هیدرودینامیکی هوای مجار شیشه است که از شبیه سازی دینامیک سیالات محاسباتی بدست آمده. با تغییر در محل پنلهای هوای ورودی و خروجی بخارزدایی، به آرایشهای متفاوتی از جریان می توان دست یافت. در این مقاله ۶ حالت مختلف از آرایش جریان مورد بررسی قرار گرفته است. در نهایت بهترین حالت برای بخارزدایی شیشه جلو، پاشش هوا از پانل تعبیه شده در A-pillar سمت چپ و پانل زیر شیشه و مکش هوا از A-pillar سمت راست خودرو می باشد. زمان بخارزدایی شیشه جلو توسط این روش با شرایط اولیه یکسان نسبت به سایر روشها مینیمم می باشد.

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