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IMPACT ON PEOPLE IN MICROCLIMATE BODY OF MOTOR VEHICLES

Abstract: *Microclimate and indivdualni parameters can significantly affect the health, safety, comfort, work capacity and efficiency of the people in the workplace, where they carry out their functional tasks. The paper discusses the influence of microclimate conditions and factors affecting the thermal comfort in an extremely unfavorable microclimate congested and closed working environment upgrade of motor vehicles during the testing. At the end of the paper defines the acceptable criteria of comfort based on PMV and PPD index for the crew working in the middle of a heat-ridden in accordance with ISO 7730. Also heat comfort presented the satisfaction of the people performing their tasks in an environment where he feels comfortable and satisfied.*
Keywords: *Microclimate, thermal comfort, testing, standard.*

1. INTRODUCTION

During the work of the people working in areas that are on the upgrade of a motor vehicle where they perform specific complex tasks it is necessary to have a favorable microclimate environment and an adequate thermal comfort. Upgrading vehicle represents mostly poor isolated limited workspace. In the space of a motor vehicle upgrades to people affected by different unfavorable factors in the random process that can potentially harm the health of the individual. These identification is necessary to identify, identify sources and causes and their connections, measure and prescribe measures for their improvement and maintenance within the limits required for a given position. The identification of the underlying that can impair human health in the upgrading of a motor vehicle includes micro-climatic conditions, noise and vibration. Disturbed microclimate conditions may adversely affect the room, mental and physical labor of man. Due to the long-term activity of the organism to overcoming disorders microclimate conditions leads to fatigue of the people in the work process.

During operation, the temperature in the working and auxiliary rooms containing workplaces must be adequate, depending on the working methods and activities, as well as the physical stress of employees, in addition to workplaces where the consequence of technological process. At workplaces indoors should be provided sufficient fresh air, having regard to the working methods and activities, and tasks that are performed in the process of work and physical effort that are required. [1]

Microclimate of the upgrade of a motor vehicle consists:

- air temperature,
- air humidity,
- flow velocity of air and
- thermal radiation of the environment.

The preferred value of air temperature in the workplace depend on the severity of operation (easy, medium or hard heavy),

and ranged from 12 to 28°C. Average air temperature in the upgrading of motor vehicles in the wintry period should amount to between 17 and 22°C, in summer conditions should not exceed 28°C. The optimum temperature should allow for a smooth exchange of human body heat to the surrounding air so that when it does not produce heat burden on the driver. Humidity is the amount of water vapor that air can absorb at a given temperature. Since the quantity of the absorbed moisture moves from zero to some maximum value, that the air humidity is expressed as the relative humidity. The optimum relative humidity in the upgrading of the motor vehicle is 40 to 60%. The air flow has a great influence for good ventilation upgrade the motor vehicle to be between 15-20 m^3 of fresh air per hour, with a velocity of 0,2 to l m/s. The body of a man receiving heat from the surrounding thermal radiation of heated body emit heat radiation and if the environment is less heated than the surface of their skin. The intensity of thermal radiation is the amount of energy falling on the unit area per unit time and is expressed in W/m^2. The prescribed value for the energy of thermal radiation in the workplace depends on the body surface exposed to radiation and the amount of up to 100 W/m^2, less than 25% of the exposed surface, up to a maximum of 35 W/m^2 when 50% or more of body surface area exposed to radiation. [2]

2. THERMOREGULATION AND HEAT BALANCE

Thermoregulation is a physiological process that maintains the body temperature homeothermic organisms in a narrow range, which is a prerequisite for conducting biological processes. The physiological body temperature in humans ranges from 36,1 to 37,2°C measured under the armpit. Skin temperature may vary from 29,5 to 33,9°C, while the internal organs have a constant temperature of 37,8 to 38°C. Thermoregulation is based on the manufacturing process and heat output. [3]

Also man has physiological mechanisms to maintain a constant body temperature of the organism in a way that activates the mechanisms of regulation to restore the temperature of the heat balance.

Thermal comfort represents the state of human consciousness manifested satisfaction regarding the temperature conditions in which a person feels comfortable.

The mechanisms of thermoregulation in humans may be chemically altering the intensity metabolism and physical, radiation, conduction, convection and evaporation.

It is necessary that heat energy in humans caused by metabolism and physical activity equalized with losses of energy to meet the thermal comfort, which is represented by the equation of heat balance and thermal comfort by the formula:

$$S = M - W \pm R \pm C \pm K - E \pm Res$$

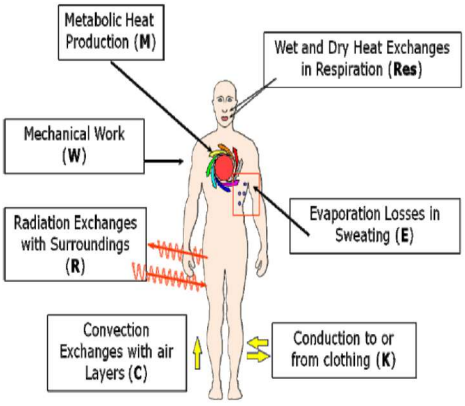

Figure 1. *Human body thermal balance [4]*

If there is a disturbance of thermal equilibrium for the human body is making further efforts to regulate body temperature condition. To the imbalance can will come because of the negative changes of meteorological factors and changes in the physiological state of the organism. Thermal equilibrium with the disorder is reducing mental and working ability of

people who work in the upgrading of the motor vehicle.

The International Organization for Standardization ISO (International Organization for Standardization) and the American Society of ASHRAE (American Society of Heating, Refrigerating and Air-Conditioning Engineers) are prescribed parameters of thermal comfort by its standards ISO 7730 and ASHRAE 55.

3. PREDICTED MEAN VOTE (PMV) AND PREDICTED PERCENTAGE DISSATISFIED (PPD)

Thermal comfort area calculates by using the model Fagers indexes of thermal comfort. PMV (Predicted Mean Vote) was developed with the aim of predicting and evaluating the mean value of declaration on the thermal comfort of a larger group of people in a given environment.

According to ASHRAE and ISO 7730, thermal comfort is defined as that state of mind which expresses satisfaction with the thermal environment. PMV index is based on the equation of heat balance of the human body and it is given by the equation:

$$PMV=(0{,}028+0{,}303*e^{-0{,}036*M})*[(M-W)- H - E - Cres - Eres]$$

or

$$PMV=(0{,}028+0{,}303*e^{-0{,}036*M}) * L$$

where the different terms represent, respectively:

PMV - Predicted Mean Vote Index

M - the metabolic rate, in Watt per square meter (W/m^2);

W - the effective mechanical power, in Watt per square meter (W/m^2);

H - the sensitive heat losses;

E - the heat exchange by evaporation on the skin;

Cres - heat exchange by convection in breathing;

Eres - the evaporative heat exchange in breathing.

L = thermal load

Table 1. Predicted Mean Vote sensation scale [5]

PMV	Sensation
- 3	Cold
- 2	Cool
- 1	Slighty cool
0	Neutral
1	Slightly warm
2	Warm
3	Hot

Metabolic power M depends of the level of physical activity. Standard IS0 8996 defines typical levels of human physical activities where some of them are presented in Table 1. It defines metabolic index Met, that represents metabolic power relative to sitting as reference metabolic activity. [6]

Table 1.b Levels of metabolic activity

Metabolic activity	W/m^2	Met
Reclining	46	0.8
Sitting	58	1.0
Office work	70	1.2
Standing	93	1.6
Light work	116	2.0
Walking 3km/h	140	2.4
Walking 4km/h	165	2.8
Walking 5km/h	200	3.4

Clothing can significantly affect human thermal comfort sensation. Standard ISO 9920 defines thermal insulation coefficient index (Table 2) for various types of clothing. Thermal insulation coefficient index is referencing to thermal insulation coefficient of human body without clothes.

Table 2. Clothing thermal insulation index

Clothing	m^2K/W	clo
Without clothing	0	0
Slimmer doming (shorts, T-shirt, sandals)	0.05	0.3
Summer doming (trousers, shirt, shoes)	0.08	0.5
Spring clothing (trousers, shirt, jacket, shoes)	0.11	0.7
Winter clothing (trousers, sweeter, jacket, shoes)	0.2	1.3

In order to predict the percentage of dissatisfaction of people in a given thermal environment it is defines PPD - Index (Predicted Percentage Dissatisfied), that is associated with the PMV index.

$PPD = 100 - 95*\exp[-(0{,}03353*PMV^4 + 0{,}2179*PMV^2)]$

Dependence PMV and PPD index is shown in Figure No. 2.

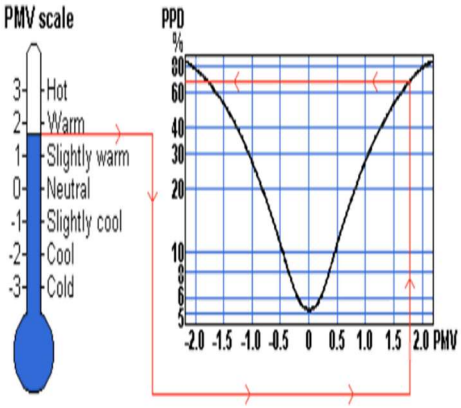

Figure 2. *PMV i PPD scale, [7]*

From this expression can be seen that, in a situation of full thermal comfort, ie. When the PMV = 0 be the minimum proportion of 5%. For a maximum of 10% of dissatisfied (PPD <10%), that is acceptable according to standard ISO 7730 Standard ISO 7730 recommended the use of PMV index in the range of -2 to +2, provided that the level of metabolism from 0,4 to 4 meters, thermal resistance of clothing 0 to 2 clo, air temperature of 10-400C, air velocity from 0 to 1 m/s and relative humidity of 30-70%. [8]

4. CONCLUSION

The paper presents the key microclimate and individual parameters that affect thermal comfort in the working environment upgrade of motor vehicles during tests.

Also, the paper presents conditions of creating and maintaining optimal microclimate suitable to enable a productive and comfortable work without additional strain of the human body.

It has been defined criteria acceptable thermal comfort based on both the Fanger PMV and PPD indices in accordance with ISO 7730.

Favorable microclimate conditions and thermal comfort are manifested by the productivity and satisfaction of the people performing their tasks in an environment where they are feeling comfortable and satisfied.

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