RESPONSE OF HUMAN BODY TO IRREGULAR RADIATION LOAD

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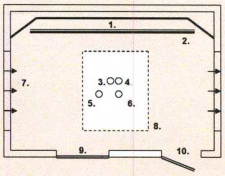
Introduction: The aim of this study was to verify the response of human body on irregular thermal load in the course of mental work during experimental conditions in climatic chamber. Organization of the climatic chamber is in the picture No.1.



Legend:
1. vertical radiant area
2. cool area
3. radiation temperature
4. stereotermometer Jokl-Jirák
5. air velocity
6. global termometer Vernon-Jokl
7. orientation of air circulation
8. horizontal radiant area
9. window
10. enter

Fig. No. 1: Organization of the climatic chamber

Table 1: Heat conditions of stages in climatic chamber

Vertical radiant area								Horizontal radiant area				
Experiment	t_g (°C)	t_i (°C)	$\Delta t_i t_g$ (°C)	Experiment	t_g (°C)	t_i (°C)	$\Delta t_i t_g$ (°C)	Experiment	t_g (°C)	t_i (°C)	$\Delta t_i t_g$ (°C)	W.m^{-2}
1	24	24	0	4	24	29	+5	7	24	45	29	100
2	24	14	-10	5	24	34	+10	8	24	58	34	200
3	24	19	-5	6	24	44	+20	9	24	24	0	0

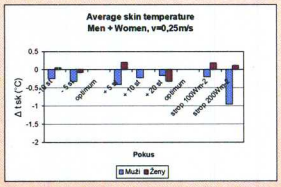


Fig. No. 2: The difference of average skin temperature in comparison with optimal values (v = 0,25 m/s)

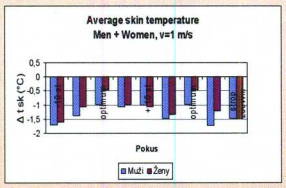


Fig. No. 3: The difference of average skin temperature in comparison with optimal values (v = 1 m/s)

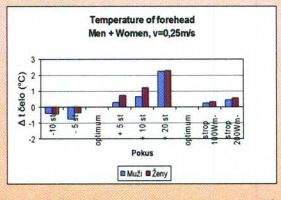


Fig. No. 4: The difference of average temperature of forehead in comparison with optimal values (v = 0,25 m/s)

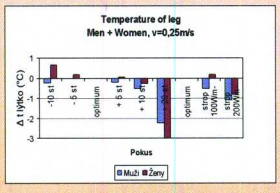


Fig. No. 5: The difference of average temperature of leg in comparison with optimal values (v = 0,25 m/s)

Methods: Experiments were held in climate chamber in a set of 20 students (10 men and 10 women). Experimental persons (EPs) were dressed in uniform suit with thermal resistance 0.7 clo. The experiments were divided into two phases according to air velocity: I. v_a=0.25 m.s^{-1} and II. v_a=1.0 m.s^{-1}. The resultant temperature of the globe thermometer (tg) was convenient with optimal conditions for mental sedentary work, i.e. 24°C. The difference between radiation temperature in direction of radiation (t_{rA}) and tg (Δt_{rA}-t_g) in case of vertical radiation surface was in range from -10°C to +20°C, in case of horizontal radiation surface in range from +20 to +34°C (100 - 200 W.m^{-2}). Heat conditions are presented in the Table 1. EPs were exposed to the same conditions always in duration of 1 hour. In the course of experiments EPs were sitting next to computer and were solving computer games making demands on attention and short term operational memory. In the first and last EPs were exposed to optimal thermal conditions in which dry air temperature (t_a), t_{rA} and t_g were identically 24°C. In the course of experiments thermal and humidity settings were continually measured in the height of head (110 cm) and height of ankles (10 cm) i.e tg and stereo temperature (t_{stereo}) measured by globe stereo thermometer Jokl-Jirak and recorded into the computer. Parameters t_a, v_a, t_{rA} a RH were measured by Indoor Climate Analyser type 1213 Bruel a Kjaer. Of physiological parameters heart frequency, skin temperature at six places on body surface and body temperature were continually measured and recorded. At the end of experiment each person filled questionnaire including total temperature sense impressions. Temperature sense impressions were expressed in scale ASHREA in range -3(cold) to +3 (hot).

Results: Significant differences in values of heart frequency and body temperature between individual experimental conditions were not detected. The difference of average skin temperature in comparison with optimal values was under all conditions in phase I in the range ± 0.5 SD, in phase II (v_a = 1 m.s^{-1}) in range -0.5 to less then -1.5 SD (Fig. No. 2,3). Temperature of forehead was increasing in relation to radiation component from both vertical and horizontal radiation surface from negative values (-0.5 to -1.5 SD) to values +1.5 SD (Fig. No. 4) and above whereas temperature of leg was decreasing from average values as to values lower than -1.5 SD. (Fig. No. 5) Results of subjective assessment of heat conditions are presented in Table 2. The percent of dissatisfied subjects illustration kind of gray colour in the table. The feeling of heat or cold is presented as total assessment. The relationship of subjective assessment to values of environment are presented in Fig. 6 – 9.

Women perceived temperature conditions in climatic chamber as colder and had higher temperature of skin than men.

Conditions on cold vertical radiation surface and higher air temperature were perceived as warmer whereas on hot vertical radiation surface and low air temperature as colder. Thermal radiation from ceiling was perceived on the same values Δ trA-tg better than from vertical radiation surface.

Table 2: Results of subjective assessment of heat conditions

Vertical radiant area				
Condition	EI v = 0,25 m.s^{-1}		EII v = 1 m.s^{-1}	
	% dissatisfied	Final evaluation	% dissatisfied	Final evaluation
Cool area -10°C	5	1,37	16	-0,24
Cool area -5°C	15	1,68	31	-0,57
Optimum	5	1,32	5	1,11
Hot area +5°C	0	1,16	16	-0,5
Hot area +10°C	42	0,11	31	-0,56
Hot area +20°C	58	-1,63	42	-0,79
Horizontal radiant area				
Optimum	5	1,32	5	1,11
Hot area 100 W	10	0,63	42	-0,98
Hot area 200 W	32	-0,42	53	-1,09

15 % and less dissatisfied
16až 20 % dissatisfied
21 až 30 % dissatisfied
31 % and more dissatisfied

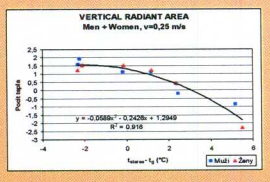


Fig. No. 6: The relationship of subjective assessment to values of environment

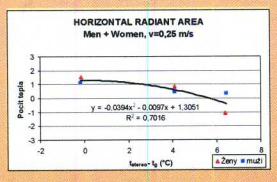


Fig. No. 7: The relationship of subjective assessment to values of environment

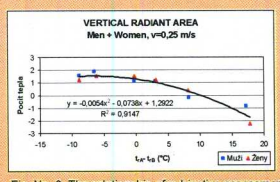


Fig. No. 8: The relationship of subjective assessment to values of environment

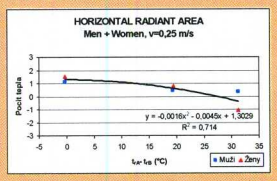


Fig. No. 9: The relationship of subjective assessment to values of environment

Conclusion: Sense impressions of thermal discomfort due to irregular radiation load caused by negative or positive radiation of surrounding surfaces is given by both difference between intensity of radiation and cooling effect of air velocity and difference of skin temperature of forehead and leg.

Keywords: microclimate, irregular thermal load, thermal discomfort, skin temperature

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