THEORETICAL ASSESSMENT OF THE IMPACT LOW-EMISSION PLASTER ON THE MICROCLIMATE OF BUILDINGS

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Summary

This paper deals with CFD simulation of internal environment and energy consumption of a building with normal and low emissive plaster.

It was simulated two heating systems. The first one – a heating system with radiator and the second one – a heating system with long-wave radiation.

The using of low emissive plaster can about save 6 % energy for heating of the selected room.

Keywords: internal environment, CFD simulation, low emissive plaster

1 Creation thermal-moisture properties of the internal air - microclimate and energy intensity

The most important part of the building microclimate is thermal-moisture properties of the internal air - microclimate. This is created by mechanisms of heat and moisture transfer evaporation and condensation of water phase. During the winter term the microclimate depends on internal insulation properties of building envelope and system of heating and ventilation and occupancy rate. Thermal comfort of the room is mostly influenced by insulation properties of building envelope, system of heating. Up to most dominant of type of heat transfer in the room we can sort heating unit to convection a radiation.

Each type of heating has different impact on thermal comfort and the energy demand is also different.

2 Low emission plasters

In the frame of research project of Ministry of Industry and Trade: No.: 2A – 3TP1/090 with the name “Special composite material with high absorption of infrared radiation” were tested different type of final surface of internal wall. It was plaster, boards and different painting. Main goal is find out the best surface material for high thermal comfort and low energy consumption in the room. For comparing of influence different surface emisivity was tested high emissive material $\varepsilon = 1.0$ and low emissive material $\varepsilon = 0.2$.

3 Reference rooms

For calculation of general influence of difference ε on energy demand for heating was tested on reference room with window and size 5x4x3 m. On surfaces was applied $\varepsilon = 0.2$; 1.0 in two cases:

- Case A – all surfaces $\varepsilon = 1$
- Case B – ceiling, door and internal walls $\varepsilon = 0.2$; other surfaces $\varepsilon = 1$.

The final criteria for same condition in the room was operative temperature in the geometrical centre of the room $t_o = 20$ °C ± 0,1 K. Operative temperature was calculated from temperature of the air and temperature of globe [1]. The final operative temperature was reached by iteration method – power of heating units.

3.1 Description of reference room

The referenced room is living room with forced ventilation and two types of ventilation unit.

- Case I – electric radiating ceiling panel
- Case II – convection unit (under window)

Geometry of solved room is on the **Fig. 1.**

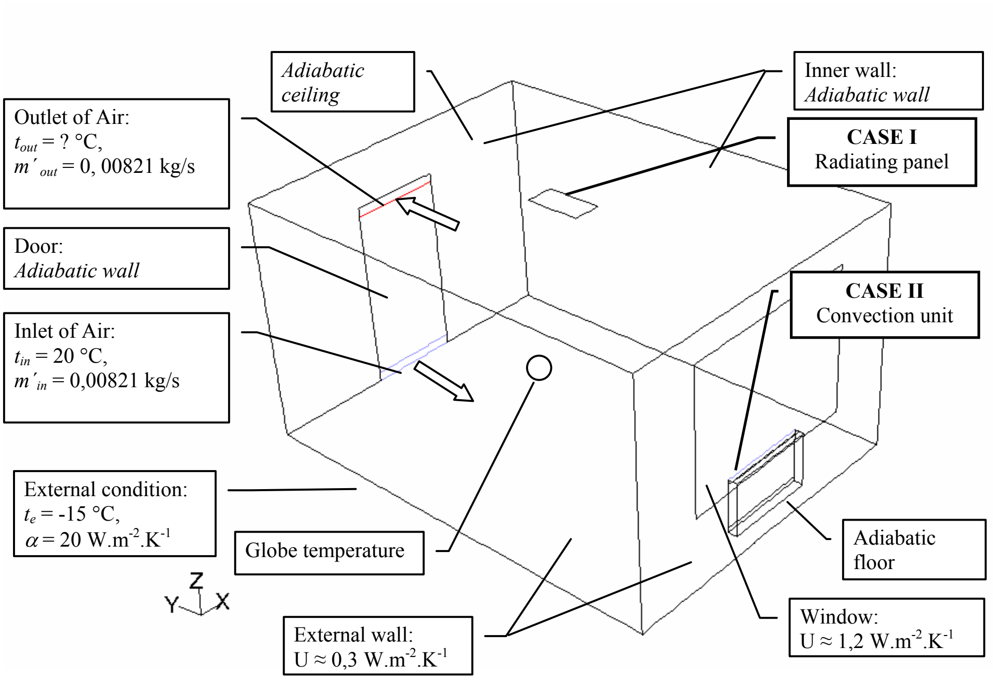

Fig. 1 Solved room

3.2 Description of used CFD model

For simulation was used software Fluent 6.3 and calculation mesh was done in software Gambit 2.4. Geometrical model is 3-D and mash combine blocs and hexahedrons.

Simulation was done for steady state flow. Model of turbulence was RNG k - ε. The air was uncompressible with changing of density by ideal gas. Model of radiation was used DO (Discrete Ordinates).

4 Results of simulation

From results is presented distribution of air temperature and irradiative temperature –**Fig. 2 to Fig. 5**. Comparing of energy consumption was made by comparing of actual heat flow rates of both heating unit – **Tab. 1.** CFD simulations show real mechanisms of exchange of heat both types of heating units inside room.

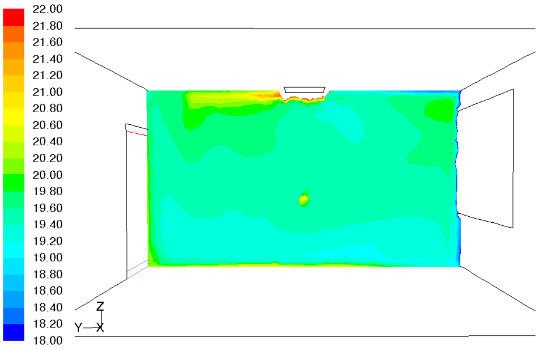

Fig. 2 Case IA – air temperature [°C]

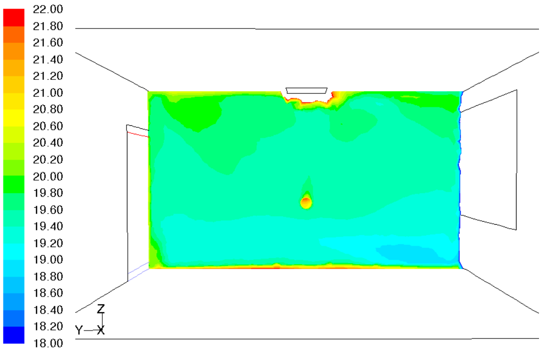

Fig. 3 Case IB – air temperature [°C]

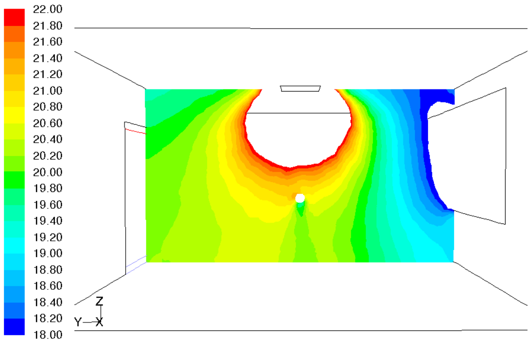

Fig. 4 Case IA – average irradiative temperatures [°C]

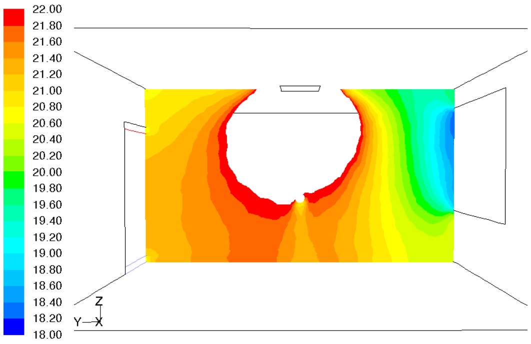

Fig. 5 Case IB – average irradiative temperatures [°C]

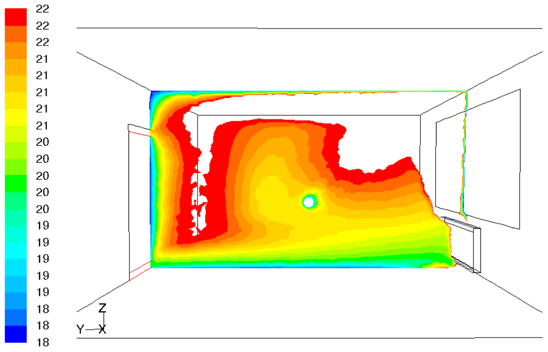

Fig. 6 Case IIA – average irradiative temperatures [°C]

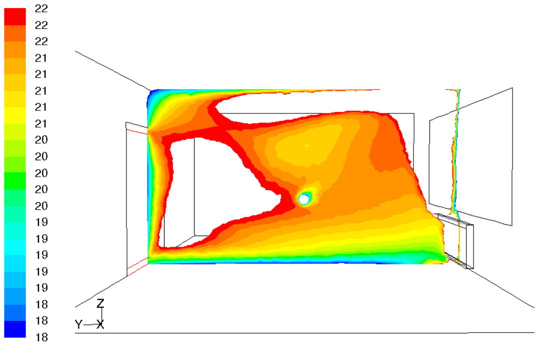

Fig. 7 Case IIB – average irradiative temperatures [°C]

Tab. 1 Comparing of results

Case	Conditions in reference point			Power of heating unit
	Temperature of air	Irradiative temp.	Operative temp.	Total
	θi	θr	θo	Q´tot
	[°C]	[°C]	[°C]	[W]
IA - $\varepsilon = 1$	19.54	20.26	**19.9**	**330**
IB - $\varepsilon = 0.2$	19.5	20.75	**20.1**	**310**
IIA - $\varepsilon = 1$	21,18	18,62	**19,9**	**291**
IIB - $\varepsilon = 0.2$	21,65	18,45	**20,05**	**283**

5 Conclusion

Calculated results show for model electrical radiating ceiling panel - case I lower energy heating consumption of the room 6 % for low emission plaster opposite to common emissive plaster. In case with convection electrical unit was power save about 3 %. This result was not satisfied first expatiations of project.

References

[1] ČSN EN ISO 7730 Ergonomic thermal environment – Analytical determination of thermal comfort by calculation of PMV and PPD criteria and local thermal comfort.

[2] Kalousek, M., Final report 2009 of project of Ministry of Industry and Trade: No.: 2A – 3TP1/090 Special composite material with high absorption of infrared radiation.

[3] Manual of Fluent 6.3, Ansys Inc. , corp. 2009