Mathematical modeling of ceramic block heat transfer properties

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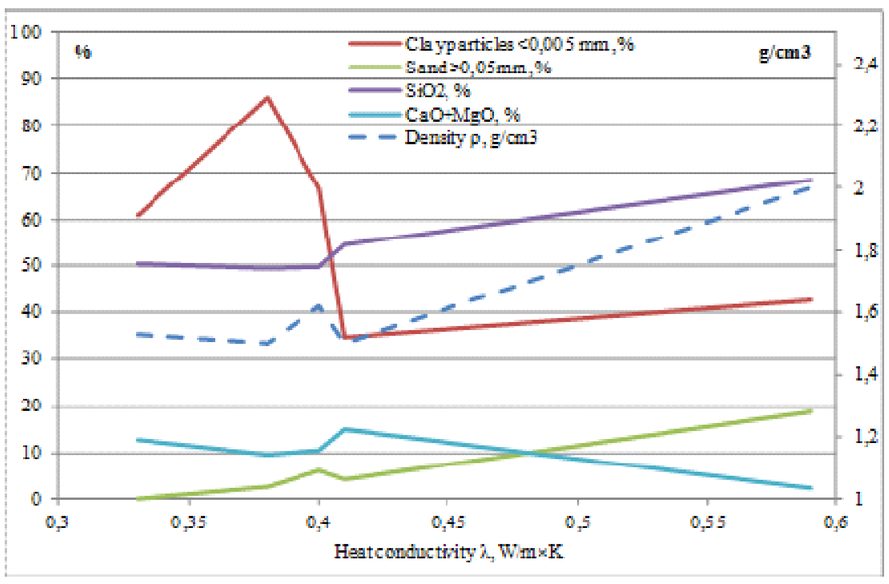
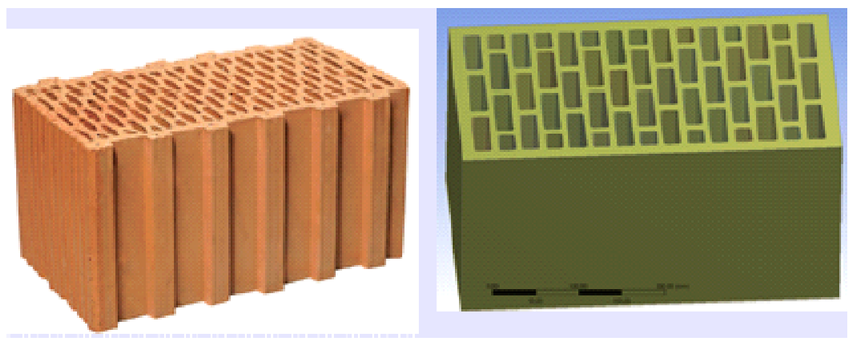
Factors influencing thermal conductivity of ceramic body



Building blocks *Keraterm 44* produced presently by *JSC „Lode"* (left) and modelled block with experimental cavity combination (right).



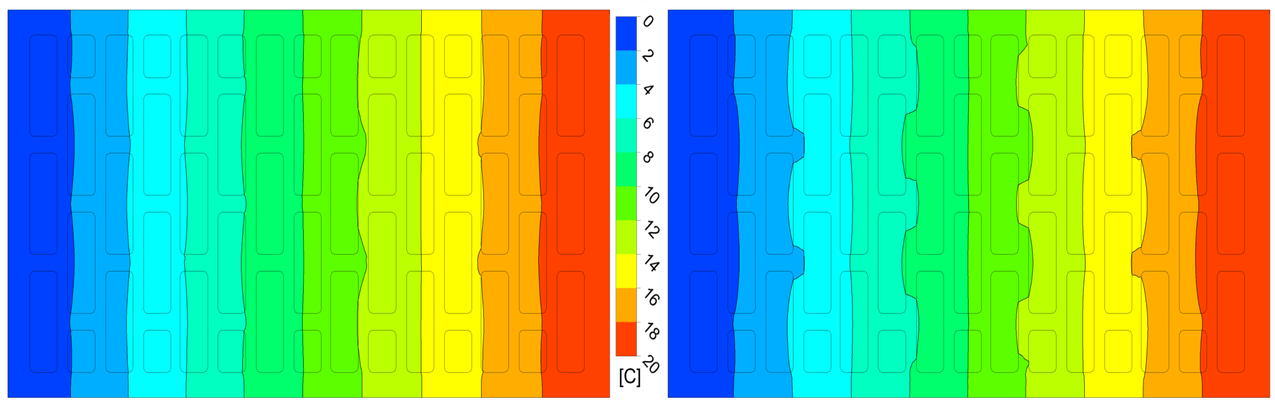
Properties of materials used for mathematical modeling

Material	Density ρ (kg/m³)	Specific heat capacity c_p (J/(kg·K))	Thermal conductivity λ (W/(m·K))
Ceramic	1460	920	0.278
Air	1.185	1000	0.0261
Mineral wool	220	2100	0.038
Polyurethane foam	40	1500	0.026

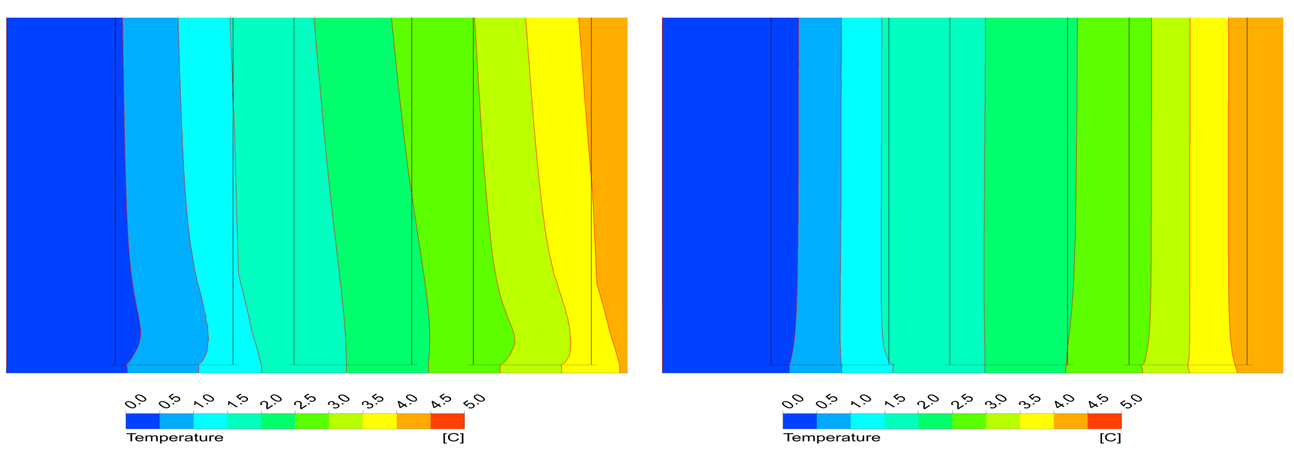
Experimental data (*Keraterm 44*) and modelling results (A, W, P, A0.3)

Model	Cavities filling	Surface emission ε (-)	Heat flux Q (W)	Heat transmittance U (W/(m²·K))	Thermal conductivity λ_e (W/(m·K))
Keraterm 44	Air	*Experimental measurements*			0.129
A	Air	0.9	0.4522	0.384	0.169
W	Mineral wool	0.9	0.2947	0.250	0.110
P	Polyurethane foam	0.9	0.2578	0.220	0.097
A0.3	Air	0.3	0.3159	0.268	0.118

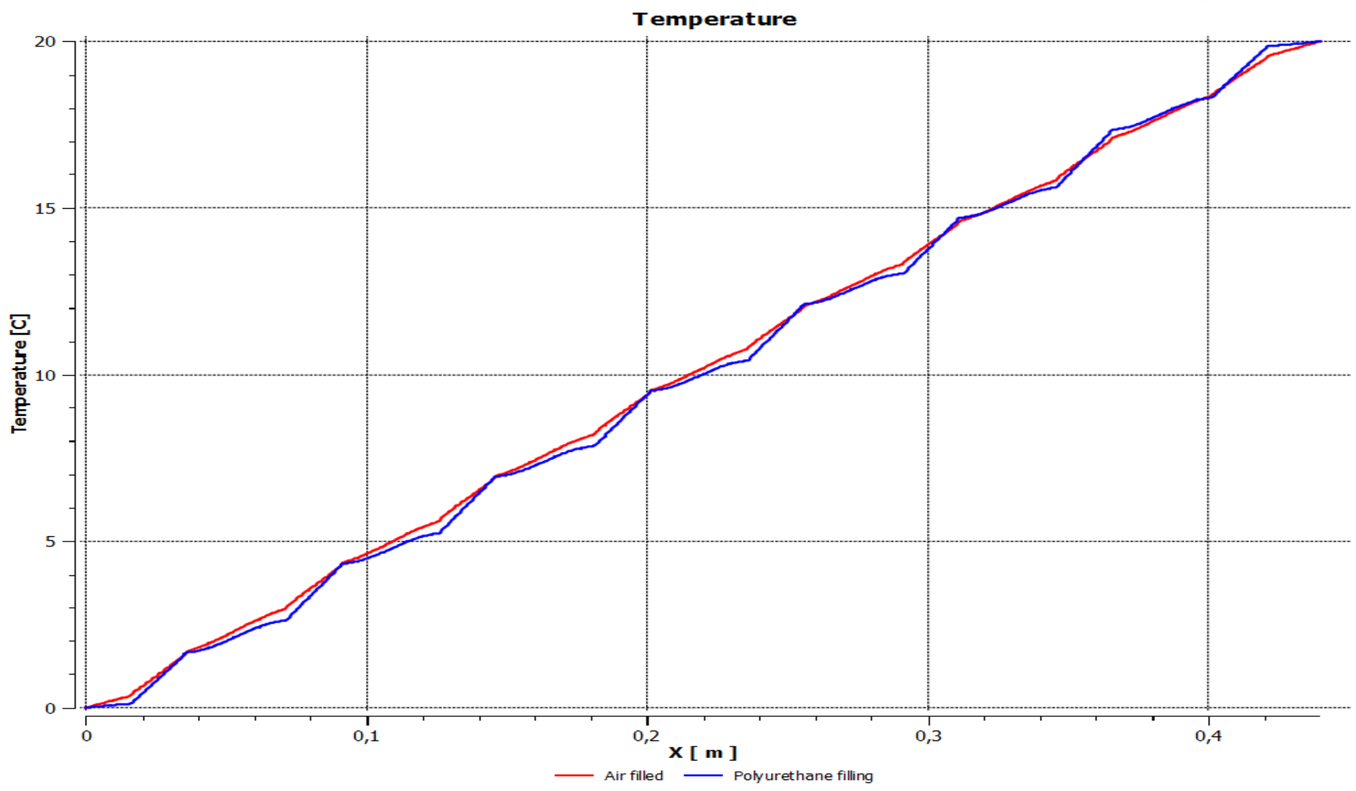
Temperature field on top of the block for model A (left) and model P (right).



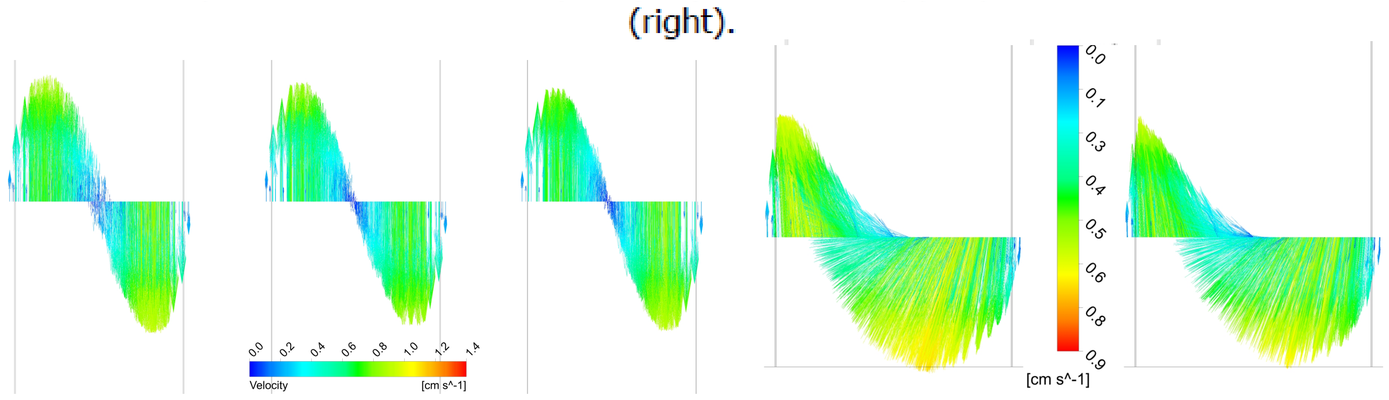
Temperature field on bottom part of vertical cross-section in the middle of block for model A (left) and model P (right).



Temperature profile on the middle line (in direction of temperature gradient).



Velocity vectors in the middle part (left) and in the upper part of the cavities (right).



IEGULDĪJUMS TAVĀ NĀKOTNĒ

ERAF

EIROPAS REĢIONĀLĀS ATTĪSTĪBAS FONDS

Project Nr. 2011/0003/2DP/2.1.1.1.0/10/APIA/VIAA/041

VTPMML

LODE KERA TERM

Conclusions

Possibilities to decrease thermal conductivity of ceramic block

1. Decrease thermal conductivity of ceramic body
   Limits: clay composition and compressive strength of material
2. Decrease thermal conductivity of the block applying different combination of technological cavities
   Limits: compressive strength of material, production technological problems, cost of equipment

Mathematical modeling provides possibility

3. To calculate decreasing of thermal conductivity of the cavities with different type of fillings
4. To find best possible combination of the cavities
5. Mathematical modeling is precise method – thus radiation, convection and heat transfer in solid materials is included in the model.

Mathematical modeling of the physical processed within the building blocks was made using commercial computational fluid dynamics software ANSYS CFX (Ansys Inc., 2012).