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CONSTRUCŢII. ARHITECTURĂ

CONVECTIVE HEAT TRANSFER ANALYSIS IN FLUID FLOW WITH TURBULENCE PROMOTERS WITH HEAT PIPES

BY
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The present paper proposes the analysis and the simulation of the convection heat transfer into the fluid flow with turbulence promoters utilizing heat pipes.

The study is based on the necessity of the unconventional energy forms capitalization, increasing of the energy efficiency and leads to the energy consumption decrease in concordance with the sustainable development concept.

1. Heat Pipes. General Presentation

The *Heat Pipe* is a device which realizes an efficient heat transfer combining, in a closed circuit, the phenomenon of vaporization, vapour transport, condensation and the condensation return [1].

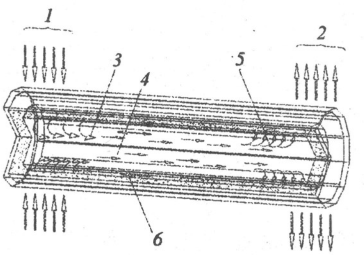

Fig. 1.– The presentation of Heat Pipe: *1* – heat contribution; *2* – extraction; *3* – evaporation; *4* – vaporous flowing; *5* – condense; *6* – condense fluid flowing.

From a constructuve point of view, the *Heat Pipe* is extremely simple. It is made, in general, of a tight enclosure of form rolls, covered or not inside with a porous material, forming a kind of capillary structure, which is imbued with the fluid used (Fig. 1) [2].

By heating an end of the tube, the vapour pass through the pores of the wall and move towards the other end, which is colder, where by condensation there is a release of heat towards outside.

2. Heat Exchanger with Heat Pipes

The *Heat Pipes* heat exchangers have the most application spread of these devices in different domains.

Heat recovery and the utilization of it in miscellaneous purposes is motivated by the energy saving and the environment protection.

The residual heat is used for the space heating, preliminary heating of the air, preparation of the household hot water and more.

The first heat exchanger with *Heat Pipes* was built by Q-Dot Corporation in the USA [3].

Heat exchangers may be classified according to their flow arrangement:

a) In *parallel-flow* heat exchangers: the two fluids enter in the exchanger at the same end, and travel in parallel to one another to the other side.

b) In *counter-flow* heat exchangers: the fluids enter in the exchanger from opposite ends. The counter-current design is most efficient, because it can transfer the most of the heat [4].

For a high efficiency, heat exchangers are designed to maximize the surface area of the wall between the two fluids, while minimizing resistance to fluid flow through the exchanger. The exchanger's performance can also be affected by the addition of fins or corrugations in one or both directions, which increase surface area and may create channel fluid flow or induce turbulence.

3. Features and Benefits of the Heat Pipes Heat Exchangers

a) Reliable operation due to the individual heat pipes not depending upon another.

b) No moving parts for virtually maintenance free operation.

c) Easy to clean.

d) Integral fin design minimizing the adverse effects of metal expansion.

e) Good level of sensible effectiveness for rapid payback.

f) Available in a wide range of custom sizes.

4. The Analysis of the Geometry Surface Transfer for the Optimization of the Thermal Flux and the Heat Quality Gained from the Secondary Agent

4.1. Hypothesis and Flow Modeling

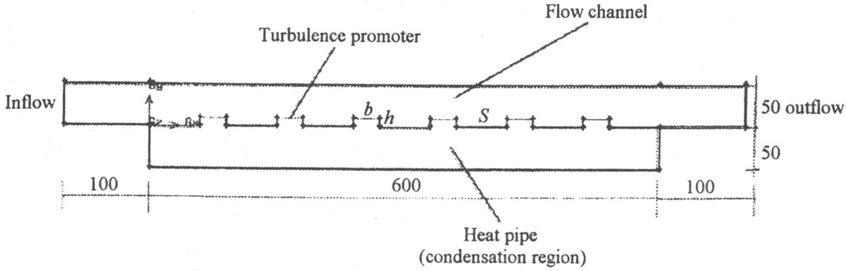

Fig. 2.– Analysed model for the influence of the turbulence promoters geometry.

a) *Initial parameters*

1. Heat pipe temperature in the condensation region: +60°C.
2. Inflow air temperature: +6°C.
3. Velocity of the air: 1 m/s.
4. Environment temperature: +20°C.

For the analysis of the influence of the turbulence promoters three cases was studied:

a) Fluid flow without turbulence promoters, case *A*.

b) Fluid flow with turbulence promoters and the ratio $b/h = 3$; 1.5; 1 (cases *B*, *C*, *D*).

c) Fluid flow with turbulence promoters and the ratio $S/b = 1$; 1.5; 2; 3 (cases *E*, *F*, *G*, *H*).

The flow modeling was made using the *Fluent* software and the results are presented in what follows.

5. Visualization of the Results and their Interpretation

The visualization of obtained results are represented in Figs. 3,...,6.

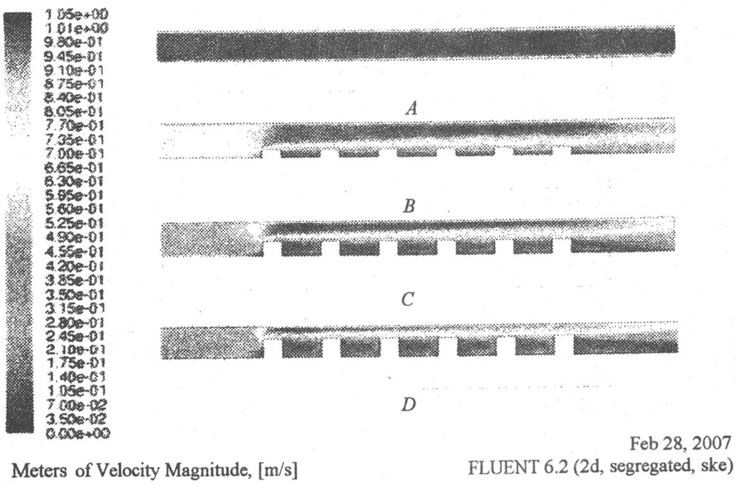

Fig. 3.- Velocity field for the cases *a* and *b*.

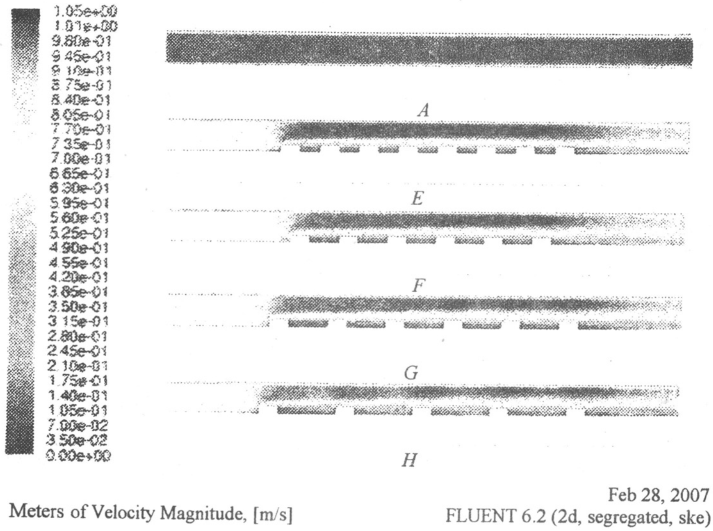

Fig. 4.– Velocity field for the cases a and c.

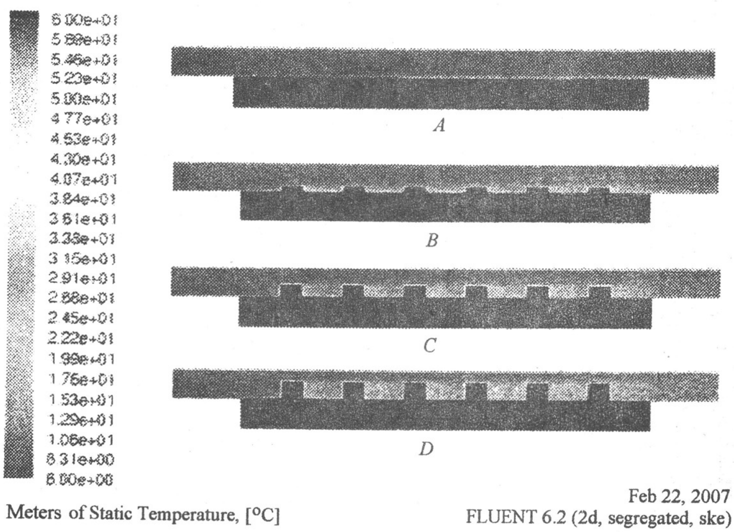

Fig. 5.– Temperature field for the cases a and b.

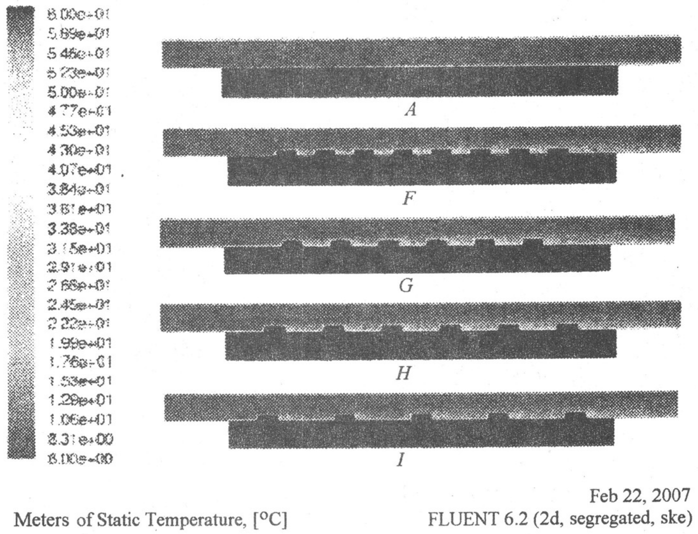

Fig. 6.– Temperature field for the cases *a* and *c*.

For the $b/h = 0.66$ ratio we obtain a maximum thermal flux of 1,110.6 W/m^2 (Fig. 7).

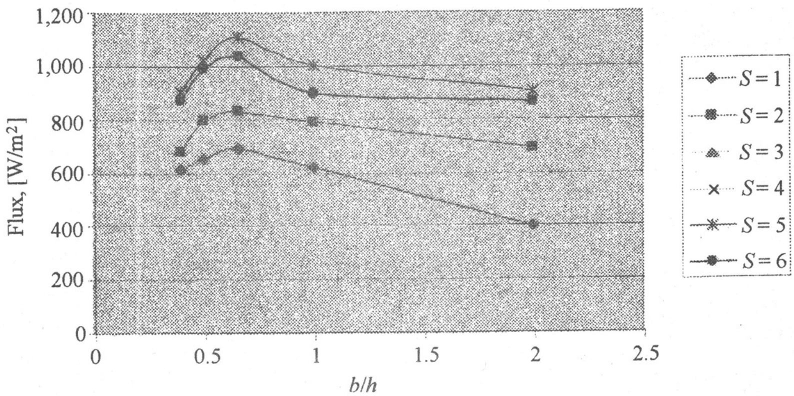

Fig. 7.– Correlation between the total heat flux and the b/h ratio.

For the $b/h = 0.66$ ratio we obtain a maximum convection heat transfer coefficient of 48.2 $W/m^2.K$ (Fig. 8).

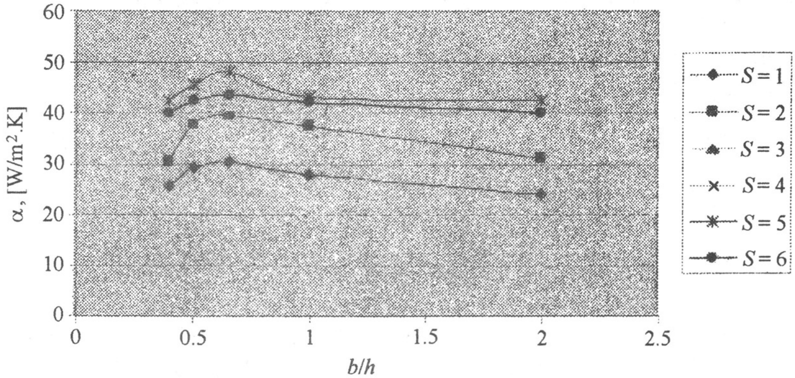

Fig. 8.– Correlation between the heat transfer coefficient and the b/h ratio.

From the variation of the α/α_0 ratio for the optimum b/h ratio it results the maximum value of $S = 5$ (Fig. 9).

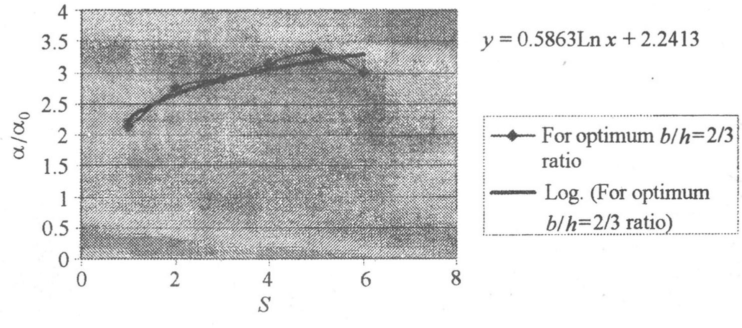

Fig. 9.– Correlation between α/α_0 ratio and S for the optimum b/h ratio.

6. Conclusions and Perspectives

The obtained results confirm the opportunity of the performed study, the diversification of the constructive solutions and of the specific applications for building equipment engineering.

The facilities offered by the numerical calculus, thanks to the rapid emphasizing of the influence of any parameter, allow a complete and profound understanding of the phenomena.

The flow modeling can be made for different initial parameters.

Further research for capitalization of the unconventional energy forms are foreseen in next papers.

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ANALIZA TRANSFERULUI CONVECTIV DE CĂLDURĂ ÎN CURGERI DE FLUIDE CU PROMOTORI DE TURBULENŢĂ CU TUBURI TERMICE

(Rezumat)

Se propune analiza şi simularea transferului convectiv în curgeri cu promotori de turbulenţă utilizând tuburi termice.

Studiul are la bază necesitatea valorificării formelor neconvenţionale de energie, creşterea eficienţei energetice şi reducerea consumului de energie în concordanţă cu cerinţa de dezvoltare durabilă.