

RESEARCH ON DRYING BARLEY WITH GEOTHERMAL WATER BY INCREASING THE HEAT TRANSFER SURFACE USING THE POROUS HEAT EXCHANGER

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Abstract

*By using a porous medium heat exchanger, which contains inside a core of porous material with a specific mass heat c convenient, the problem of heat transfer is solved by increasing the heat exchange surface, which greatly reduces the amount of geothermal water. necessary for heat exchange, thus leading to an increase in the thermal efficiency of drying the barley plant with geothermal water.***Key words:** Geothermal water, heat exchanger porous medium, drying malt.

INTRODUCTION

Industrial processes is an interesting target for the use of geothermal water.

Beach water temperatures below 423 K is considered geothermal used in basic processes such as preheating, washing, peeling, evaporation and distillation, sterilization and drying, etc.

Given the fact that the energy required pre-drying and drying process one tone of malt using the geothermal water heating is 3000 MJ, geothermal water temperature is 365 K, the temperature required for pre-drying Air Malta is in the range of 297 ÷ 318 K temperature of air required for drying malt 353 K and the temperature required pre-drying (withering) Malt humidity varies depending on such:

43÷34% moisture →296÷298 K

34÷24% moisture →299÷303 K

24÷12% moisture →313÷323 K,

By malt drying plant which used geothermal water, is recommended to use a heat exchanger with porous medium.

The porous core heat exchanger, heat transfer is achieved indirectly through a surface exchange (intermediate heat exchanger wall between the fluid and the environment). (Iancu C, 2011)

To maximize the heat transfer medium in heat exchangers of steel pipe or aluminum shot is necessary to increase the transport section and the hydraulic pressure and water volume reduction facility. These goals can be achieved by using cores of porous materials with appropriate λ and c optimally placed inside the heat exchanger tubes. (Denis, 2008)

For drying malt plant uses geothermal water heat exchanger core of coke shown in Figure 1.

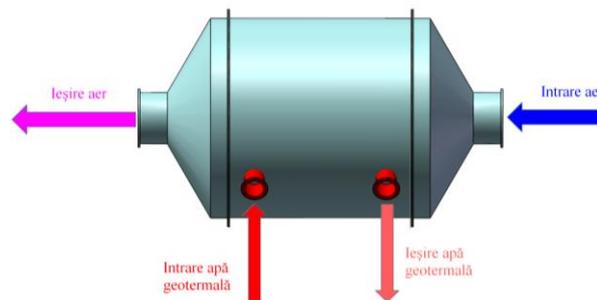


Figure 1. Heat exchanger with porous medium

This type of exchanger shown in Figure 2 consists of an insulated jacket to the outside, two baffles that are designed to swirl valve geothermal water pipes 3 and 4 foam core made of coke pore size of $0.1 \div 0.5$ mm.

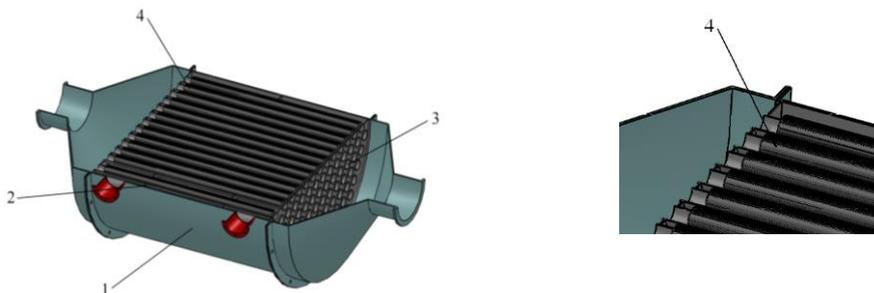


Figure 2. Section through the heat exchanger with porous medium

MATERIAL AND METHOD

Heat exchange surface area for porous media (SSP) with porosity size between 0.1 and 1 mm M^2/M^3 is 8000 while for plate heat exchangers with 4 mm distance between them (for air-liquid heat exchange) SSP is 630 M^2/M^3 porous medium, which provides a much smaller volume of the exchanger. (Iancu C, 2011)

Inlet and outlet temperature of air and water for geothermal exchanger is shown in Figure 3.

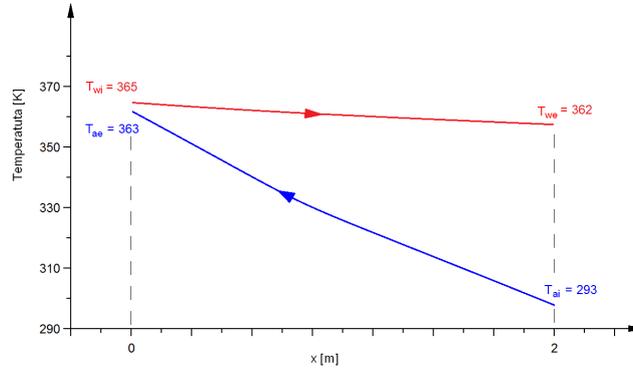


Figure.3. Inlet and outlet temperatures of air and water exchanger for geothermal

Use heat exchangers parallel beam pipes filled with coke. (Comsol 2008)

Required heat exchange surface is determined by the relationship:

$$S_w = \frac{Q_t}{\alpha_w \cdot \Delta T} [m^2], \quad S_a = \frac{Q_t}{\alpha_a \cdot \Delta T} [m^2], \quad S = \frac{Q_t}{k \cdot \Delta T} [m^2],$$

$$\Delta T = \frac{\Delta T_1 - \Delta T_2}{\Delta T_1 / \Delta T_2} [K], \quad \Delta T_1 = T_{wi} - T_{ae} [K], \quad \Delta T_2 = T_{we} - T_{ai} [K]$$

Air mass flow will be:

$$\dot{m} = \frac{n \cdot Q_t}{c_p \cdot T_{ai} - T_{ae}} [Kg / s], \quad \text{Geothermal water mass flow will be:}$$

$$\dot{m} = \frac{n \cdot Q_t}{c_p \cdot T_{wi} - T_{we}} [Kg / s]$$

For air, the relationship for calculating the convective heat transfer coefficient α_a is: (Comsol 2008)

$$\alpha_a = 0,024 \cdot \frac{\lambda_{CO2}}{d_i} \cdot \text{Re}^{0,8} \cdot \text{Pr}^{0,37} [W / m^2 K]$$

For hot water, the relationship for calculating the convective heat transfer coefficient α_w is:

$$\alpha_w = 1,72 \cdot \frac{\lambda_{ac}}{d_e} \cdot (d_{ech})^{0,6} \cdot R_e^{0,6} \cdot P_r^{0,33} [W / m^2 K] \quad (\text{Comsol 2008})$$

In these relationships, the similarity criterion Re is Reynolds and Prandtl Pr is the criterion of similarity.

At the macroscopic level is limited to solving Navier-Stokes equations by taking account of the border. Navier-Stokes's equations are a set of equations, written in the form, differential or integral, noting relations between fundamental quantities.

$$\rho C_p \left(\frac{\partial T}{\partial t} + (u \cdot \nabla) T \right) = -(\nabla \cdot q) + \frac{\tau}{S} - \frac{T \partial p}{\rho \partial T} \bigg|_p \left(\frac{\partial p}{\partial t} + (u \cdot \nabla) p + Q \right)$$

RESULTS AND DISSCUSIONS

Study techniques and computer analysis of the processes of heat transfer and flow, both aimed at using new methods and extension of methods already known and is the subject of widespread research. (Iancu C, 2011)

For analysis of porous filling the heat exchanger (temperature, heat flux, pressure drop and speed) Comsol Multiphysics to use program that allows a problem solving and post processing heat exchange.

For the porous medium, the analysis of heat flow variation highlights for each area of the section, the share of heat transfer by convection and conduction.

Value flow in Figure 4. A figure 5.și Figure 6. total stream flow is not porous medium heat transmitted from the air.

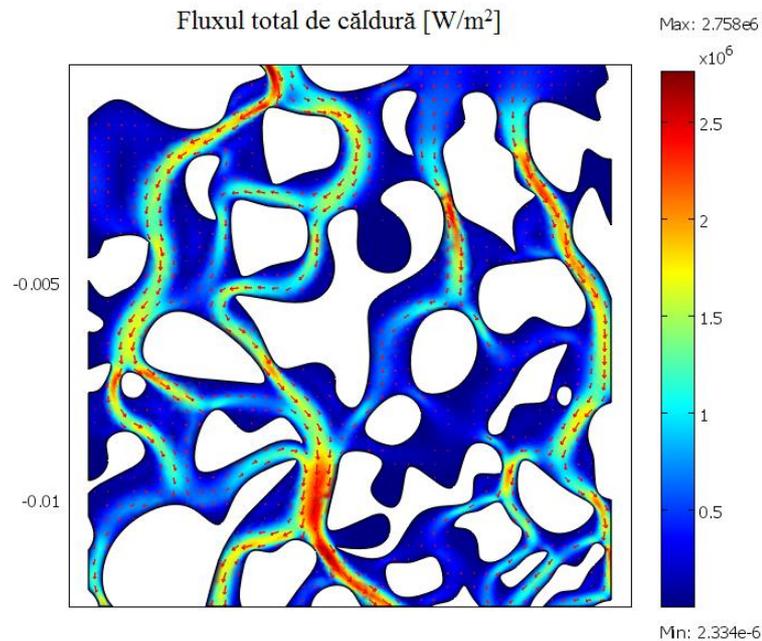


Figure. 4. Total flow of heat dispersion in porous medium

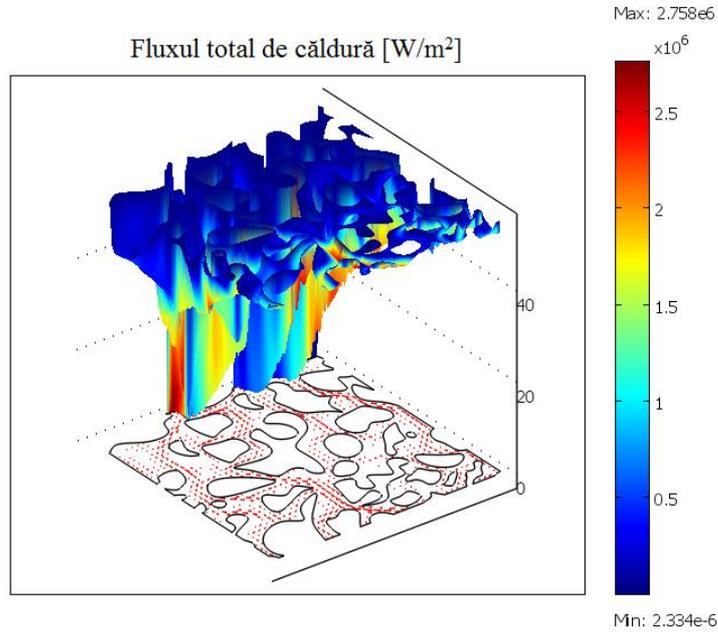


Figure. 5. 3D dispersion flow in porous medium heat total

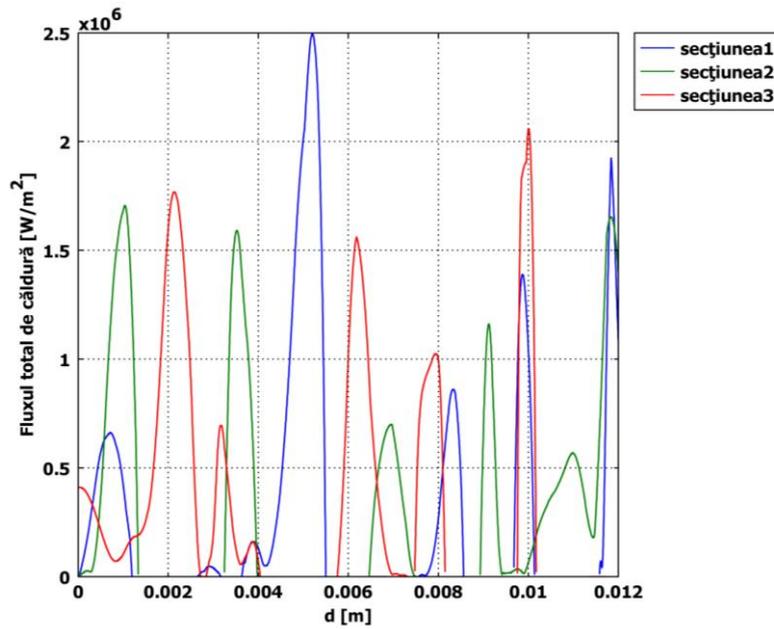


Figure 6. Diagram of variation of total heat flow in porous medium

It is noted that the total heat flow value is determined by the amount of air speed section. This is due to the weight of heat transfer by convection to the conduction.

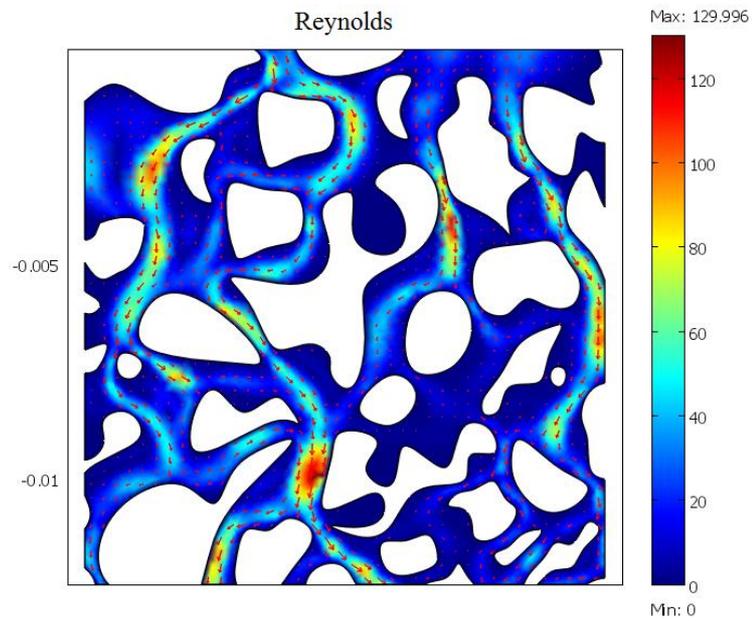


Figure 7. View Reynolds number in porous medium

It is noted that the porous medium, due to the randomness of the flow channel size and value their position, the Reynolds number is different on the same section.

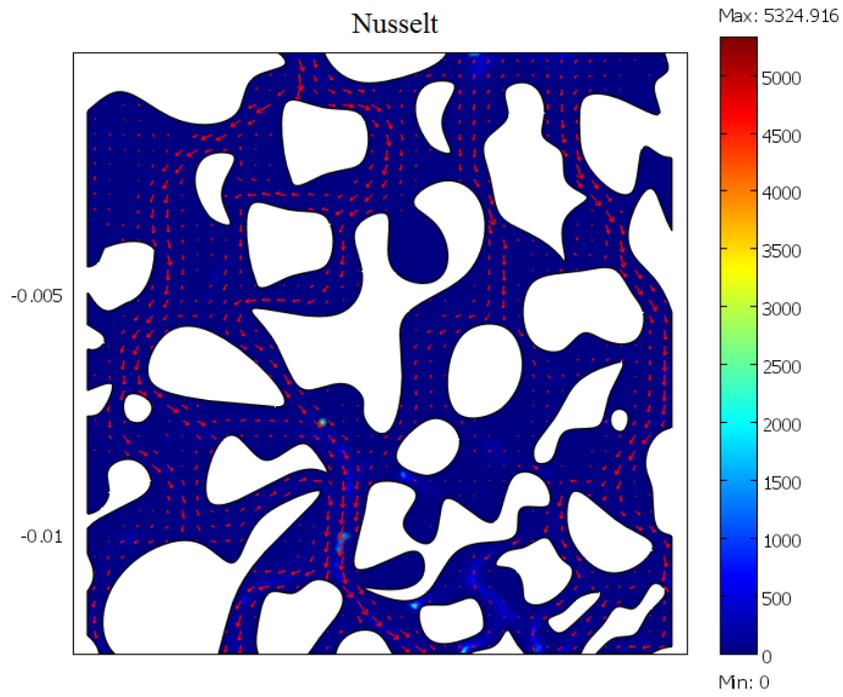


Figure 8. Nusselt number variation diagram of the porous medium

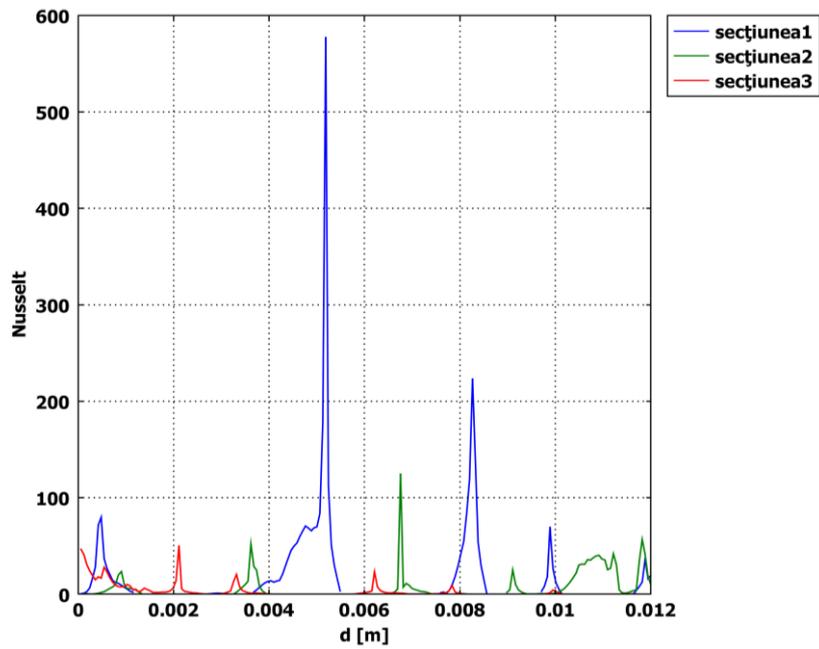


Figure 9. Nusselt number variation diagram of the porous medium

It is noted that due to large fluctuations in Nusselt number shows the speed values in a wide range (0 ÷ 600). (Iancu C, 2011)

CONCLUSIONS

Resource efficiency is a crucial issue given that resources are limited. Thus, the choice of heat exchanger is very important because the overall system efficiency is paramount and this can be done only benefit from the best technologies to minimize waste of resources. Optimizing resource consumption is a major issue in all areas of research for finding the optimal solution only in terms of technology we can achieve results in research. (Iancu C, 2011)

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