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MODELING THE HEAT EXCHANGER WHEN DRYING THE MALT WITH GEOTHERMAL WATER USING THE FUZZY CONTROLLER AT THE SYSTEM

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Abstract

This paper has proposed modeling of heat exchanger for drying malt system by adjusting the temperature and heat flow malt dryer, using fuzzy controller.
The simulation results showed that the performance control system with fuzzy controller to the classic system of drying, dry malt increase productivity by increasing speed of response and the controller's stability.

Key words: controller fuzzy, geothermal water, heat exchange, rmalt drying

INTRODUCTION

The heat exchanger is a device that realizes the heat transfer between a fluid and the environment, between which there is a temperature gradient. The functioning of the heat exchanger with the role of thermic resistance in an hot water heated installation without a phase changing with a closed circuit is continuous. At the heat exchanger with porous core the heat transfer is realized indirectly through an exchange surface (the wall of the heat exchanger permits the transfer between the fluid and the environment)

The heat exchanger functions for normal temperatures (50-150°C) being low pressure devices, the liquid that circulates through the net having a pressure of a few bars. According to the previously presented fact, in order to maximize the heat transfer towards the environment, for the steel pipe or aluminium pipe heat exchangers it is necessary to increase the A section of transport and the hydraulic pressure and also to reduce the water volume from the installation. These aims can be reached by using cores made of porous materials with appropriate λ and optimum c arranged inside the heat exchanger pipes and by arranging, in the closed interior hydraulic circuit of a small water electro pump to ensure a pressure difference necessary to the fluid circulation in a closed circuit heating installation.

The use of the normal steel or of aluminium exchangers as thermic resistances in the closed hydraulic circuit present the following disadvantages.:

- high caloric energy consumption;
- a huge volume of water that needs to be pre heated;

• a longer time to transport the pre heated water in the interior hydraulic circuit of the heating installation.

These disadvantages are eliminated if, in the geothermal water heating installations special core heat exchangers made of porous thermo rigid materials are used, exchangers that have high thermic hysteresis and which have the capacity of a thermo regulator. The physical laws and phenomena which are at the basis of the new construction of porous core thermic registers are the transport phenomena of the thermic energy, the first law of the aero dynamics, Fourier's law for thermic radiations and the law of thermic conduction (electric lectern, the law of Ohm).

MATERIAL AND METHOD

The aim of the simulation consists in establishing the characteristics of the drying system and defining some fixing component which may allow the improvement of these characteristics.

For a better understanding of how this model functions we shall proceed forward by describing the used thermic elements. An algebra or differential equation is attached to each element equation which afterwards (during the issue of the model) is included in an equation system which are solved by applying some numerical methods. In the case of this model we have chosen a method based on formulas of numerical differentiation with multiple pace, called "ode15s" also known as gear method. In the case of the thermic blocks used for modeling the following categories exist:

Blocks of thermic transfer: conductive and convective;

- Source blocks: of heat flow and of temperature flow;

Standard block of thermic inertness mass;

- Reference block;
- Block for temperature and for thermic flow measurement.

The conductive heat transfer has Fourier's at the basis and it is described through the equation:

$$Q = k\frac{A}{D}\left(T_A - T_B\right) \qquad (1)$$

I which: Q – thermic flow; k – Thermic conductivity of the material; A – normal area to the heat flow direction; D – the distance between two layers TA, TB- Temperatures on one side and on the other side of the layer, and the heat flow is considered positive if it has the direction from A to B.

The convective heat transfer block has Newton's law at the basis and it is described through the equation:

$$Q = hA\left(T_A - T_B\right) \qquad (2)$$

in which: Q – thermic flow; h - coefficient of heat transfer; A – area of the convection surface; TA,TB – the temperatures of the two environments.
The thermic mass block represents the thermic inertness of an environment (the ability of the latter to store internal energy), expressed through the relation:

$$Q = cm\frac{dT}{dt} \qquad (3)$$

in which: Q thermic flow; c – specific heat of the material; m - mass; T - temperature, t - time; the heat flow is considered positive if the mass stores heat.
The heat source blocks and the temperature source blocks are considered ideal sources of the sizes that they are defining..
The thermic reference block is the absolute zero point to which the other temperatures from the system are determined.
The flow sensor block represents an ideal measuring instrument able to measure the heat flow and the Senzor temperature block represents an ideal thermometer. Within the model the geothermal water is defined through the flow (geothermal water flow) and through temperature (geothermal water temperature).
The characteristic sizes of the geothermal water represent the entry for the group of three heat exchanger tied up in a series.
The exit from the exchangers is the temperature of the heated air (air temperature) which represents an entry in the drying sub system (Dryer). The initial temperature, the malt flow and the wet malt (tinit malt) represent entry measures in the dryer.

The cold air is represented through the sum between the air's average temperature (air's average temperature) and sinusoidal variation (air temperature variation) that models the temperature variation with an amplitude of 5 Celsius degrees and a period of 24 hours (3600 x 24 seconds). These features of the cold air represent entries in the heat recovery sub system in which the air that comes out of the dryer releases heat to cold air pumped at the entry of the recuperator.

The measures for monitoring the system are the heat temperature and flows in different stages of the process, represented by the view blocks of the evolution diagrams 9e.g (entry temperature, entry flow, etc). Each sub system includes schemes or sub systems on an inferior hierarchical level. The heat exchanger with the circulation of the fluids in counter flow has been chosen for the final variant of the drying system model. Each exchanger was modeled from four identical segments which transmit one another the working parameters. This is how the gradual heating modeling phenomenon is done as the fluids cross the heat exchanger, obtaining the addiction of the two fluids' temperature to the distance crossed in the exchanger.

Figure 1 presents the block scheme of the malt drying sub system. In this scheme the in going heat flow (supported by the hot air) is consumed at the convection between the air and the malt (number 2 source of heat) and also when the water evaporates from the malt. (number 3 source of malt). These are defined as being " cold" sources of the system.

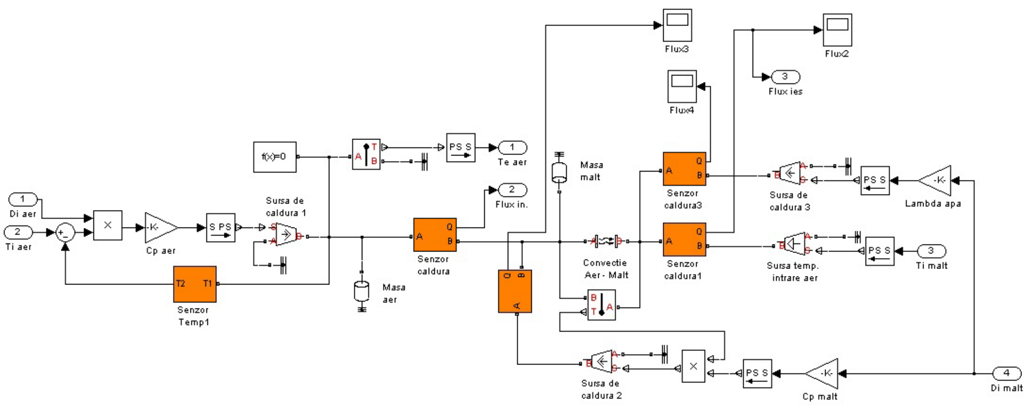

Figure. 1. The block scheme of the numerical model for the malt dryer

Figure 2 shows the scheme of the numerical model for the heat exchanger with counter side circulation of the two types of liquids

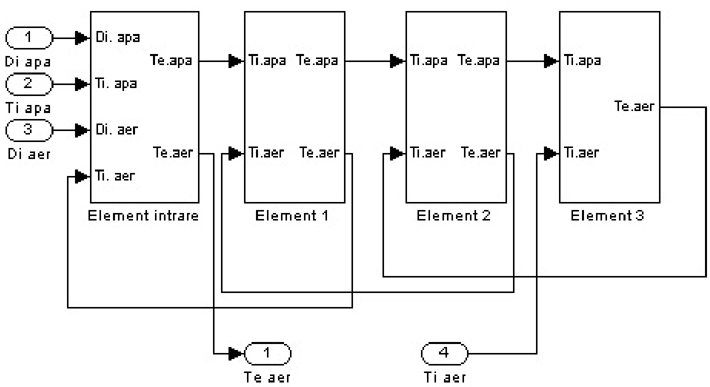

Figure 2. The general scheme of numerical model for the heat exchanger

RESULTS AND DISSCUSIONS

Monitoring system sizes are heat flows and temperatures in different stages of the process represented by block view diagrams of events (such as Temp Input, input flow, etc..).

Monitoring may be adjusting the fuzzy while viewing the simulation through the graphical user interface shown in Figure 3.

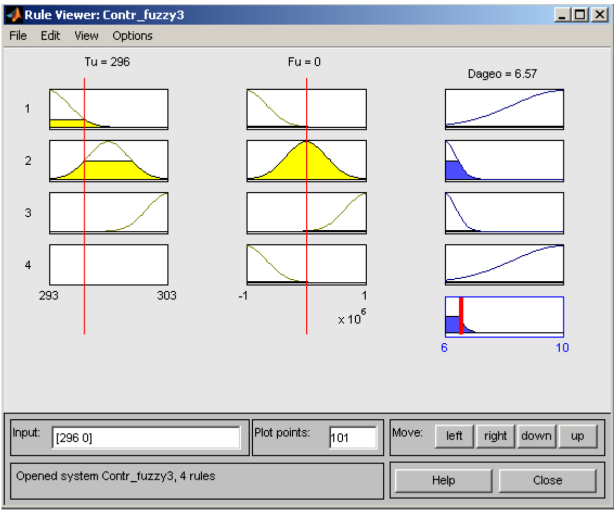

Figure 3. View drying monitoring control system with fuzzy controller

The simulation results presented as control charts quantities (temperature and heat flow out of the dryer) in Figures 4 and 5.

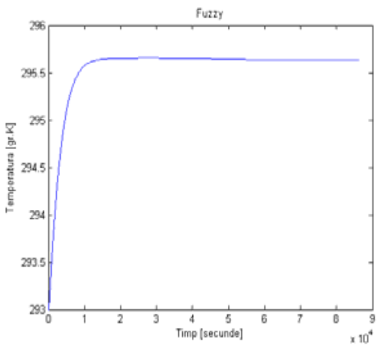

Fig. 4. Diagram from the heat exchanger outlet temperature

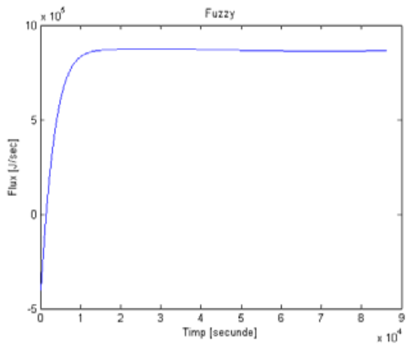

Fig. 5. Output flow diagram of the heat exchanger

CONCLUSIONS

Each exchanger was modeled from four identical segments which transmit one
another the working parameters. This is how the gradual heating modeling phenomenon is done as the fluids cross the heat exchanger, obtaining the addiction of the two fluids' temperature to the distance crossed in the exchanger.

Monitoring system sizes are heat flows and temperatures in different phases of the process represented by blocks view diagrams of events (such as Temp Input, input flow, etc.).

The chart shows an increase in productivity by 1.3 hours using this heat exchanger.

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