MODELING THE CEREAL DRYER USING GEOTHERMAL WATER AS HEATING AGENT BY APPLYING ARTIFICIAL INTELLIGENCE AS AN AUTOMATIC GUIDANCE WAY

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Abstract

This work has in view to model the guidance process of drying the cereals from the dryers using thermal water as a heating agent and appealing to the utilisation of guidance systems which use artificial intelligence through Fuzzy controllers.

The temperature of the air and the thermal flow have been measured when they got out of the dryer in order to obtain information related to the cereal drying time, their humidity and the quality of the dried cereals.

The experimental measurements have been done on an industrial dryer at SC Nutrientul Palota in September 2013, a dryer meant for cereal drying. The exit temperature when coming out of the dryer is 4500 seconds at drying system without adjustment and 2400 seconds at drying system with fuzzy adjustment.

From comparing the experimental data with the simulation data it comes out that the cereal drying system with Fuzzy controller is much more efficient.

Key words: cereals, dryer, geothermal water, artificial intelligence, fuzzy controller, automatic guidance

INTRODUCTION

The weak point in drying the cereals has proved to be the high consumption of energy used to eliminate a high content of water from the cereals and so, once the world energetic crisis has shown up the cereal drying activities have also strongly reduced (Hashemi, Mowla, et al., 2009).

The newly world wide issued and developed preoccupations related to finding technical equipment solutions with high efficiency of the electric power consumption or utilisation to such an aim of some alternative regenerating sources of energy, especially of geothermal energy have brought back the drying of cereals using the geothermal water (Pantea, Rosca, et al., 2010, Elena Zierler 2008).

In the world wide practice, the utilisation of the geothermal energy as an alternative source of energy can be of great importance. (Tester, Anderson et al., 2006, Lund 2000, Romocea, et al., 2012). This fact is true especially in the countries where there is a high geothermal potential. (C. Pantea, G.M. Rosca, et 2010, Elena Zierler 2008, Tester et al., 2006). The major contribution to the development of the specific technological equipment in the utilisation of this type of energy (drilling, pumps, transport equipment, chemical treatment of the fluid, heat switchers, etc) is realized in the technologically advanced countries such as USA and the west European countries.

The industrial utilisation of the geothermal energy is still at the beginning in Europe. Still, the existence of some geothermal fields as well as the insufficient resources of conventional energy represent the challenge for future investigations in this domain. The quality of the geothermal resources available in Europe dictates the utilisation of this type of energy in the technological processes that use low temperature. These processes are significantly present in different industry fields, the preoccupation for their diversification being totally legitimate. (Tester, Anderson et al., 2006, Lund 2000). In what the technologies of using the energy of geothermal waters is used there is the tendency to develop utilisations which are less polluting, utilisations which can ensure maximum output and high economical efficiency with a minimum consumption of energy in order to obtain complex processes.

The expansion, during the last decades of the numerical command systems has added extra advantages to the systems that use the energy of the geothermal waters. The researchers' attention from the automatization field has headed to the study of some aspects capable to contribute to a better elucidation of what the guidance process means and, on the other hand of the technological possibilities offered by this process. (Bara 2001, Bennet, 1994, Popescu, et al., 2001, Volosencu 1997, .Villegas 2009, López, et al., 2007)

All these are arguments in emphasizing the idea that nowadays the research related to the automatic guidance processes of the systems are necessary and desirable (Borangiu, Dobrescu, 1986, Curtis, 1988, Dionissios P. Margaris et 2006, Dorf, Bishop, et al.,1998).

For the time being the control of the grain drying process is in expansion and it is successfully used in countries like Japan, which is also a market leader in this field, then it is used in China, Spain, U.S.A and also in Romania, etc, following to obtain some superior quality parameters.

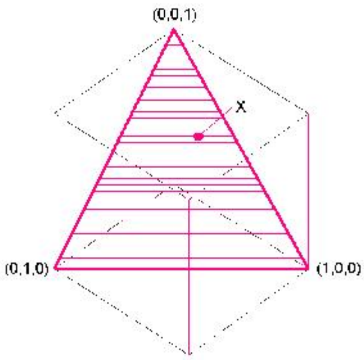

Fig. 1. Kosko's cube (Bara, 2001)

„The Kosko cube" presented in figure 1 suggests the difference between the exact logic and the fuzzy logic in dealing with problems. (Bara 2001, Bennet 1994, Popescu, et al., 2001, C. Volosencu 1997, Javier A.Villegas 2009, López A., et 2007)

The preferred objective of the fuzzy logic is represented by the controllers from the structure of automatic systems. (Ilhan Kocaarslan, Ertuğrul Çam et, 2006,). A fuzzy controller is programmed with rules like an expert system but the rules are more flexible.

MATERIAL AND METHOD

In order to obtain the data necessary to validate the numerical model for drying the cereals with geothermal after experimental measurements have been done on an industrial dryer at SC Nutrientul Palota in September 2013, a dryer meant for cereal drying.

The temperature of the air and the thermal flow have been measured when they got out of the dryer in order to obtain information related to the cereal drying time, their humidity and the quality of the dried cereals.

In this way one can check if the numerical modeling of the cereal drying with geothermal water using the fuzzy controller can be considered correct and the results of the numerical simulation are validated by the experimental data.

Fig. 2 Industrial dryer model "Strahl" FR from SC Nutrientul Palota

Experimental measurements have been done in what the relative humidity is concerned (RH%) and in what the exit temperature of the air from the dryer is concerned, on an industrial dryer of the type „STRAHL"FR like in figure 2 from SC Nutrientul Palota, having the following characteristics:

• air flow of 1050 m3/h;

• cereal flow of 500 kg / 3-4 minutes;

The dryer is supplied with 40 tons of cereals. The supply is continuous as the cereals are unloaded. The drying programmer is done from a PLC, where the drying temperature from within the dryer can be set as well as the unloading time. Every 4 minutes a quantity of 700 kg of cereals is dried in order to obtain a humidity of cereals below 14%. The dryer has got temperature sensors which measure the air temperature inside the dryer and outside the dryer displaying these temperatures on the PLC's screen.

After the dryer's period of time has expired then malt begins to be unloaded in the silo. Cereal samples are prevailed in order to determine their humidity. The final humidity has been checked with the Granomat humidity meter which is homologated for the determination of the humidity content.

The structure of the system is in fact a steady way of organization of some elements interconnected on the basis of the relations existent between them and of the restrictions imposed by compatibility. The whole system perfectly reflects the interaction with the outside environment.

In the practice of adjustment with fuzzy logics, many times there appear problems related to the elimination of static stages or to the oscillations at exit. The answer is considered admissible if it fits within the imposed quality indicators.

The linear models of the system are idealized models, made only for a simple analysis and design. In practice, there are no linear systems due to the fact that physical systems are not linear.

The processes are described through models with relations between the entry and exit signals. The modern systems of guidance are numeric guidance systems which use microprocessors.

The action of the fuzzy controllers should be similar to the human being one when the latter has to control a system for which it is important to know the way it interacts in different situations. It seems clear enough that making a decision is made on an actual situation and on the experience of the operator in controlling the respective process.

The operator appreciates the estate of the process through the angle of the sizes which interest him/her and which s/he then transposes into linguistic terms (qualitative appreciations) and the decision which rules is according to the degree in which this situation is close to a previously existent situation from the database. In order to replace the human operator in the control process it is necessary to introduce a new block in the adjustment scheme which might be capable to understand the relevant control units of the human operator.

RESULTS AND DISSCUSIONS

The dryer, that the experimental research has been performed on, is divided in two floors, and on these floors there are also two overlapping zones as in the plane dryers. The overlapping vertical layers are separated with the help of some clacks so that the enamel layer can be transported from one superior floor to an inferior one. The whole drying installation is situated in a vertical tower like building. The heated air is mixed with the freshly cooled air and is set in each drying zone according to the temperature and content of humidity.

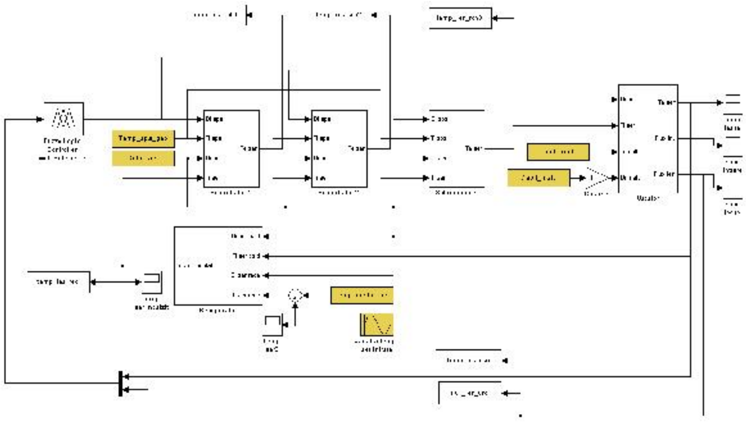

Fig. 3. The block scheme of the numerical model for the drying system with fuzzy controller

When studying the regulation characteristics of the drying system, it is necessary to release a numerical model like in figure 3, which has the capacity to simulate the functioning of the cereal dryer as well as of its thermo dynamic features. In order to do this we have decided to use a simulation programmer through which one can determine the thermic elements (conduction, convection, temperature sources and thermic flow sources) as well as the connections between these.

The thermic processes are correlated within the numeric model so that they reflect the characteristics of the real system.

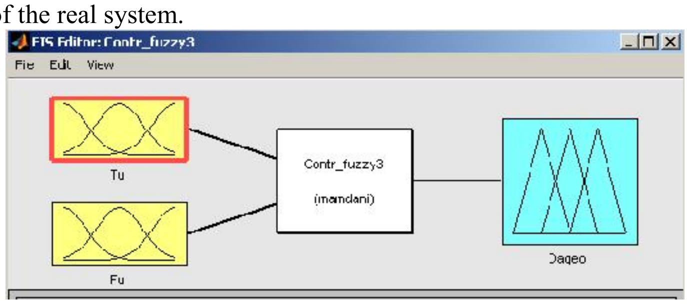

Fig. 4 The editing file for the adjustment system

The editing file presented in figure 4 is launched through the fuzzy command. The main window has got three menus on the main command bar through which all the development and management commands of the system are ensured.

By accessing the graphical elements of the fuzzy system the interfaces corresponding to the apartenance functions open for the entry variables and for the exit variable presented as well as for the interface for editing the rules.

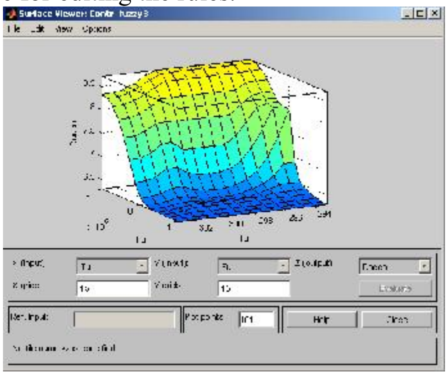

Fig. 5 The decision surface

The answer of the system is graphically presented in figure 5 through a 3D representation under the form of a decision surface.

The Surface Viewer window is interactive in the sense that it allows the orientation with the help of the mouse, of the surface representation trihedral, different points of view being possible.

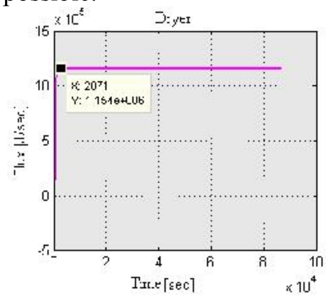

Fig. 6. a. The variation diagram of the thermic flow at the Fuzzy controller adjustment

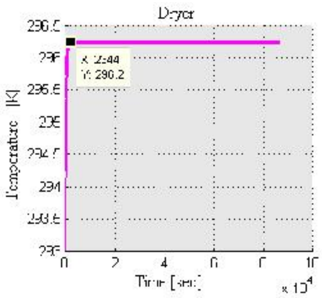

Fig. 6. b. The variation diagram of the exit temperature at the fuzzy controller adjustment

After the simulation programmer, the following diagrams have been obtained like in figure 6 a and 6 b.

From the diagrams obtained after the simulations for the drying systems without adjustment and with fuzzy controller we have obtained the stabilization time presented in table 1.

Table1

Results mesure

Stabilization time [seconds]	**Drying system without adjustment**	**Drying system with fuzzy adjustment**
Stabilization time for the diagram; The exit mperature when coming out of the dryer the drye	4500	2400
Stabilization time for the diagram exit flow when coming out of the dryer.	4600	2800

CONCLUSIONS

In order to test the way in which the simulation of the cereal drying with fuzzy controller is supported by experimental measurements we have done a comparative analysis of the measured values with the simulated ones. The values refer to the temperatures of the air when it got out of the dryer and to the thermal flow when it got out of the dryer, too. In order to compare the measured values with the simulated ones we have calculated the values of the temperature and of the thermal flow resulted after the simulation program corresponding to the unloading times. It means that we have calculated the temperatures and the flows corresponding to those 150, 180, 210, 240, 270 seconds.

The differences between the simulated values and the measured ones for the exit temperature of the air and for the thermal flow when it got out of the dryer can be justified as follows:

The experimental system has not got the control to adjust the temperature of the air when it gets out of the dryer and of the thermal flow either. The dryer used for experimental research adjusts the temperature from the inside of the dryer and the unloading time thus the final humidity of the cereals is not controlled but it is obtained through many trials and time experience.

The exit temperature when coming out of the dryer is 4500 seconds at drying system without adjustment and 2400 seconds at drying system with fuzzy adjustment. From the comparison of the experimental data with the simulation data, it comes out that the cereal drying system with Fuzzy controller is much more efficient.

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