

## USING SIMULINK/MATLAB TO SIMULATE THE BEHAVIOR OF A MELTING AND DRYING OF FLAX AND HEMP CENTER DURING A TYPICAL WINTER DAY OF THE BIOLOGICAL PHASE

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**Abstract.** In order to check the correctness and the functionality of the model that we have created in Excel, this paper presents the simulation of the operation of the flax and hemp retting and drying center, in winter conditions, for one day within the biological phase.

### 1. Introduction

The mathematical model has been developed in Excel and it has certain advantages, emphasized by its running under different conditions, but for the practical analysis of the global action of the center, certain limits of the Excel programming environment are also underlined.

For instance, the described model reflects a perfect automation of the system; that is, we can say that a variation of the environmental conditions will lead to an immediate variation of the geothermal water consumption. In real equipments, delays appear based on the chosen automation type. In order to be able to analyze and predict the real action, we need to develop a model in a program which allows the study of non-linear phenomena as well. We have chosen as a working environment the MATLAB [2], [3], software, the center model being developed within the Simulink software package. The basis for the development of the model in Simulink is the mathematical model written in Excel. Unlike Excel, where the solving of the differential equations is difficult to do, if not even impossible, Simulink can simulate even the non-linear action of the constituting elements of the processing center.

The model that we have created in Simulink for the technical crops processing center is also a linear model, that is, a model having a perfect automation [1]. Working in the Simulink environment allows nevertheless a subsequent development of a non-linear extension which reflects the influence of the delays caused by the response of the real regulators, of the tap driving elements, of the non-linearity of the heat exchange, etc. This field can be one of the directions that this thesis can open for future studies. Moreover, the creation in the first stage of a linear system similar to the mathematical model previously developed can help us confirm the correctness of the created sub-models, by comparing the results of the partial simulations to the results of the different series of lines in Excel. Finally, the curves that we will obtain using the linear model in Simulink/MATLAB, in the **scope** blocks, will have to be similar to the series of curves obtained using the Excel software, which will confirm the correctness of the model in Simulink.

As principles for the construction of the model in Simulink we can mention: the storage of the physical data of the designed elements (geometrical dimensions, layout, materials, number of pieces, etc.) of the designing phase. These can be changed if we want to obtain the simulation of the action of a similar model which is slightly different from the designed one; the preservation of the capacity of the software to decide the size of the accepted batches; the modeling of each heat exchanger in part; perfect and immediate automation; for running the simulation, the same sinusoidal variations are used for the environmental parameters; for the subsequent development, the possibility of integrating a

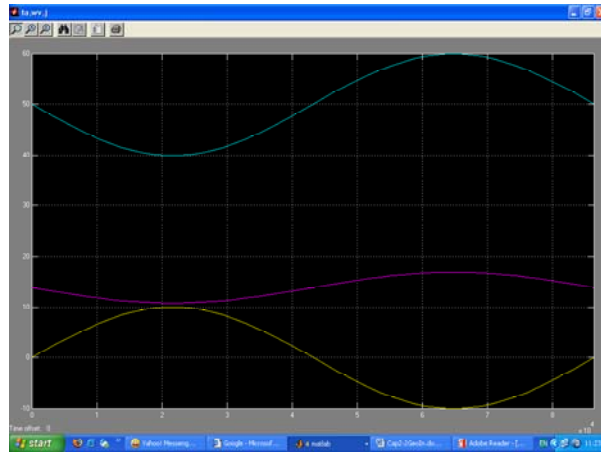
## 2. Running the Simulation in the Winter Season and Results Presentation

As we can notice in the figure, there is a series of source blocks, which represent the input sizes: environmental parameters (air temperature and humidity, wind speed), geothermal water flow and temperature at the well, the imposed temperature for the retting water in the tanks, the number of days of a production cycle, the suggested size for the batches in the current cycles, as well as information on the season and on the priority of the drying process as opposed to the retting process (or the other way round), when resources are not enough for both (see the Excel mathematical model).

394

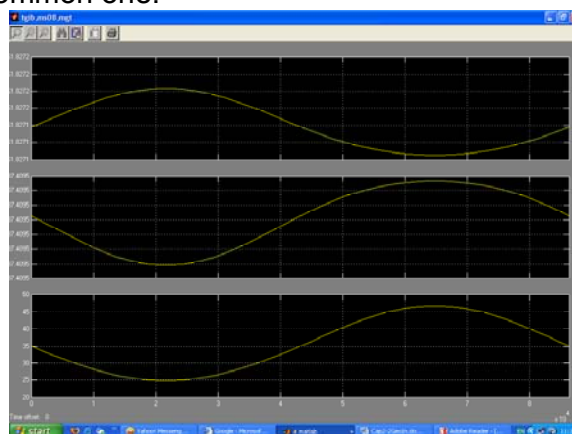
water at the level of the air preheater. The output sizes of these blocks are emphasized using some display blocks – for the fixed sizes, such as the values accepted for the batches and those redirected to the next cycle – respectively some scope-type blocks for the graphical presentation of the time variations of the different interest sizes, consumptions, temperatures, etc.

We have fixed the simulation period to one 1 day = 24 h = 86,400 seconds. The obtained results were graphically represented using four **scope** blocks, as follows: in figure 2, the variations of the environmental parameters are given (air temperature and humidity and wind speed) for a typical winter day; in figure 3, the variations of geothermal water consumption at the retting tanks and at the drying tunnel are grouped, as well as the output temperature at the drying tunnel radiators; in figure 4, the diagrams of the geothermal water consumption at the preheater are given, as well as the output temperature of this water and the temperature of the used water which leaves the center; and in fig. 5, the deviation angle of the blades and the secondary agent flow are represented.



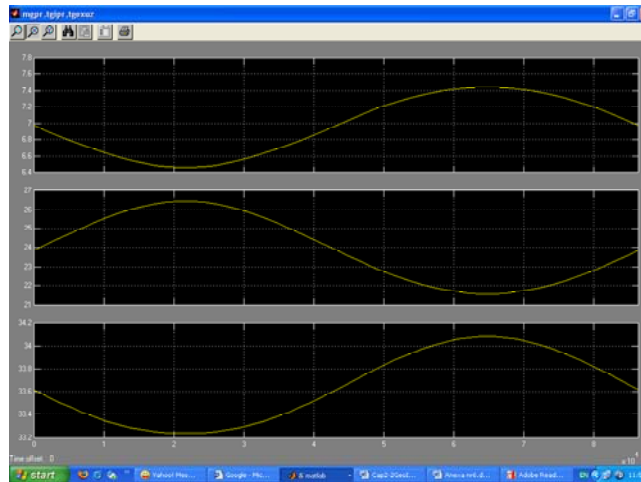
**Figure 2. Results of the Running for the Variation of the Environmental Parameters**

We have chosen that the input should be of a vector type, so that the three curves have the same y axis – that is, the same scale, even if the measurement units are different ( $^{\circ}\text{C}$  – for temperature, m/s – for wind speed and % - for relative humidity), and they are represented in different colors. The **scope** block does not allow multiple axes for a vector size, so we preferred that the other **scope** blocks have several scalar inputs, so that we could fix the scale for each size in part. Each size will be represented using its own y axis, the x axis being the only common one.

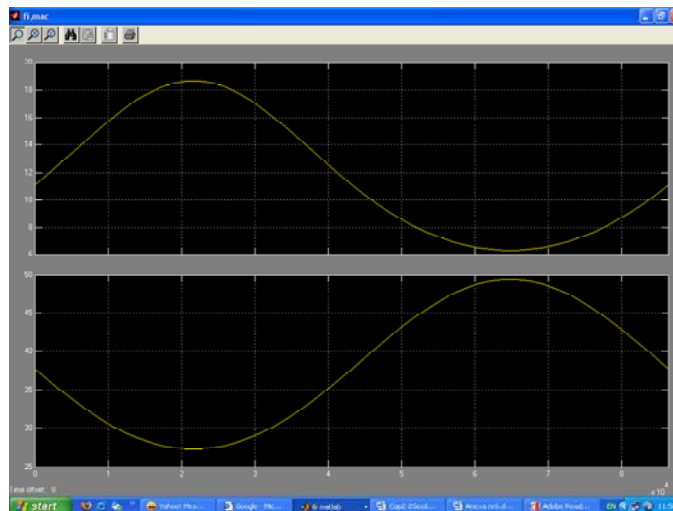


**Figure 3. Results of the Running for the Variation of the Consumptions during Retting and Drying**

In figure 3, the three sizes, a temperature and two flows are all represented in yellow, but in three different fields. The *autoscale* option – for the automatic fixing of the scale on the y axis – of the **scope** block makes it look like we have the same curve for the flows, but if we read the numerical indications on the y axes, we will see that the curves are, in fact, different. If the two flows had been represented at the same scale, then the consumption curve during the drying process would have practically been a straight-line, the variations being very small.



**Figure 4. Results of the Running for the Variation of the Consumption at the Preheater and of the Output Temperature of the Geothermal Water in the Preheater and the Center**



**Figure 5. Results of the Running for the Variation of the Secondary Agent Flow and of the Shutter Blades' Rotation Angle**

However, in figure 5 we can see that as compared to the curves obtained in the Excel software, the curves obtained following simulation in Simulink/MATLAB are more even, they do not show discontinuous variations of the gradient, because Simulink is dedicated to simulation and has a much more efficient internal solver than the user functions written in Visual Basic for Excel (the convergence is finer). In order to obtain the same degree of evenness of the curves, the iteration rate of the functions in Excel should be even smaller, and the recalculation time of the worksheet would be considerably higher.

### 3. Conclusions

In conclusion, the simulation of the flax and hemp processing center (for the *winter* season) has lead us to the same results as the mathematical model developed in Excel, which **confirms the correctness of the model developed in Simulink/MATLAB**. Moreover, the curves obtained following simulation in Simulink are more precise and more even than the ones obtained using the model written in Visual Basic for Excel. The simulation (for permanent, non-transitory conditions) in MATLAB lasts for 2 or 3 seconds, but in Excel, the recalculation of the entire worksheet may last for more than 30 seconds, which is a net advantage to the simulation in MATLAB.

Which is even more advantageous for the model in MATLAB is the fact that it can subsequently adapt to different developments by writing new sub-models, including a block-sub-model for the description of the non stationary processes, based on the solutions chosen for the automation of the center. In Excel, such a module is difficult to write and even more difficult to run; the recalculation of the sheet can reach very high time intervals, while in Simulink/MATLAB it will remain at values of the order of seconds.

### References

1. Indrie, L.: Paper on the doctoral dissertation: "*Contribuții privind utilizarea cu eficiență sporită a căldurii din apele geotermale la topirea și uscarea inului și a cânepii*" ("Contributions Regarding the More Efficient Use of Geothermal Water Heat for Flax and Hemp Retting and Drying"), Oradea, 2004;
2. Muraru, C.,V.: *Metode numerice. Seminarii Matlab*, Editura EduSoft, Bucuresti, 2005.
3. Ogata, K: *Solving Control Engineering Problems With Matlab*, Prentice Hall, New Jersey, 1993;