RESEARCH ON THE DESIGN, REALIZATION AND EXPERIMENTATION OF AN INNOVATIVE MODEL OF GRAIN DRYER

Petru CÂRLESCU, Vlad ARSENOAIA, Radu ROȘCA, Ioan ȚENU

[1]"Ion Ionescu de la Brad" University of Agricultural Sciences and Veterinary Medicine of Iasi, Faculty of Agriculture, 3 Mihail Sadoveanu Alley;700490 Iași, România

INTRODUCTION

Artificial drying of agricultural seeds ensures conditions for their preservation while by reducing the water content of seeds, it is possible to keep them for long periods of time, without the need of complex storage facilities. During the drying process, both moisture and a significant amount of heat are lost, resulting in high energy consumption. Recovery of lost heat from the used drying agent was achieved in an innovative model of the vertical dryer so that the energy consumption of the drying process was reduced.

CFD (Computational Fluid Dynamics) simulation in innovative vertical dryer uses heat and mass transfer mathematical models, and the results presented are the distribution of drying agent temperature and temperature in the seed layer.

The results obtained by the CFD simulation of the dryer have an error of ± 5% against the experimental determinations, which is an accepted level in the heat transfer field.

MATERIAL AND METHODS

Designing the innovative vertical dryer for agricultural seeds requires several steps: sketch, CFD simulation, 3D drawing, execution and experimentation. If the results of the process correspond to the initial requirements of the project (a high energy efficiency vertical grain dryer), the project is implemented. If these requirements are not met, the process is resumed from the start.

The innovative vertical dryer model with heat recovery for seed grain drying has complex execution geometry, but for CFD simulation it is simplified so that it is possible to define and visualize the internal flow regions of the drying, and heat transfer (Fig. 1).

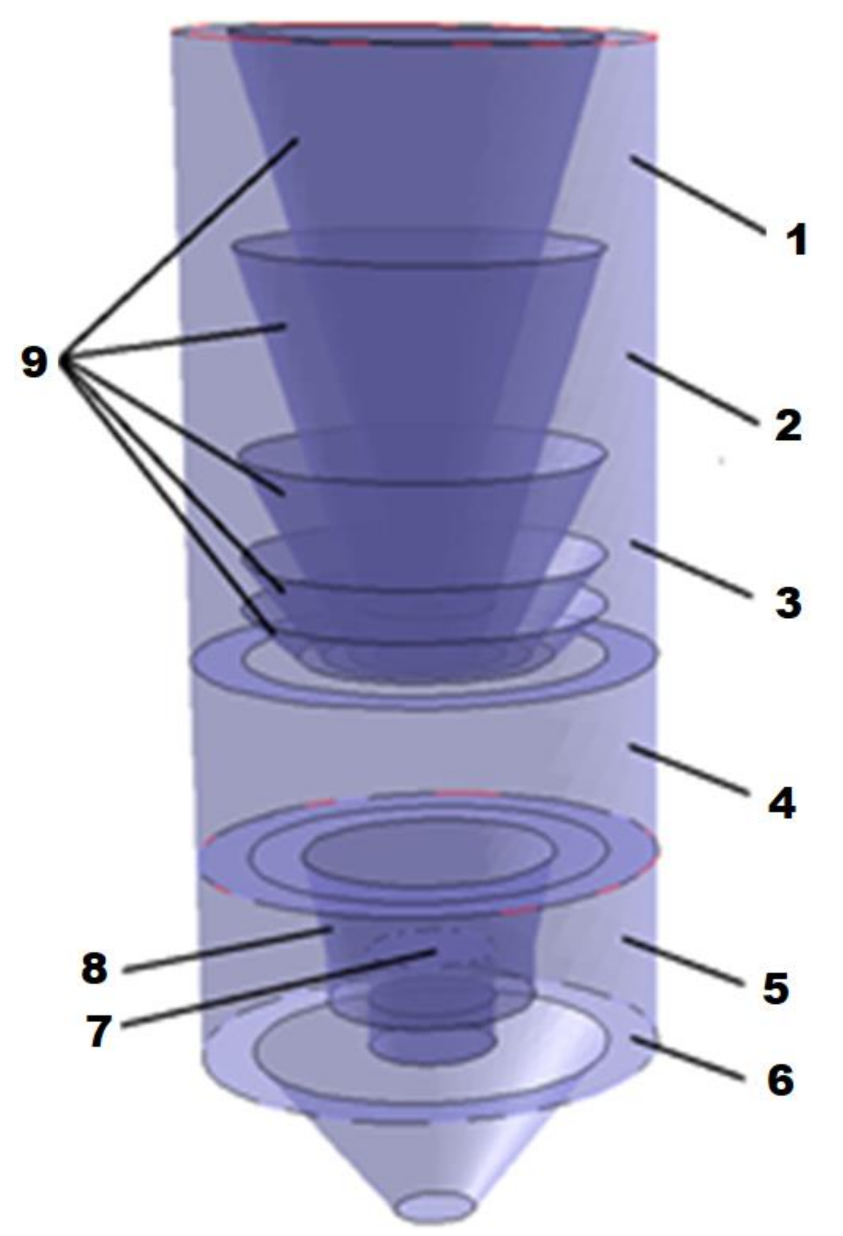

Figure 1. Innovative vertical dryer geometry 1, 2, 3 drying sections; 4, 5 cooling sections; 6 grain seed layer; 7 warm air inlet for drying; 8 nozzle; 9 deflector cones.

The mathematical model for heat transfer is given by the energy equation based on the first principle of thermodynamics of energy conservation. The abbreviated form of this equation is:

$$\rho \frac{DU}{dt} = \frac{\partial Q}{\partial t} + k\nabla^2 T + \Phi$$

where: U is the internal energy, t time, Q term heat source, k coefficient of thermal conductivity, T temperature, Φ the term dissipation.

The amount of maize seed introduced into the dryer was 660 kg. Corn seeds had a moisture content of 19% at the beginning of drying and at the end of drying they reached an average humidity of 14%. The drying velocity of the seed layer on the three drying sections had an average value of 2 m/s.

RESULTS AND DISCUSSIONS

The temperature gradient distribution on the drier vertical section has shown in Fig. 2. The two regions can be distinguished vertically from the dryer: the upper drying region where the average temperature is 53°C, decreasing from top to bottom, and the cooling region at the bottom where the temperature is 27°C.The temperature in the hot air inlet area for drying is 80°C. Experimentally, a temperature transducer was introduced into the three drying regions, and after 25 minutes of operation, the temperature obtained in the drying region was 48.6°C, and in the cereal seed cooling region was 23.3°C.

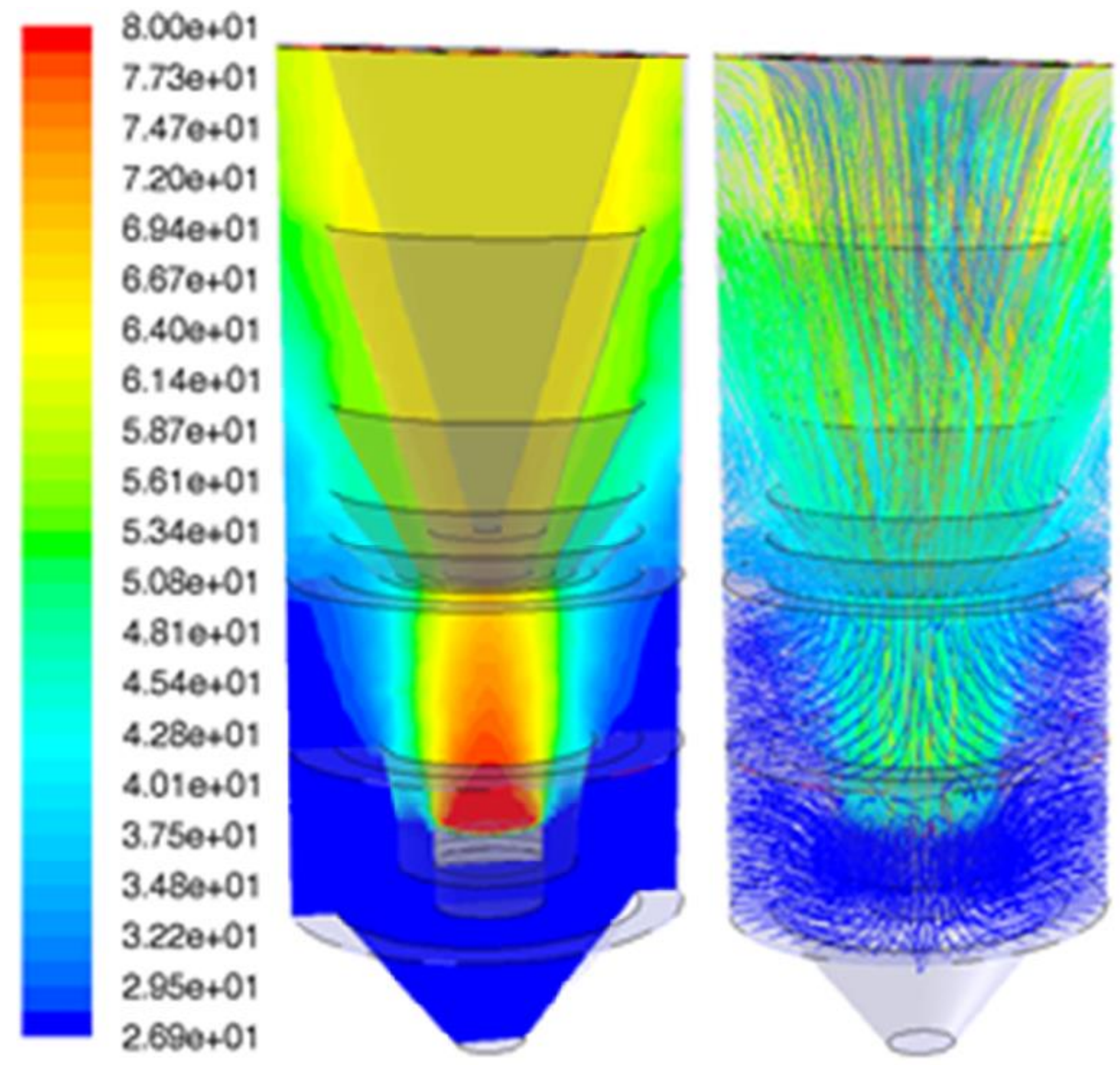

Figure 2. Temperature field and pathlines in the vertical dryer (°C)

The average power consumption per dry corn seed unit was 0.033 kWh/kg.

Dryer power consumption when operating with corn seeds

Dryer parts	Electrical power (W)	Operating time (h)	Energy (kWh)
Pneumatic fan + Lock	2.873	0.25	0.718
Fan + Heater Air Battery	21.582	1	21.582
		Total energy	**22.300**

CONCLUSIONS

- By using the innovative vertical dryer model, energy consumption per unit dry product is reduced by 6-10% and the drying time decreases by 10-15%.

ACKNOWLEDGEMENT

This work was supported by a grant of the Romanian National Authority for Scientific Research and Innovation, CNCS/CCCDI – UEFISCDI, project number PN-III-P2-2.1-PED-2016-1357 within PNCDI III, contract number 18 PED/2017.