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INNOVATIVE MODEL OF VERTICAL DRYER FOR CEREAL SEEDS

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INTRODUCTION

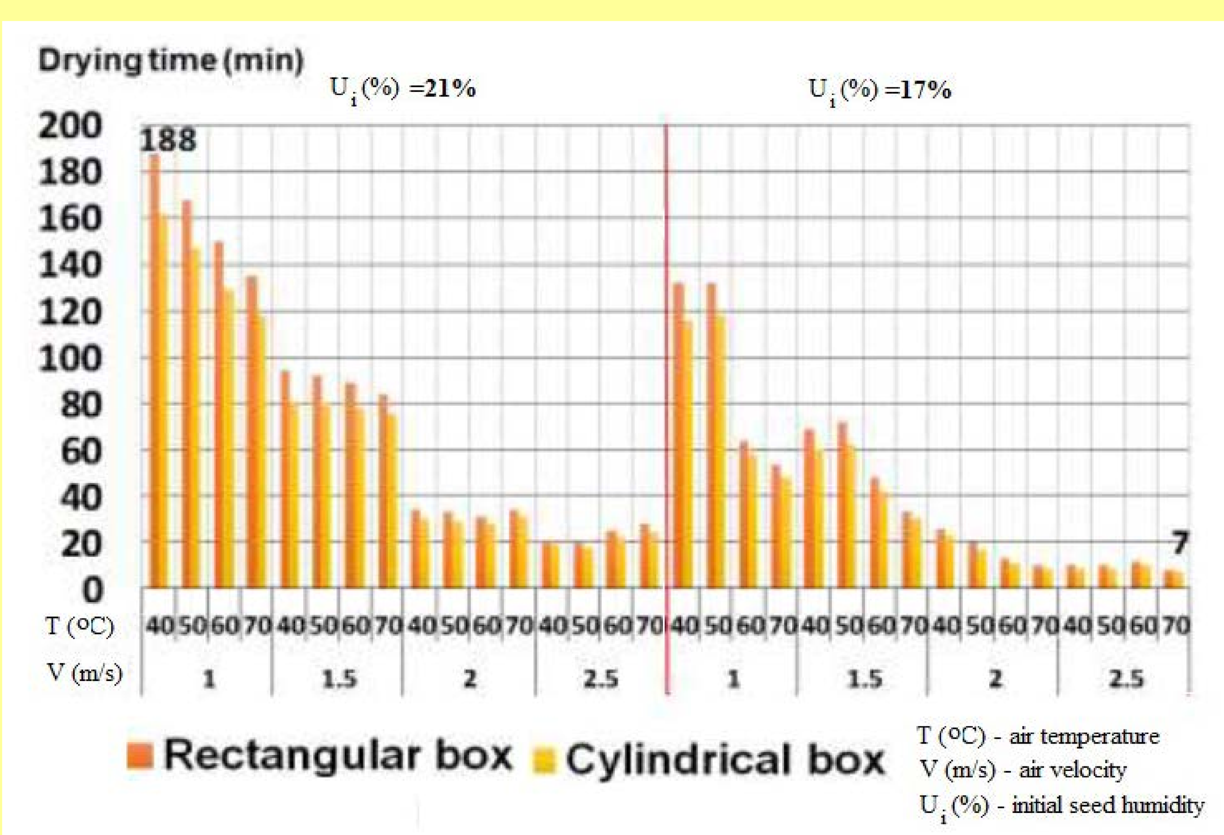
Reducing post-harvesting loses contributes to the increase of food safety and depends on threshing, cleaning, drying and depositing seeds. Drying represents removing moisture so that it allows seeds depositing for long periods, as well as satisfying the quality conditions the quality conditions imposed for seeds destined for consumptions or sowing, thus adequately responding to handling and processing.

Drying is the most intense energy process in the food industry. That is why, in the case of seed dryers, it is necessary to manage the thermal regime thoroughly by knowing their technical and functional parameters. Reducing energy consumption and ensuring high quality, with minimal increase in economic inputs, have become the targets for the continuous modernization of these machines.

Several mathematical modelling and simulations were conducted in order to identify and determine a series of specific parameters based on which was dimensioned and designed the innovative *Model of vertical dryer with heat recovery (MIUV-0)*.

METHODOLOGY

In order to estimate and track the evolution of temperature and moisture fields over time at any point of the product layer (cereal seeds) subjected to the drying process, a mathematical model was developed using CFD (Computational Fluid Dynamics) simulation and a laboratory dryer, which can be equipped with two drying boxes: rectangular or cylindrical. The process of drying cereal seeds is carried out by convection, the heat being brought into the layers of material, through the means of hot air (the drying agent). Once it enters the cereal mass, mass transfer (water) begins from the inside of the product towards its surface, where the evaporation phenomenon occurs. During the drying process, moisture decreases continuously, following complex variation laws.



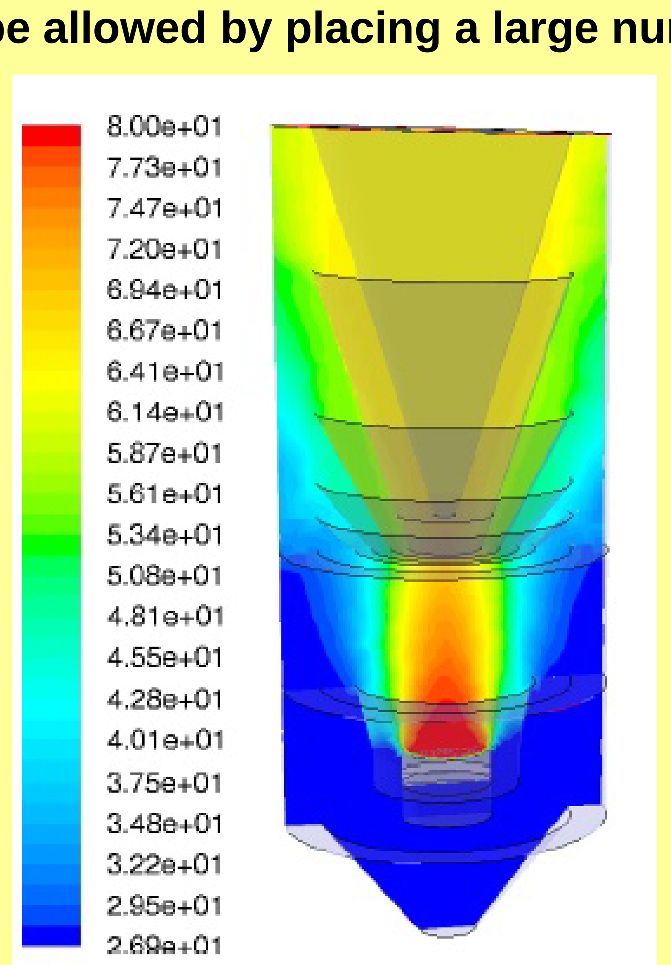
Variation of drying time for cereal seeds (wheat)

For the cylindrical case, the current lines of thermal agent obtained had a laminar flow at the entrance to the box, and the thermal agent had a uniform distribution in the layers of seeds subjected to drying along the cylindrical sieve. This had favorable consequences in terms of the drying time, which was of a lower duration as well as on the uniformity of drying. For cereal seeds is not recommended to use aggressive drying conditions, characterized by high temperatures and low moisture content of the drying agent, because they negatively influence the initial quality of the material, expressed mainly by the gluten content. The values of the temperature, the relative moisture of the drying agent and its speed (parameters of the drying regime) influence both the drying process and the quality of the material to be dried.

Based on mathematical modeling, the use of experimental data and CFD simulations, calculations were performed (energy balance, pneumatic transport, sizing, resistance, etc.) for a cereal seed dryer with heat recovery, modulated, of cylindrical shape. The hourly heat quantity required for the operation of the installation was evaluated, dimensioning the air current generating ventilator, the system for heating the medium, the pneumatic system for feeding the seed dryer and the supporting frame elements were evaluated.

After evaluating the execution documentation, MIUV-0 was constructed. In order to solve the heat flow and heat transfer problems inside the vertical drier, the CFD simulation method was used. The complex construction geometry of the innovative vertical drying model with heat recovery for drying cereal seeds was simplified for CFD simulation, so that the inner flow areas of the thermal agent and the transfer of heat that occurs during drying can be visualized.

The dimensions of the dryer used in the CFD simulation were identical with those of the built-in model, and the simplifications of the vertical drier geometry did not influence the physical phenomena occurring during the drying process (height - 3 m, diameter - 1 m, layer thickness - 0.1 m, module height - 0.4 m; Φ hot-air inlet -0.2 m) [8]. CFD simulation allowed the temperature fields to be drawn in point of the vertical dryer (a), which would not be allowed by placing a large number of temperature transducers.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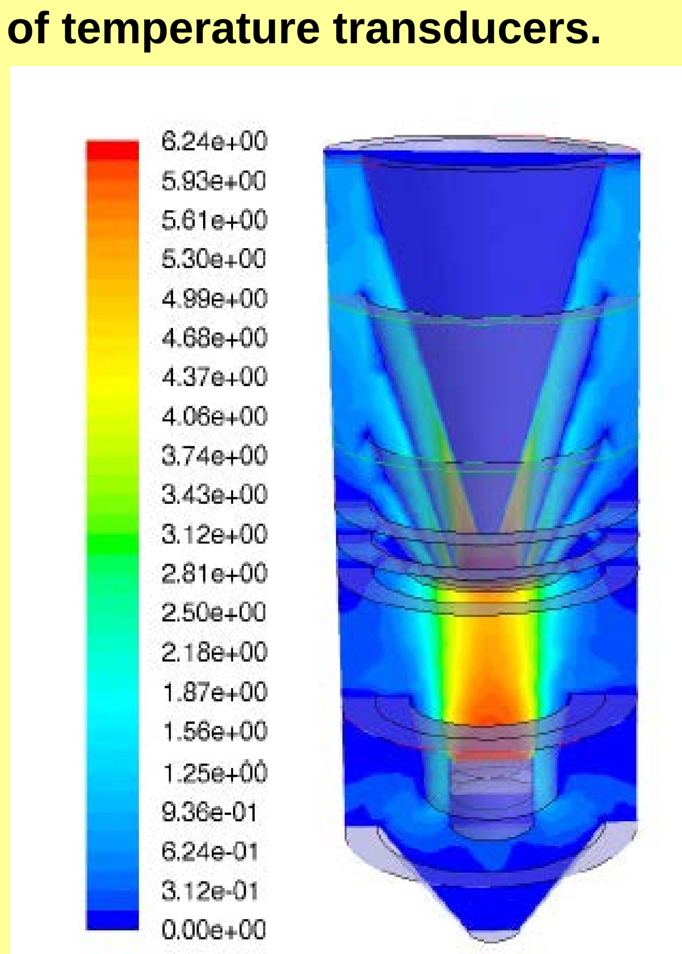
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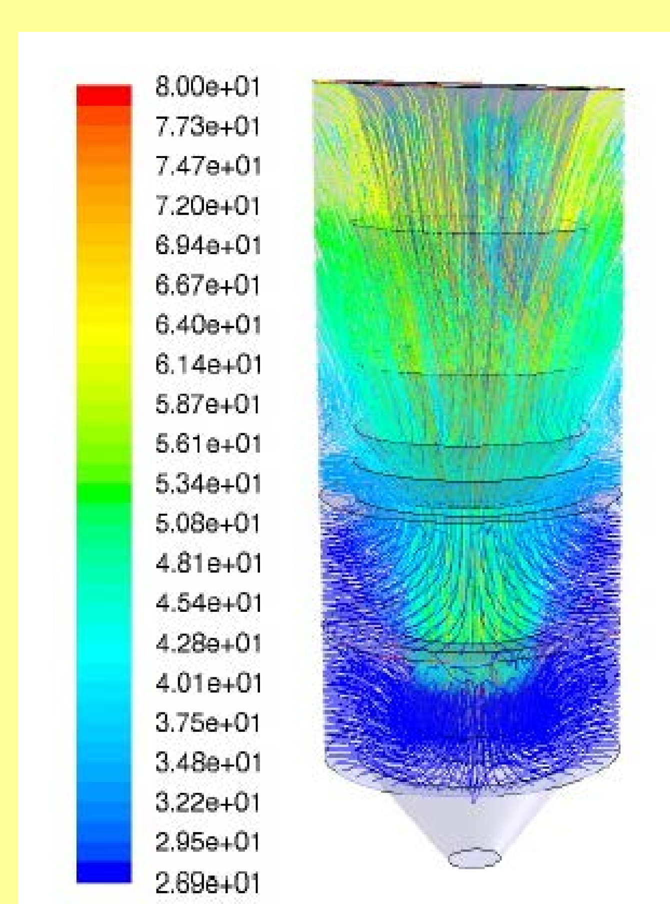
c

By introducing the five cones inside the drier, air velocity distribution in the three drying zones became uniform, and the velocity vector was directed from inside the drier to the outside (b). In the two cooling regions at the bottom of the drier, the insertion of the injector made it possible to orient the velocity vector from the outside to the inside by absorbing the cold air from the atmosphere to cool the cereal layer. The air velocity at the entrance of the dryer was 6 m s-1, and in the cereal layer was 1...2 m s-1.

Innovative model of vertical dryer with heat recovery

The distribution of current lines from the exterior and the thermal agent inside the vertical dryer (c) shows the role of deflector cones and of injector nozzle formed inside the drier. By the construction formation of the injector and by placing it in the lower part of the dryer, a local pressure drop occurs, leading to the absorption of air from the atmosphere through the two lower cooling regions of the dryer, causing cooling of the dried cereals. Thus, part of the heat they accumulated through the drying process was recovered and reintroduced into the dryer's general circuit. The temperature obtained by CFD simulation had an error of ± 5% compared to the experimental determinations, representing an acceptable level in the heat transfer domain.

CONCLUSIONS - Following the CFD simulations on the pilot installation, the calculations and the design, a modular *Innovative Vertical Dryer Model* with heat recovery was developed, equipped with heating / cooling agent equalizing devices. Modulated construction offers the possibility of assembly and adequate adjustments inside the dryer, at the level of devices for temperature and velocity parameters uniformity. The development of the machine contributes to the development of research in the field of additional devices for guiding airflow towards the cereals layers, because vertical driers that are currently available on the market, are not provided with such endowments.

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