DESIGN OF AN INNOVATIVE EQUIPMENT HYBRID DRYING FOR CEREAL SEEDS

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INTRODUCTION

The design of the innovative hybrid dryer model, with microwaves and convection for dehydrating agricultural seeds, started from the concept, which aimed to achieve quality drying of agricultural seeds in the shortest possible time. The main challenge of the project was that the design of the innovative model could be carried out at the lowest possible cost, and after the execution to achieve the proposed technical performances for drying cereal seeds. For this, it was necessary to adopt a modern design strategy, in which mathematical modeling, Multiphysics simulation, laboratory model experimentation and the execution design of the hybrid drying equipment are combined. The small-scale experiments aimed to determine power and time parameters necessary for microwave drying of cereal seeds, so that they retain their integrity at the end of drying. The mathematical modeling and Multiphysics simulation of the hybrid drying equipment started from a 3D geometric model, which was simultaneously subjected to combined CFD-DEM-EM (Computational Fluid Dynamics - Discrete Element Method – Electromagnetic) simulations, introducing a series of experimentally obtained data. The data obtained from the simulation and their analysis led to the dimensional completion of the project and the execution of the innovative equipment for hybrid drying of cereal seeds.

MATERIAL AND METHODS

The design strategy of the innovative hybrid dryer model requires as a first step before execution, that the 3D geometric model of the hybrid dryer is numerically simulated, applying several combined mathematical models (multiphysics): CFD (calculation of fluid dynamics for hot air flow and thermal transfer), DEM (discrete element calculation bidirectionally coupling the flow of the thermal agent and agricultural seeds) and EM simulation by coupling the distribution of electromagnetic waves and their thermal effect on agricultural seeds, (figure 1).

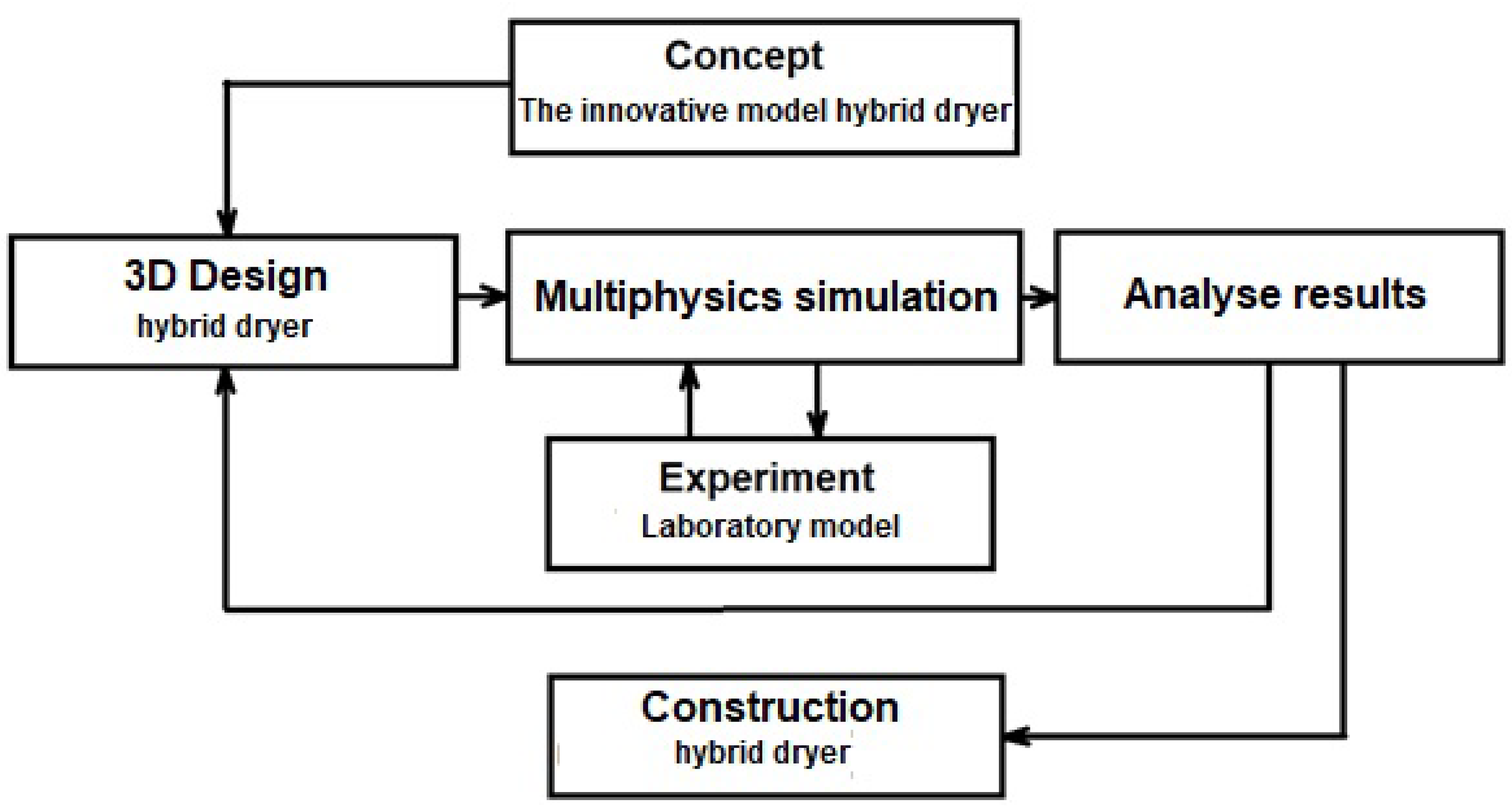

Figure 1. The design strategy of the innovative hybrid dryer

In order to increase the accuracy of the simulation, an experimental pre-test stage was necessary, previously carried out on laboratory models, in order to accurately establish the input parameters in the numerical simulation, such as: the drying time of different agricultural seeds that determine the duration of the truncated cone dryer by seeds; the maximum warm air temperature that determines the maximum drying temperature of the seeds; the power level of the high-frequency currents for drying depending on the type of seeds and their initial moisture, which determines the power and number of antennas required for drying; the initial moisture and the final moisture of the seeds which determine their mass in the simulation upon entering the dryer; different physical and electromagnetic parameters of agricultural seeds during drying, which determine in the simulation the input functions for specific heat, thermal conductivity, electrical permittivity, etc. In parallel with the simulation for the design and execution, analytical calculations were made regarding the mass and energy balances.

RESULTS AND DISCUSSIONS

Technically, the hybrid drying plant is designed for dehydrating agricultural seeds, being presented as a whole through two views, made in a covered space. They help to assemble and position the component parts of the drying equipment. The design and execution of the hybrid dryer has been made so that it can be assembled and disassembled easily, occupying a small space, useful requirements for small and medium grain producers.
Schematic of the innovative hybrid dryer equipment through high frequency and convection currents for dehydrating agricultural seeds, (figure 2, figure 3).

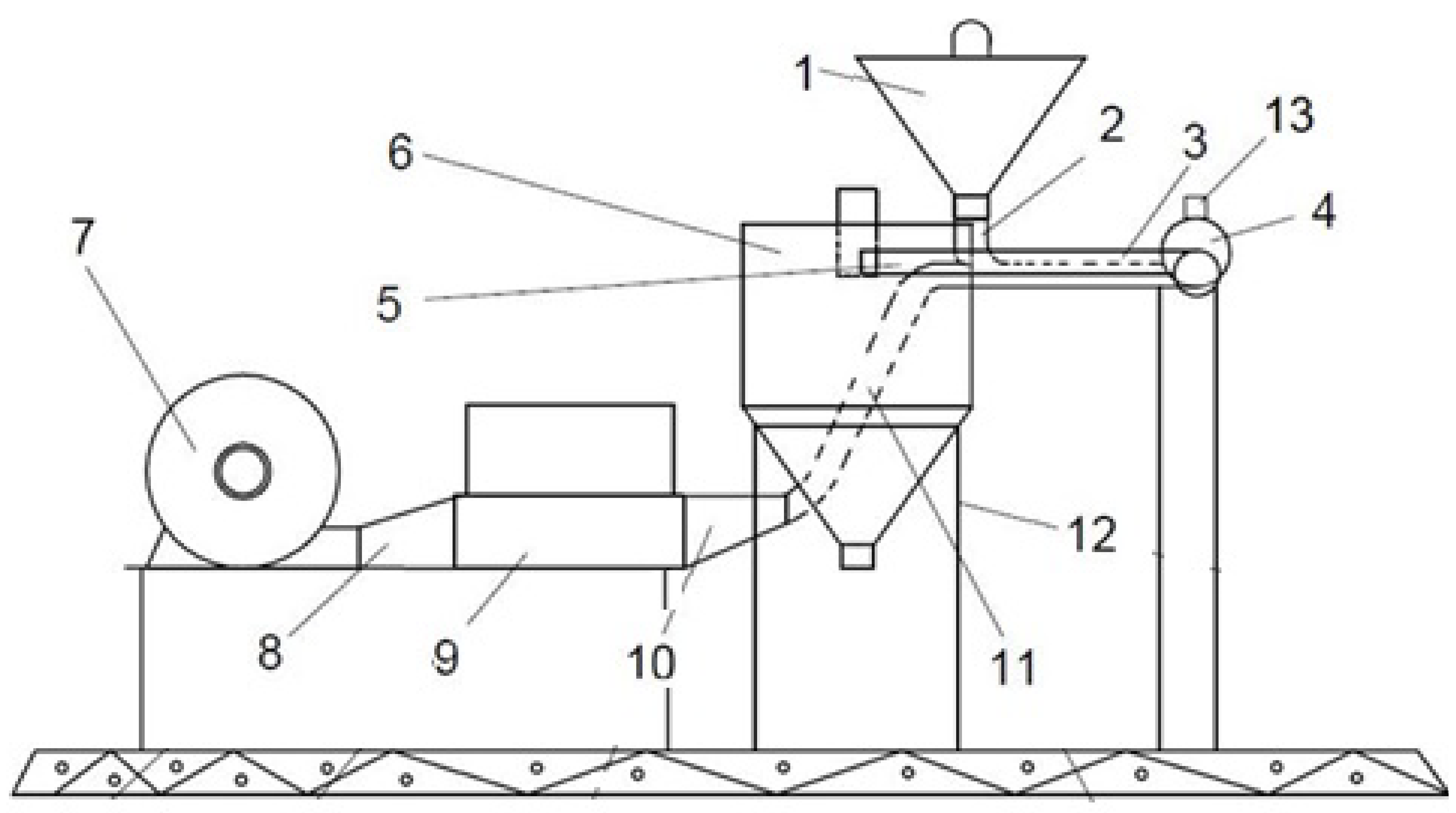

Figure 2. Schematic of the innovative equipment hybrid dryer for drying seeds (left side view)

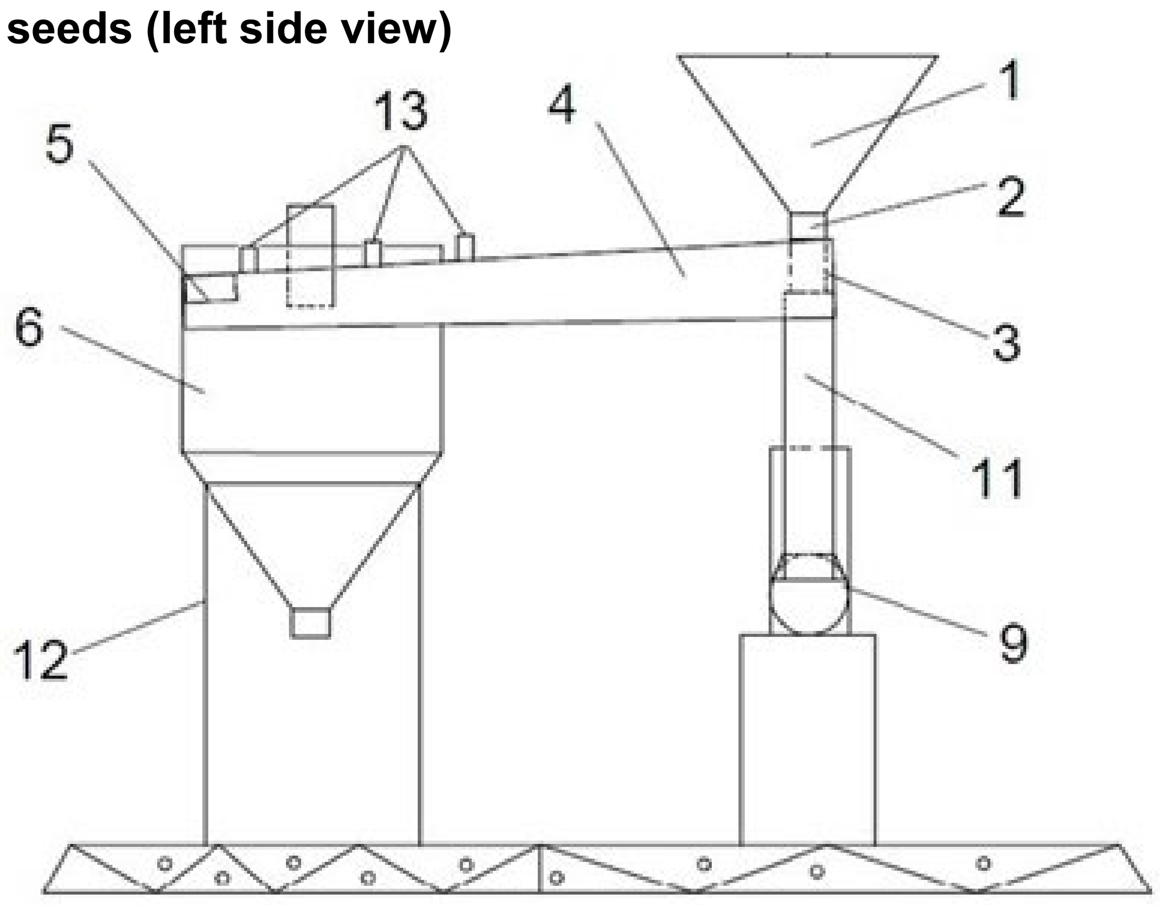

Figure 3. Schematic of the innovative equipment hybrid dryer for drying seeds (front view)
(1 wet seed hopper; 2 lock; 3,5 pipelines; 4 hybrid truncated cone dryer; 6 cyclone; 7 fan; 8,10 link pieces; 9 air heating battery; 11 hot air pipe; 12 support brackets; 13 antennas)

CONCLUSIONS

- By using a modern design strategy and using the modern computational technique it was possible to design an innovative equipment for hybrid drying of cereal seeds.

ACKNOWLEDGEMENT

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