INCREASING THE EFFICIENCY OF THERMAL AGENT DISTRIBUTION IN TUNNEL DRYING INSTALLATIONS

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The food industry involves a wide range of processes applied to the transformation of raw materials, among which drying represents a fundamental thermal treatment for agro-food products.

Introduction. Food dehydration preserves quality and extends shelf life, but traditional tunnel-type drying installations suffer from exceptionally high thermal energy consumption. A primary driver of this inefficiency is uneven aerodynamic distribution inside the chamber, causing localized over-drying or under-drying of agro-food products. This study focuses on improving the thermal and aerodynamic uniformity within the drying chamber by designing a specialized mechanical airflow distribution device.

Material and Methods. A 3D model of the proposed distribution mechanism was engineered using SolidWorks software. Individual structural elements were designed within the "Part" environment, accounting for aerodynamic constraints, and subsequently compiled using the "Assembly" module to ensure structural integrity. The kinematic behavior, structural pathing, and mechanical clearances of the distribution mechanism were simulated and evaluated using the "Motion Study" integrated tool.

Results and Discussion. The developed 3D mechanism actively regulates airflow dispersal across the entire cross-section of the tunnel geometry. Dynamic control over the air stream is achieved by adjusting the relative geometric positions of the main connecting rod and the crank system. The simulation verified that the continuous motion of the mechanism prevents the formation of stagnant zones and boundary layers of humid air around the product trays. By modifying the kinematics of the system, heat agent velocity and volumetric flow rate are balanced evenly throughout the internal drying volume. This spatial homogeneity drastically reduces uneven drying rates across different sectors of the tunnel load. Consequently, optimizing the aerodynamic trajectory of the thermal agent minimizes the total processing time required to reach safe moisture thresholds, resulting in a calculated reduction of the installation's overall thermal energy demand.

Conclusions. The integration of a mechanical distribution device successfully solves the problem of thermal stratification in drying tunnels. Ensuring a uniform flow profile directly enhances the thermal efficiency of the dehydration process. This system contributes to the sustainable advancement of food preservation equipment by lowering energy footprints while maintaining strict product quality standards.

Keywords: *aerodynamics, dehydration, food preservation, kinematics, solidworks simulation, thermal energy*

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