

Production of High-Quality Dried Agricultural Products Based on Modern Technologies in Pneumatic Drying Equipment

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Abstract: Agriculture plays an important role not only in food supply but also in preserving natural resources, processing, and long-term storage. In Uzbekistan, improving the efficiency of agriculture and enhancing product quality requires the implementation of modern technologies and innovative approaches. Pneumatic drying equipment (aerodynamic drying) is one of the most effective methods for this purpose, as it allows products to be dried with high quality and relatively low energy consumption.

Keywords: Pneumatic drying (aerodynamic drying), modern technologies, automation, energy efficiency, intelligent systems, multi-stage drying, recuperative systems.

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The Process of Pneumatic Drying

Pneumatic drying equipment is a technology based primarily on the efficient control of airflow and temperature. This method allows adjustment of airflow and temperature according to the characteristics of the product being processed. In pneumatic drying, the product is placed in an airstream, where moisture is maximally removed, resulting in high-quality drying.

The main stages of the pneumatic drying process are as follows:

1. **Product feeding:** Agricultural products (e.g., fruits and vegetables, meat, dairy products) are fed into the airflow.
2. **Airflow effect:** A high-speed stream of air is directed at the product, initiating the drying process.
3. **Moisture evaporation:** Under the influence of temperature, moisture from the product evaporates into the airflow and is removed.
4. **Parameter control:** The drying process is monitored and optimized by adjusting temperature, humidity, and airflow in stages.

Advantages of Pneumatic Drying

Key advantages of pneumatic drying equipment include:

1. **High-quality drying:** Enables quick and precise drying, preserving the moisture balance and minimizing changes to product composition.
2. **Energy efficiency:** Consumes less energy compared to traditional drying methods.
3. **Preservation of natural flavor and aroma:** Maintains the organoleptic properties (aroma, taste, appearance) of the product.
4. **Intensive process:** Accelerates the drying process and increases production capacity.

Modern Technologies in Pneumatic Drying

Modern technologies applied in pneumatic (aerodynamic) drying focus on improving product quality and energy efficiency. New technical and technological solutions are introduced to make the drying process faster and more effective. These technologies help preserve product quality, reduce energy consumption, and optimize the production process.

Intelligent Systems and Automation

Modern pneumatic drying units are widely equipped with intelligent and automatic control systems. These systems allow real-time monitoring of the drying process, including temperature, humidity, and airflow parameters. When additional drying or corrective actions are needed, automatic systems make timely adjustments.

Advantages of this technology:

- **Automatic control:** Airflow and temperature can be adjusted based on the type of product.
- **Real-time monitoring:** Parameters such as temperature and humidity are monitored automatically, ensuring efficient process management.
- **Improved efficiency:** Minimizes manual intervention and reliance on human supervision.

Energy Efficiency

Modern pneumatic drying equipment may incorporate new energy sources and technologies to improve energy efficiency. For example, multi-stage drying and recuperative energy systems are used.

Multi-stage drying:

- This method gradually increases air temperature, starting from low to high, which contributes to energy savings.

Recuperative energy systems:

- Special recuperators are used to recover hot air from the drying process. These systems help reuse heat, improving energy conservation.

Advantages of these technologies:

- **Reduced energy consumption:** Recycles used hot air and energy.
- **Long-term operation:** Multi-stage drying helps lower energy consumption over time.

Accelerated Drying Methods

Modern pneumatic drying equipment also uses accelerated methods such as micro-pulse addition and vacuum drying. These methods help speed up the drying process and preserve organoleptic properties.

Micro-pulse addition:

- Enhances high-speed drying by combining airflow with product agitation during the process.

Vacuum drying:

- Uses reduced air pressure and controlled high temperatures to ensure accurate and energy-efficient drying.

Advantages:

- **Fast and efficient drying:** Significantly accelerates the drying process.
- **Quality retention:** Preserves product characteristics with lower energy use.

Integration of Drying Systems

Modern pneumatic drying methods can be integrated with other technologies. For example, systems powered by solar or biogas energy can be combined with automatic control systems.

Advantages of integration:

- **Renewable energy sources:** Alternative energy options can be used in the drying process.
- **Improved efficiency and capacity:** Modern systems improve production capacity and sustainability.

Nanotechnologies

The use of nanotechnologies in pneumatic drying allows for the formation of micro-coatings, proper moisture distribution, and improved process accuracy. This results in better structural integrity and resource savings.

Advantages:

- **Improved product structure:** Nanomodeling enhances product quality.
- **Preservation of microstructures:** Maintains the natural characteristics of the product.

Electromagnetic Applications

Electromagnetic technologies are being introduced as a new method in pneumatic drying. These systems affect molecules through electric fields to accelerate moisture removal. Electromagnetic drying acts directly on the product surface, simplifying the moisture elimination process.

Advantages:

- **Controlled airflow:** Electromagnets help manage airflow uniformly.
- **Preservation of aroma and flavor:** Helps retain sensory characteristics of the product.

Conclusion

Modern technologies in pneumatic drying significantly contribute to maintaining high-quality agricultural products and improving energy efficiency. Intelligent systems, energy-saving approaches, accelerated drying methods, and nanotechnologies support product preservation and production process optimization. Thus, modern pneumatic drying technologies are an effective tool for further advancing the agricultural sector.

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