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RESEARCHING OF ONION POWDER DRYING WITH NON-CONVENTIONAL ENERGY SOURCES

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ABSTRACT:

This article examines the innovative use of non-conventional energy sources, such as solar, biomass, and geothermal energy, in enhancing the onion powder drying process. The study highlights the environmental, economic, and energy efficiency benefits of these renewable energy sources and explores the challenges and opportunities in integrating them into the food production industry. By evaluating the advantages and limitations of each energy source, the article provides insights into how sustainable drying practices can improve the quality of onion powder while reducing the industry's carbon footprint and operational costs.

INTRODUCTION. The demand for onion powder has steadily increased due to its convenient use in food processing, seasoning, and spice industries. However, the traditional methods of drying onions, which typically rely on electricity or fossil fuels, are energy-intensive and have significant environmental impacts. As the world shifts towards sustainable practices, alternative energy solutions are gaining attention. Non-conventional energy sources, including solar, biomass, and geothermal energy, provide an eco-friendly and energy-efficient means of drying agricultural products, including onions. These methods offer numerous advantages, such as reduced environmental impact, lower operational costs, and a more sustainable drying process. This article explores the innovative use of non-conventional energy sources in the onion powder drying process, highlighting their benefits, challenges, and potential applications in the food industry.

The conventional drying process for onion powder typically involves the use of electric or gas-powered dryers. While these methods are widely used, they consume large amounts of energy, leading to high operational costs and significant carbon emissions. In addition, the quality of the final product can be compromised by the excessive use of heat, which may alter the flavor, color, and nutritional content of the onions. As a result, there is a growing need to explore more sustainable and energy-efficient alternatives for onion drying that minimize environmental impact while maintaining product quality.

Solar energy is one of the most widely used non-conventional energy sources for drying agricultural products. Solar drying works by harnessing the power of sunlight to heat the air and facilitate moisture evaporation. This can be done through passive solar drying (exposing products directly to sunlight) or active solar drying systems (using solar collectors, fans, and ducts to improve airflow and heat retention).

- Low operational cost after installation
- Environmentally sustainable, with minimal emissions
- Reduces dependency on non-renewable energy sources
- Weather dependency, making it less effective in cloudy or rainy regions
- Large land area required for solar drying setups

Biomass energy involves using organic materials, such as agricultural residues (e.g., wood chips, crop waste), to produce heat for drying. Biomass drying systems are particularly effective in rural areas where biomass resources are readily available. These systems offer a reliable heat source, are relatively low-cost, and contribute to reducing waste.

- Advantages:
  - Utilizes waste materials, helping reduce environmental pollution
  - Renewable and sustainable
  - Available year-round, unaffected by weather
- Challenges:
  - Requires a steady supply of biomass materials
  - Installation and maintenance costs may be higher than solar systems

3. Geothermal Energy

Geothermal energy uses heat from beneath the Earth’s surface to provide a constant and stable heat source for drying. Geothermal drying systems are well-suited for regions with geothermal activity and can provide consistent temperatures that are ideal for drying onions effectively without fluctuation.

- Advantages:
  - Provides a reliable and continuous heat source
  - Low environmental impact and minimal emissions
  - Can be integrated into existing infrastructure in geothermal-rich areas
- Challenges:
  - Geographically limited to areas with geothermal resources
  - High initial setup cost and installation complexity

Comparison of Non-Conventional Energy Sources

While solar, biomass, and geothermal energy all offer significant benefits, the choice of energy source largely depends on geographical location, available resources, and financial feasibility. Solar energy is ideal for sunny regions but may not work as efficiently in areas with frequent cloud cover or limited sunlight. Biomass energy provides a reliable option in rural areas where agricultural waste is abundant. Geothermal energy, although highly efficient, is location-specific and requires significant upfront investment.

In many cases, a hybrid approach that combines these energy sources could optimize the drying process. For example, solar energy can be used as the primary heat source, with biomass or geothermal energy providing supplemental heat during overcast weather or during the colder months.

Advantages of Non-Conventional Energy Sources in Onion Drying

- Environmental Benefits: Using renewable energy sources significantly reduces the carbon footprint associated with onion powder production. This contributes to sustainability by lowering greenhouse gas emissions and minimizing reliance on fossil fuels.
- Energy Efficiency: Non-conventional energy systems typically consume less energy compared to traditional drying methods, improving overall energy efficiency. This translates into reduced operational costs and less energy waste.
- Cost Savings: Over the long term, utilizing renewable energy sources like solar and biomass can result in substantial cost savings. While the initial investment may be higher, the operational and maintenance costs are typically much lower than conventional energy sources.
- Improved Product Quality: Non-conventional energy drying methods offer better control over temperature and humidity levels, reducing the risk of over-drying and preserving the quality of the onion powder, such as flavor, texture, and nutritional content.

While non-conventional energy sources offer promising solutions, there are several challenges to overcome. The initial capital investment for solar, biomass, or geothermal

drying systems can be high, especially for small-scale producers. Moreover, the availability of resources like biomass or geothermal energy is location-dependent, limiting the widespread applicability of these methods. As the technology evolves, the cost of installation and maintenance is expected to decrease, making these systems more accessible to a broader range of producers. Additionally, hybrid systems that combine multiple renewable energy sources could help mitigate the limitations of individual systems.

Discussion. Solar energy has gained widespread attention due to its abundance and minimal environmental impact. It is an ideal renewable resource for drying agricultural products, particularly in regions with ample sunlight. Solar drying systems, both passive and active, work by harnessing solar radiation to provide heat and airflow necessary for drying onions. Passive systems depend solely on natural sunlight, while active systems use solar collectors and fans to enhance heat retention and circulation, thereby improving drying efficiency. Benefits: The most notable advantage of solar energy is its low operational cost. Once the solar drying systems are installed, they incur minimal ongoing expenses compared to conventional energy sources. Additionally, solar drying does not produce harmful emissions, making it an environmentally friendly option for reducing the carbon footprint of onion drying operations.

Biomass energy, derived from organic materials such as agricultural waste, wood chips, and other biodegradable matter, presents a compelling solution for drying onions. Biomass-powered drying systems operate by burning these organic materials to produce heat, which is used to dry onions. Benefits: Biomass is a renewable resource that is readily available, particularly in rural areas where agricultural residues are abundant. Using these organic materials not only provides an efficient drying method but also helps reduce waste, contributing to a circular economy. Biomass drying systems also operate independently of weather conditions, providing consistent drying performance year-round.

Conclusion. The adoption of non-conventional energy sources for onion powder drying represents an innovative and sustainable approach to food processing. Solar, biomass, and geothermal energy offer significant advantages in terms of environmental sustainability, energy efficiency, and cost savings. By embracing these renewable energy sources, the onion powder industry can reduce its carbon footprint, improve product quality, and contribute to a more sustainable food production system. Continued advancements in technology, as well as further research into the integration of these energy sources, will play a crucial role in optimizing the drying process and promoting a greener, more energy-efficient future for the food industry.

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