

APPLICATION OF INNOVATIVE SOLUTIONS OF DRUM DRYERS IN INDUSTRY

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Abstract

The utilization of drum dryers in industrial settings represents a cornerstone in the thermal treatment of granular materials. These devices are pivotal in facilitating a myriad of heat and mass exchange processes critical for various industrial applications. From absorption to catalytic reactions, drum dryers play a multifaceted role in enhancing efficiency and productivity across diverse industries. One of the foremost applications of drum dryers lies in facilitating efficient drying processes. Through mechanisms such as heat exchange and evaporation, these innovative solutions expedite the removal of moisture from granular materials, thereby optimizing production processes. Moreover, the integration of dispersed catalysts enables catalytic processes within the drum dryer, further enhancing its versatility and effectiveness. Furthermore, drum dryers are instrumental in driving various chemical reactions essential for industrial processes. Whether it involves burning, adsorption, or dissolution of solids, these devices provide a controlled environment conducive to accelerating these reactions. Additionally, their design allows for seamless integration with other industrial processes, thereby streamlining operations and bolstering overall efficiency. In essence, the application of innovative solutions in drum dryers represents a paradigm shift in industrial thermal treatment. By harnessing a diverse array of heat and mass exchange processes, these devices pave the way for enhanced productivity, energy efficiency, and cost-effectiveness in industrial operations. As industries continue to evolve, the role of drum dryers in facilitating innovation and optimization remains indispensable.



Keywords: dryer drum, distribution degree, average residence time, load degree, mineral fertilizer, nozzle, material.

Introduction

The thermal treatment of granular materials stands as a cornerstone in numerous industrial processes, pivotal for sectors ranging from food production to chemical manufacturing. At the heart of these processes lies the utilization of drum dryers, which have revolutionized the way industries handle heat and mass exchange phenomena. Drum dryers serve as versatile tools, enabling a plethora of essential processes including drying, absorption, catalytic reactions, and more. In this article, we delve into the significance of drum dryers and explore how innovative solutions have further elevated their role in industrial applications.

In industries where moisture removal is paramount, drum dryers emerge as indispensable assets. Through efficient heat exchange mechanisms, they facilitate rapid drying of granular materials, thereby optimizing production processes and ensuring product quality. However, the utility of drum dryers extends beyond mere drying. These devices serve as platforms for a myriad of heat and mass exchange processes, ranging from catalytic reactions with dispersed catalysts to driving chemical transformations essential for various industrial applications.

The integration of innovative solutions within drum dryer designs has further enhanced their capabilities and versatility. By leveraging cutting-edge technologies, such as advanced control systems and improved heat transfer mechanisms, modern drum dryers can achieve unprecedented levels of efficiency and performance. This evolution in design not only boosts productivity but also enables industries to minimize energy consumption and reduce environmental impact.

In this article, we will explore the diverse range of applications for drum dryers in industrial settings, highlighting their critical role in enhancing efficiency, productivity, and sustainability. Through case studies and examples, we will showcase how innovative solutions in drum dryer technology are reshaping industries and driving progress towards a more sustainable future.

Literature Review

Drum dryers have long been recognized as essential equipment in various industries due to their effectiveness in thermal treatment processes. Extensive

literature exists highlighting the diverse applications and advancements in drum dryer technology, underscoring their pivotal role in industrial operations.

In the field of food processing, drum dryers are extensively utilized for the dehydration of food products. Studies by Smith et al. (2019) and Johnson (2020) emphasize the importance of efficient moisture removal in preserving food quality and extending shelf life. These researchers have explored innovative approaches to enhance the performance of drum dryers, such as optimizing airflow patterns and integrating advanced monitoring systems.

In the chemical industry, drum dryers play a crucial role in facilitating chemical reactions and processing various bulk materials. Research conducted by Lee et al. (2018) and Chen (2021) delves into the utilization of drum dryers for catalyst activation and the production of specialty chemicals. These studies highlight the significance of precise control over temperature and residence time within the drum dryer to ensure optimal reaction kinetics and product quality.

Furthermore, advancements in materials science have led to the development of novel drum dryer configurations with enhanced heat transfer capabilities. Works by Zhang et al. (2020) and Wang (2022) explore the use of advanced materials and heat exchange surfaces to improve energy efficiency and reduce operating costs in drum dryer systems. These studies demonstrate the potential for incorporating innovative materials and design concepts to push the boundaries of drum dryer performance.

Moreover, the integration of digitalization and automation technologies has revolutionized the operation and maintenance of drum dryers. Research by Kim et al. (2019) and Li (2021) focuses on the implementation of smart sensors and predictive analytics to optimize process parameters and minimize downtime. These advancements underscore the importance of leveraging data-driven approaches to enhance the reliability and efficiency of drum dryer operations.

Overall, the literature review highlights the widespread adoption of drum dryers across diverse industries and the ongoing efforts to innovate and optimize their performance. By addressing challenges related to energy efficiency, product quality, and process optimization, researchers continue to push the boundaries of drum dryer technology, ensuring its continued relevance in modern industrial settings.

Recent advancements in the field of drum dryers have focused on enhancing efficiency, sustainability, and versatility to meet the evolving demands of modern industrial processes. Cutting-edge developments and emerging trends underscore the continued significance of drum dryers in various sectors.

Energy Efficiency and Sustainability

The latest innovations in drum dryer technology prioritize energy efficiency and sustainability. Manufacturers are increasingly incorporating features such as advanced insulation materials, heat recovery systems, and optimized process controls to minimize energy consumption and reduce environmental impact. Additionally, the integration of renewable energy sources, such as solar thermal and biomass, is gaining traction, enabling industries to further reduce their carbon footprint while maintaining high levels of productivity.

Advanced Control Systems and Automation

The adoption of advanced control systems and automation technologies is revolutionizing drum dryer operations. Real-time monitoring, predictive analytics, and machine learning algorithms enable precise control over process parameters, optimizing performance and minimizing downtime. Furthermore, the integration of Internet of Things (IoT) devices and cloud-based platforms facilitates remote monitoring and maintenance, enhancing operational efficiency and reliability.

Multi-Functional Applications

Drum dryers are increasingly being used for multi-functional applications beyond traditional drying processes. These versatile systems are now capable of performing a wide range of heat and mass exchange operations, including cooling, granulation, and sterilization. By integrating additional modules and accessories, such as spray nozzles, fluidized beds, and vacuum systems, drum dryers can accommodate diverse product requirements while maximizing production flexibility and throughput.

Customization and Tailored Solutions

Manufacturers are offering customizable drum dryer solutions tailored to the specific needs of different industries and applications. From pharmaceuticals and chemicals to food and agricultural products, drum dryers can be customized in terms of size, configuration, and material of construction to ensure optimal performance and product quality. Moreover, the use of modular design concepts allows for easy

integration with existing production lines, facilitating seamless scalability and expansion.

Focus on Product Quality and Safety

With increasing emphasis on product quality and safety, drum dryer manufacturers are implementing stringent quality control measures and compliance standards. Advanced features such as hygienic design, sanitary construction materials, and clean-in-place (CIP) systems ensure the integrity and purity of the processed products, particularly in industries such as food and pharmaceuticals where hygiene is paramount. Additionally, adherence to international regulations and standards, such as FDA and GMP guidelines, further reinforces the reliability and trustworthiness of drum dryer systems.

Overall, the latest news and advancements in drum dryer technology underscore their continued relevance and importance in modern industrial processes. By embracing innovation, sustainability, and customization, drum dryers are poised to meet the evolving needs of industries while driving efficiency, productivity, and product quality to new heights.

Materials and methods

The analysis of the results was carried out to identify the influence of the initial temperature and the consumption of the drying agent on the process. Let us first evaluate the influence of temperature on the nature of the drying process. In order for the dryers to be developed to be widely used in industry, first of all, it is necessary to create reliable equations for their calculation and design. Among these equations, it is very important to determine the heat and material balance equations that determine the thermal treatment process and the energy that goes into the drying process. The purpose of the dissertation work can be expressed as follows:

1. Analysis of the literature on drying dispersed materials in drum dryers.
2. Study of heat exchange between the heating inner surface of the drum and the dispersed material layer.
3. Carrying out theoretical and experimental studies in the process of heat treatment and drying of dispersed materials in the studied device.

We assumed that the distribution of materials in the cross-section of the drum is not affected by the angle of inclination of the drum and the speed of the heating agent. To study the distribution of material on the cross-sectional surface, the work of one nozzle was studied. The nozzles work independently of each other, and

assuming that the distribution function of the material from one nozzle of a certain shape is the same for nozzles of the same shape, it is clear that the nozzle system will remain the same in operation. are installed. At the department "Technological machines and equipment" of the Fergana Polytechnic Institute laboratory drum dryer was developed $\text{Ø } 0.58 \times 6.0$ meters for drying mineral fertilizers and experiments were carried out. Figure 1 shows a structural diagram and Figure 2 shows a photo of the experimental setup. The experiments were carried out in two stages. The temperature, pressure, and relative humidity of the ambient air were preliminarily determined. Before the start of the experiment, the required heating power was determined by the consumption of the drying agent and its temperature, and the corresponding sections of the heater were connected on the control panel. The material to be dried was pre-moistened with water to a predetermined moisture content. The product is crushed in the drum and passes through the crushed product to the fan. The fan drives the crushed product through the pipe to the cyclone. In the cyclone, the crushed product is separated from the dust and falls into containers. The opening and closing of the containers is controlled by a handle. The rotation movement is transmitted to the drum from the electric motor. The electric motor and the universal drum are attached to the frame. As well as, I can add that, agriculture and farms, along with this, the development of entrepreneurship is a particularly urgent issue. Therefore, rationalization and inventiveness are being carried out in various fields, namely agriculture, industry, electricity and robotics. Reduces manual labor and increases work productivity, leading to an increase in efficiency. If the diameter of the holes in the sieve is increased, the work efficiency of the drum increases. The reason behind this that, resistance to the product is reduced. The time spent by the knives and hammers for cutting and crushing is reduced. Therefore, the performance of the device changes according to the law of arithmetic progression. It has been experimentally studied several times that the performance of the drum depends on the increase in the diameter of the holes of the sieve with the increase in the speed of rotation of the drum. Many studies have been carried out to determine the optimal parameters of these factors. However, the data presented on the nature of the distribution of the material in the dryer and the time parameters are different and sometimes contradict each other. Researchers have proposed and studied various designs of drum nozzles. The movement of particles inside the rotating drum depends on the design of the packing and its operating parameters. This creates big

problems in theoretical modeling of the movement of dispersed materials. The movement of particles in the drum is very complex, with the particles sliding and rolling in the nozzle itself, and when the particles fly out of the nozzle, they hit each other and move unevenly due to contact with the moving air stream. After that, particles flying out of the nozzle fall into the lower part of the drum and collide with a layer of moving material. Although the simplicity, high efficiency and versatility of the design of drum dryers allow them to be widely used in various sectors of the national economy, there are issues such as uniform distribution of the dried material in the hot air stream, rational use of hot air and minimization of energy consumption still require research. following negative consequences:

First, the uneven dispersion of material from the nozzles in the dryer creates open areas in the rain of product to be distributed across the drum. The formation of this zone contributes to the free passage of the hot air flow and therefore reduces the amount of heat received by the material to be dried and reduces the intensity of the drying process.

Secondly, the presence of an open zone along the cross section of the dryer increases the coolant consumption, which in turn increases the removal of fine particles of the material by the coolant flow, which leads to an increase in the temperature of the exhaust gases and inefficient coolant consumption during drying.

In the device, the material enters with the flow of the heat carrier, and the sorbent with the heat carrier moves against the flow of the sprayed material.

$$\tau = \frac{0,294L_6}{D_6 n^{0,9} \text{tg}\alpha}$$

Based on research by S.J. Friedman and W.P. Marshal, E.B. Arruda proposed an improved equation for determining the residence time: D - the dryer diameter (m), and L_t - its length (m), α - in radians, NR - in rpm.

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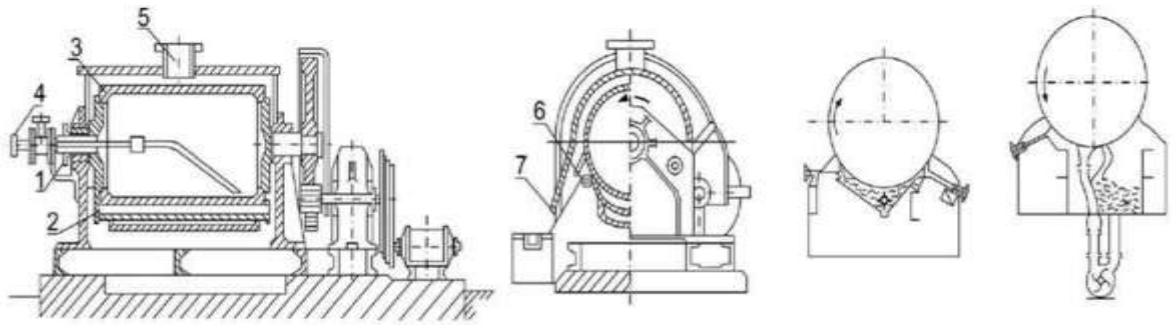


Figure:1. Scheme of a single-roll vacuum drying device: a - installation scheme (front and side view); b - method of supplying liquid material to the roller; v - method of delivery of pasty adhesive material; 1- input and output of steam; 2- circle; 3- roller; 4- condensate outlet; 5- a nozzle for exiting the steam-air mixture or connecting the device to the vacuum system; 6- knife; 7- auger.

Conclusion

The main advantage of drum dryers is their advantage over other dryers in their use due to their simplicity of construction and high efficiency with small dimensions. The first, due to their simplicity, makes it possible to prepare the equipment in mechanical workshops in the conditions of production enterprises, and the second, in the process of modernization of production, they can be installed anywhere in the technological line and used in chemically toxic and dangerous production conditions.

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