Innovative Design of Dryer in Utilization and Disposal of Livestock and Poultry Manure

Zhenbo Bao*, Panting Wang, Zhengming Qin, Jianjian Jia and Xiaoshan Zhao
Engineering and Technology College, Tianjin Agricultural University, Tianjin, China

*Corresponding author e-mail: zhenbobao@sohu.com

Abstract. With the rapid development of large-scale and intensive livestock and poultry farming, a large number of livestock and poultry manure has been produced. If livestock and poultry manure is directly stacked or improperly disposed of, it will cause extremely serious pollution to the surrounding water, air and soil, and endanger human health. It is an effective method to dispose and utilize livestock and poultry manure properly according to local conditions. However, because of the large water content of livestock and poultry manure, most of the water in the manure needs to be removed before resource disposal. Therefore, drying livestock and poultry manure is a necessary link in the resource disposal and utilization of livestock and poultry manure. In view of the shortcoming of high energy consumption, uneven drying and low drying efficiency existing in the existing drying technology equipment for livestock and poultry manure, on the basis of overall design and working principle analysis of the livestock and poultry manure dryer, innovative designs are made in the following aspects: improving the efficiency of material transportation from the sloping spiral feeding device; at the bottom of the feed box, seepage holes are equipped with, which can preliminarily filter and separate the moisture in livestock and poultry manure; the conveyor belt in the drying oven adopts three-step jump conveyor mode to realize the rolling conveyor drying of livestock and poultry manure. These innovative designs can improve the transportation efficiency, drying uniformity and drying efficiency of livestock and poultry manure, effectively reduce the moisture content in livestock and poultry manure, reduce the energy consumption of dryer, and effectively realize the resource disposal and utilization of livestock and poultry manure.

Keywords: Livestock and poultry manure, Rural environmental pollution, Dryer

1. Introduction

With the rapid development of large-scale and intensive livestock and poultry farming, a large number of livestock and poultry manure are produced. The direct storage or improper disposal of livestock and poultry manure will cause extremely serious pollution to the surrounding water, air and soil, and endanger human health. Livestock and poultry manure have become the third largest pollution source after industrial pollution and domestic sewage and garbage pollution, which is the main cause of rural environmental pollution [1-6]. The rational and safe disposal and utilization of livestock and poultry...
manure has attracted people's attention. It is an effective method to dispose and utilize livestock and poultry manure properly according to local conditions [7-8]. However, due to the large water content of livestock and poultry manure, it is necessary to remove most of the water in the manure before recycling. There are many common dehydration methods of livestock and poultry manure, including centrifugal drying, natural air drying, hot air drying, etc. However, the existing drying and dewatering technology of livestock and poultry manure has the disadvantages of high energy consumption, uneven drying and low drying efficiency [9-11]. In view of the shortcomings of the existing drying technology and equipment, a set of innovative dryer equipment is designed, which can effectively remove moisture from livestock and poultry manure.

2. Overall Design and Working Principle Analysis of Dryer in Resource Disposal and Utilization of Livestock Manure

2.1. Overall Design of Dryer in Resource Disposal and Utilization of Livestock Manure

As shown in Fig. 1, Fig. 2 and Fig. 3, the livestock and poultry manure dryer mainly consist of feeding device and drying device. The feeding device consists of a support stand 1 and a feed box 2 installed at the upper end of the support stand 1. Feed conveying winch 3 is installed in feed box 2. Feed conveying winch 3 is set in a downward inclined manner along the direction from feed end to discharge end. The feed conveying winch 3 is installed in the feed box 2, and the feed conveying winch 3 is set in a downward inclined manner from the feeding end to the discharging end. The feed inlet of the feed conveying winch 3 is located at the top of one end of the feed box 2 near the feed driving motor 4, and the feed hopper 5 is installed at the feed inlet. The outlet of the feed conveying winch 3 is arranged at the bottom of one end of the feed box 2 far from the feed driving motor 4, and the outlet is connected with the outlet of feed nozzle 6. A water seepage hole 7 is arranged at the bottom of the feed box 2, a water connection flume 8 is installed at the opposite position of the water seepage hole 7 outside the bottom of the feed box 2, and a drainage interface pipe 9 is arranged at the bottom of the water connecting flume 8. The drying device includes a drying oven 10, a material transmission device arranged in the drying oven 10 and a hot air fan 11 arranged outside the drying oven 10. The top of the drying oven 10 is equipped with a drying oven inlet 12, which is positively connected with the lower end of the discharge feed nozzle 6 of the feed box 2. The bottom part of the right end of the drying oven 10 is provided with a drying oven outlet 13. The material transmission device adopts a belt conveyor device, including a tooth-shaped conveyor belt 14, a plurality of drive shafts 15 arranged in the inner side of the conveyor belt to mesh with the conveyor belt to form meshing transmission, and a plurality of compression shafts 16 arranged in the outer side of the conveyor belt to contact the conveyor belt. Both ends of the drive shaft 15 and the compression shaft 16 can be rotatably supported on both sides of the drying oven 10. One of the drive shafts is the main drive shaft 17, and the main drive shaft 17 is connected with the belt drive motor 18 set outside the drying oven 10. The upper part of conveyor belt 14 forms a three-stage conveyor table with the height decreasing in turn from the feeding end to the discharging end of the drying oven 10. The first stage conveying platform is aligned with the drying oven inlet 12, and the third stage conveying platform terminal is aligned with the the drying oven outlet 13. The highest stage conveying table is aligned with the drying oven inlet 12, and the end of the lowest stage conveying table is aligned with the drying oven outlet 13; an air inlet 19 is arranged near the bottom of the other end side of the drying oven 10, and the air inlet 19 is connected with the air outlet of the hot air fan 11.

2.2. Working Principle Analysis of Dryer in Resource Disposal and Utilization of Livestock Manure

The working principle of livestock and poultry manure dryer: livestock and poultry manure enter the feed box 2 through the feed hopper 5. The feed driving motor 4 drives the feeding conveying winch 3 to rotate spirally, and pushes the livestock and poultry manure to move towards the outlet. In the process of transportation, the seepage liquid under the action of gravity and extrusion drops through
the water seepage hole 7 into the connecting flume 8. When livestock and poultry manure is transported to the outlet position of the feed box 2, it falls to the highest conveying step in the drying oven 10 through the feed nozzle 6. With the movement of the conveyor belt, livestock and poultry manure is driven to move towards the drying oven outlet 13. In the process of moving, the manure is dried by hot air, and then falls to the next stage of conveying table to realize a turning. Finally, the dried manure falls from the end of the lowest conveying step and is discharged through the drying box outlet 13. The receiving box or the receiving conveyor belt can be arranged under the drying oven outlet to realize the receiving of the livestock manure after drying.

1. Support stand 2. Feed box 3. Feed conveying winch 4. Feed driving motor 5. Feed hopper 6. Feed nozzle 7. Water seepage hole 8. Connecting flume 9. Drainage interface pipe 10. Drying oven 12. Drying oven inlet 13. Drying oven outlet 14. Tooth-shaped conveyor belt 15. Drive shaft 16. Compression shaft 17. Main drive shaft

**Figure 1.** Overall design of dryer in utilization and disposal of livestock and poultry manure

18. Belt drive motor

**Figure 2.** A-A sectional view of overall design of dryer in utilization and disposal of livestock and poultry manure
3. Innovative Design of Dryer in Resource Disposal and Utilization of Livestock Manure

3.1. Inclined Spiral Winch Feeding Device Is Adopted to Improve Material Conveying Efficiency

As shown in Fig. 1, 2 and 3, the livestock and poultry manure dryer adopt a special feed box 2, which is tilted and placed on the support stand 1, and a feed conveying winch 3 is installed in the feed box 2. The feeding port of the feed box 2 is arranged at the top of one end near the feed driving motor 4, and the feed hopper 5 is installed at the feeding port of the feed box 2. The feed box outlet is arranged at the bottom of one end far from the feed driving motor 4, and the feed box outlet is connected with the feed nozzle 6. The feed conveying winch 3 is set in a downward inclined manner from the feeding end to the discharging end, which can make full use of the weight of the material and the propelling function of the spiral rotation of the feed conveying winch to improve the conveying efficiency of the material.

3.2. A Seepage Hole Is Installed at the Bottom of Feeding Box to Preliminarily Filter and Separate the Moisture in Livestock and Poultry Manure

As shown in Fig. 1, 2 and 3, A plurality of water seepage holes 7 are arranged at the bottom of the feed box 2 of the livestock and poultry manure dryer, and a water connecting flume 8 is installed at the right position opposite the water seepage hole outside the bottom of the feed box 2, and a drainage interface pipe 9 is arranged at the bottom of the water connecting flume 8. During the pushing process relying on the self-weight of the material and the spiral rotation of the feed conveying winch 3, the water in livestock and poultry manure seeps out under the pushing extrusion and gravity. The seepage is collected in time through the water seepage hole 7 into the water connecting flume 8 and discharged through the drainage interface pipe 9, which is beneficial to the subsequent drying of livestock and poultry manure.

3.3. The Conveyor Belt Adopts Three-Step Jump Conveyor to Improve the Uniformity and Efficiency of Drying Livestock and Poultry Manure

As shown in Fig. 1, 2 and 3, in the direction from the feed end to the discharge end of the livestock and poultry manure drying oven 10, the upper part of the tooth-shaped conveyor belt 14 forms a three-step conveyor bench with the height decreasing in turn. The highest conveyor bench is aligned with
the drying oven inlet 12, and the lowest conveyor bench is aligned with the drying oven outlet 13. There is an air inlet 19 at the bottom of the side of the drying oven 10 (near the outlet position), and the air inlet 19 is connected with the air outlet of the hot air fan 11, so as to convey the hot air to the drying oven 10 and dry the materials falling on the upper conveyor belt table of the tooth conveyor belt 14. Livestock and poultry manure enter into the tooth-shaped conveyor belt 14 of the drying oven through the drying oven inlet 12. In the process of transferring livestock and poultry manure from the feeding end to the discharging end, the hot air fan 11 discharges hot air to dry livestock and poultry manure. Livestock and poultry manure pass through the third-order conveyor belt with gradually decreasing height in the transmission process. Livestock and poultry manure first falls on the top of the first-step conveyor belt through the drying oven inlet 12. With the movement of the conveyor belt, livestock and poultry manure falls from the first-step conveyor belt to the second-step conveyor belt. In turn, livestock and poultry manure falls from the second-step conveyor belt to the third-step conveyor belt. Finally, the material after drying falls from the third stage conveyor belt table and is collected through the drying oven outlet 13 to the receiving box. In the process of dropping livestock and poultry manure, livestock and poultry manure will be rolled once to change the contact surface between livestock and poultry manure and conveyor belt, which is conducive to achieving uniform drying of livestock and poultry manure, improving drying efficiency and achieving better drying effect.

4. Conclusion

At present, the rural ecological environment has become a prominent short-board for building a well-off society and building beautiful villages. The pollution of livestock and poultry manure has become one of the priorities of rural ecological environment management. It is an effective method to dispose and utilize livestock and poultry manure resources. In the process of disposal, due to the high moisture content of livestock and poultry manure, certain drying treatment is needed. Aiming at the problems of uneven drying and low efficiency of livestock and poultry manure, this design innovates the design of livestock and poultry manure dryer by adopting inclined spiral winch feeding device, installing seepage holes at the bottom of feeding box to remove and collect the leachate in time, and adopting three-step jump conveyor belt. It can improve the uniformity and efficiency of drying livestock and poultry manure.

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