Design on Cleaning Device for Hydroponic Vegetable Cultivation Tank

Yi Guo*, Yueying Wang, Jiwei Liu

Department of Horticulture, Beijing Vocational College of Agriculture, Beijing, 102442, China

*Corresponding author's e-mail: guoyibvca@163.com

Abstract. In this paper, for the problems of inadequate cleaning of the existing cleaning device for hydroponic vegetable cultivation tanks, the residues such as plant roots will be left on the inner wall of the cultivation tank after cleaning, and the cleaning water is one-time use, not able to be reused, large amount of water consumption, and serious waste of water resources, etc., we have designed a cleaning device for hydroponic vegetable cultivation tank. The device uses a nozzle assembly that sprays pressurized water to rinse the residue in the cultivation tank, and wipes the residue clean with a removal block to clean the cultivation tank thoroughly. This device has the function of recycling cleaning water, filtering the water used for cleaning and then recycling it for many times, which can effectively save water. The device can save labor cost as the cultivation tank is automatically transported during the cleaning process.

Keywords: Cleaning Device; Hydroponic Vegetable Cultivation Tank; Conveying System; Cleaning System

1 Introduction

Vegetables are the crops with the widest cultivation area and the highest economic status in China besides food crops. Vegetable industry has an important role in promoting the development of agriculture and rural economy in China [1]. As an important carrier of facility agriculture, greenhouse can effectively improve the agricultural production environment, improve the land output rate, resource utilization rate and labor productivity, and is an important facility to achieve high-quality and efficient crop production [2]. Modern glass greenhouse belongs to advanced facility agriculture, mainly using modern industrial technology to achieve automatic optimization of temperature and indoor environmental conditions, which can achieve the goal of balanced production throughout the year and more efficient agricultural production [3]. Since the 1980s, China has introduced a large number of greenhouses from abroad. After decades of development, the continuous glass greenhouse in China has moved from the initial stage of display and demonstration to the stage of planting and production [4]. In recent years, the continuous greenhouse with a single area of 20 hm2 and above has been emerging all over the country, and with the rising labor costs in China, large -scale

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continuous greenhouse is the demand for industrial development to reduce labor costs and improve production efficiency [5].

With the comprehensive promotion of rural revitalization strategy and the accelerated modernization of agriculture and rural areas, the construction and operation area of China's modern greenhouse is increasing year by year, the level of intelligence is getting higher and higher, and it is showing the trend of standardization and machine-friendly. In recent years, there are many relevant research results. Zhao Pengfei et al. designed an intelligent greenhouse water and fertilizer integration equipment [6]. Zhang Shangxian et al. developed a chain-type cyclic nursery mechanical structure [7]. Zhang Qianying carried out a research on daylight greenhouse water and fertilizer precision irrigation and application equipment and technology [8]. Lin Shuanbao developed technical equipment for winter cold and frost protection in Gobi greenhouses [9]. Zhang Mei et al. designed vertical cultivation equipment for urban horticultural crops [10]. Hu Yunrui et al. designed a three-dimensional cultivation and fertilization system based on feedback control of environmental parameters [11]. Gu Xiaoxiao et al. designed a control system for automatic seedling moving equipment for vegetable factory production [12]. Yao Yukang designed a continuous greenhouse spraying robot with variable pitch height adjustment and automatic target spraying [13]. Li Chaoqun designed a greenhouse roof cleaning automatic row changing platform [14]. Xi Zhijun designed a three-dimensional staggered hydroponic lettuce automatic harvesting device in fixed cup planting mode [15]. Hu Pengzhan investigated a low-loss harvesting device for hydroponic lettuce [16]. Tang Lumei developed a multi-end actuator transplanting device for hydroponic leafy lettuce seedlings [17]. Ma Ke carried out the research and development of key technology and equipment for thinning and transplanting leafy vegetables seedlings based on multi-end actuators [18]. Xue Kunpeng et al. designed a hydroponically grown leafy vegetables variable-pitch multi-layer three-dimensional automated logistics equipment [19]. Zhao Min carried out a study on the practical application of intelligent production equipment system suitable for the development of greenhouse horticulture industry [20].

In this paper, for the problems of inadequate cleaning of the existing cleaning device for hydroponic vegetable cultivation tanks, the residues such as plant roots will be left on the inner wall of the cultivation tank after cleaning, and the cleaning water is one-time use, not able to be reused, large amount of water consumption, and serious waste of water resources, etc., we have designed a cleaning device for hydroponic vegetable cultivation tank. The device uses a nozzle assembly that sprays pressurized water to rinse the residue in the cultivation tank, and wipes the residue clean with a removal block to clean the cultivation tank thoroughly. This device has the function of recycling cleaning water, filtering the water used for cleaning and then recycling it for many times, which can effectively save water. The device can save labor cost as the cultivation tank is automatically transported during the cleaning process.

2 General Structure and Work Process

Hydroponic vegetable cultivation tank cleaning device consists of conveying system, cleaning system and control system (Figure 1). The conveying system is used to convey the cultivation tank and make it move back and forth along the track. The cleaning system is used to clean the impurities inside the cultivation tank. The control system is used to control the work of the conveying system and cleaning system.

When the machine works, the cultivation tank is first placed on the lower rail of the machine with the hole facing downwards, after which the tank moves to the left under the action of the conveyor, while the nozzle of the cleaning system sprays water into the tank and the removing block removes the impurities inside the tank. With the cultivation tank continues to move to the left, the entire cultivation tank will be cleaned and removed. When the tank reaches the leftmost end, it moves to the right, while the nozzles of the cleaning system continue to spray water into the tank, and the removing block again removes the impurities inside the tank. When the tank is removed, the cleaning process is finished.

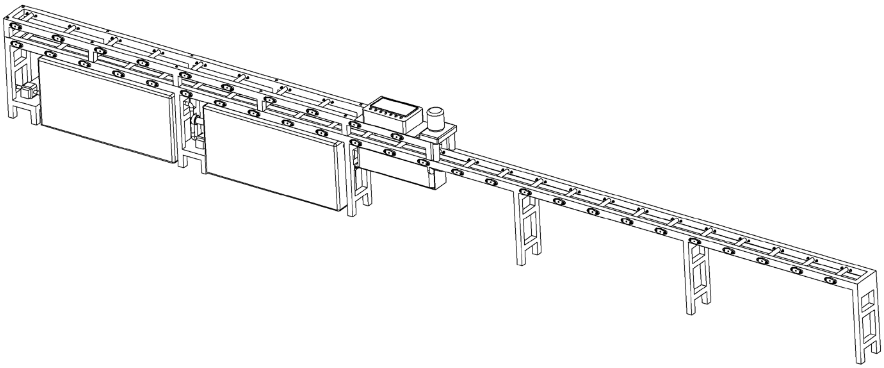

Fig. 1. Cleaning device for hydroponic vegetable tank

3 Structural Design

3.1 Design of Conveying System

The conveyor system consists of a lower rail bracket, lower rail, upper rail, conveyor, upper rail roller assembly, lower rail roller assembly, coarse filter bracket, pump A bracket, pump B bracket, and lower rail base plate (Figure 2).

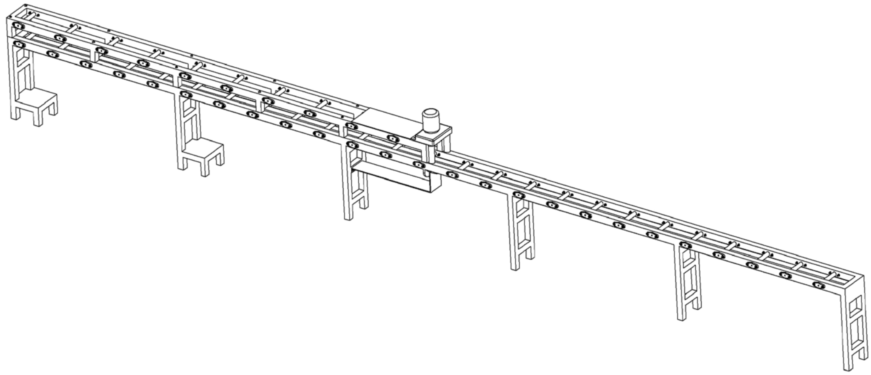

Fig. 2. Conveying system

There are 6 lower track supports, consisting of columns and beams, which are used to support the lower track and keep it stable. The lower rail is installed above the lower rail bracket, with a length of 5-6 meters, and is made of square steel welding. The upper rail is installed on the side above the lower rail, with a length of 2.5-3 meters. The conveyor consists of motor, gear box, transfer rollers, bearings and bearing housing. The conveyor is mounted above the upper track side. The conveyor motor drives the gears in the gearbox to rotate, thereby driving the conveyor rollers to rotate in opposite directions, so that the cultivation trough between the two conveyor rollers moves along the lower track. The upper track roller assembly is used to assist the lower track in positioning the trough. The lower rail roller assembly is used to support the cultivation tank and reduce resistance to the movement of the cultivation tank. A coarse filter bracket is mounted in the center of the lower rail for mounting the coarse filter. The pump A bracket is used to install the pump A. The pump B bracket is used to install the pump B. The lower track bottom plate is used to collect the water after cleaning the cultivation tank, and there is an opening in the middle of the lower track bottom plate from which the water after cleaning the cultivation tank flows into the coarse filter below it.

3.2 Design on Cleaning System

The cleaning system consists of coarse filter, tank A inlet pipe, tank A, pump A, fine filter, tank B inlet pipe, tank B, tank B outlet pipe, pump B, nozzle supply pipe, bracket B, removal block B, nozzle assembly B, removal block A, nozzle assembly A, bracket A (Figure 3).

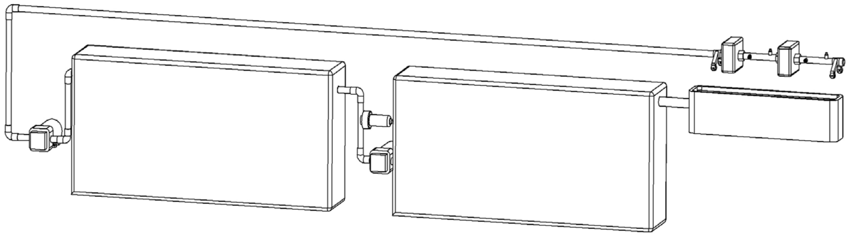

Fig. 3. Cleaning system

The coarse filter is used to filter the impurities in the water after cleaning the cultivation tank, and the filtered water flows through the inlet pipe of the water tank A into the water tank A. The inlet pipe of the water tank A is used to transport the filtered water of the coarse filter to the water tank A. Tank A is used to store the water filtered by the coarse filter. Pump A is used to transfer water from tank A to tank B. The fine filter is mounted in the middle of the inlet pipe of tank B and is used to filter impurities from the water flowing into tank B. The fine filter is mounted in the middle of the inlet pipe of tank B and is used to filter impurities from the water flowing into tank B. Tank B inlet pipe is used to transfer water from tank A to tank B. Tank B stores water filtered through a fine filter. Tank B outlet pipe is used to convey water from tank B to pump B. Pump B is used to pressurize the cleaning water. The nozzle supply hose is used to convey the cleaning water to the nozzle assembly B and the nozzle assembly A. Bracket B is used to support the nozzle supply pipe. The removal block B is used to remove impurities remaining in the cultivation tank. The nozzle assembly B comprises three nozzles, one nozzle upward, one nozzle leftward, and one nozzle rightward, to clean the cultivation tank that passes through the nozzle assembly B, respectively. The removal block A is used to remove impurities remaining in the cultivation tank. The nozzle assembly A comprises three nozzles, one nozzle upward, one nozzle leftward, and one nozzle rightward, to clean the cultivation tank that passes through the nozzle assembly A, respectively. The bracket A is used to support the nozzle supply pipe.

3.3 Design on Control System

The control system is used to set the working parameters, including: conveying speed and water spraying volume. It mainly consists of controller, contactor, relay, sensor and display.

4 Conclusion

In this paper, for the problems of inadequate cleaning of the existing cleaning device for hydroponic vegetable cultivation tanks, the residues such as plant roots will be left on the inner wall of the cultivation tank after cleaning, and the cleaning water is one-time use, not able to be reused, large amount of water consumption, and serious waste of water resources, etc., we have designed a cleaning device for hydroponic vegetable cultivation tank. The device uses a nozzle assembly that sprays pressurized water to rinse the residue in the cultivation tank, and wipes the residue clean with a removal block to clean the cultivation tank thoroughly. This device has the function of recycling cleaning water, filtering the water used for cleaning and then recycling it for many times, which can effectively save water. The device can save labor cost as the cultivation tank is automatically transported during the cleaning process.

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