

Dishwashing System based on Loofahs

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Abstract—This article presents a design scheme for a dishwashing system based on loofahs and develops a prototype. The dishwashing system contains seven parts: the transceiver device, the slag removing device, the main cleaning device, flushing device, the drying and the sterilizing device, the water supply and drainage device and the monitoring interface. We use PLC timing to control the transceiver device, which can save labor and reduce costs. The slag removing device cleans the dishes roughly using loofah brush heads. The main cleaning device contains a rotary cleaning part and a conveying cleaning part. Both of them are easy to disassemble and update; the PLC module controls the block cylinder to fix the dish, and then the conveyor belt drives the loofah cleaning belt to clean the bottom of dish, at the mean time the loofah brush head cleans the groove of dish. The flushing device rinses dishes with tap water. The drying and sterilizing device consists of a turnover part, a water absorption part and a heat drying part. Finally, we can get dry and sterile dishes. The water supply and drainage device comprises a sewage pipe, a water circulation pipe and a waste heat utilization pipeline, and it realizes the water circulation of the whole dishwashing system. The monitoring interface ensures the cleaning effect of the dishwashing system. Compared with the traditional dishwashers, the dishwashing system in this paper has remarkable energy-saving and emission reduction effects, along with great market space and promotion value at the same time.

Keywords—*loofah; dishwashing system; energy-saving; emission-reduction*

I. INTRODUCTION

Dishwasher integrates the functions of washing dishes, sterilizing, drying and storing, so that people can get rid of the shackles of hand washing dishes and improve the quality of life. From the perspective of three meals a day, the usage frequency of the dishwasher is theoretically higher than the washing machine. With the continuous improvement of people's living standards and the level of automation, the automatic washing of kitchen utensils has been paid more

attention to by consumers, and the popularization of intelligent dishwashing system will be an inevitable trend.

In recent years, the energy demand has been increasing and the environmental pollution has become more and more serious. China has vigorously promoted the development of low-carbon economy. Building a resource-saving and environment-friendly society has become an important component of China's sustainable development strategy. In 13th Five-Year Plan, it is pointed out that we should do our best for bettering the labor resource allocation. Loofah, as a cleaning material for dish washing, is environmentally friendly, biodegradable and inexpensive. Loofahs combined with the transceiver device, not only can save water and reduce pollution emissions, but also can save labor force and promote the process of building a conservation-oriented society. It has a broad market prospect.

Most dishwashers on the market in China are small-scale and household. According to relevant statistics, more than 90% of current domestic dishwashers are import products, and the price is expensive and penetration rate is less than 1%. While in developed countries penetration rate is as high as 70%, but dishwasher still need to use much detergent, causing environmental pollution and waste of water resources.

We have investigated and found that the traditional dishwasher on the market have three main limitations. Firstly, the mechanical washing method results in a great waste of water resources; secondly, the chemical composition of the detergent will cause pollution to the environment; thirdly, the traditional dishwasher has small capacity and cannot complete a lot of cleaning for a long time. In view of the above limitations of the traditional dishwashers, this paper designed and developed a set of embedded dishwashing system based on loofahs, which can save water and reduce pollution emissions^[1-3].

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II. DESIGN SCHEME

A. Overall framework of the dishwashing system

Our dishwashing system is contained of seven parts: the transceiver device, the slag removing device, the main cleaning device, the flushing device, the drying and sterilizing device, the water supply and drainage device, and the monitoring interface of washing effect. The overall framework of the dishwashing system is shown in Fig. 1.

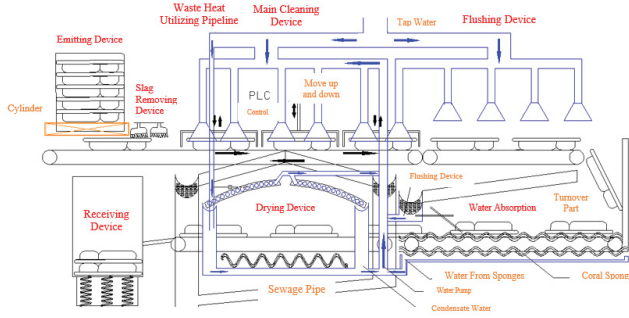


Fig.1 Overall framework of the dishwashing system

B. Transceiver device

• Principle and structure of the emitting device

The emitting device works with two cylinders to separate the dishes. When placed in the tray, the first cylinder extends to hold all dishes. When dishes are needed to conveyor belt, the second cylinder extends to hold the penultimate dish. After the first cylinder is retracted, the bottom dish falls into the conveyor belt. Through this device, dishes can be ensured to enter the conveyor belt orderly. The schematic diagram of the emitting device is shown in Fig. 2.

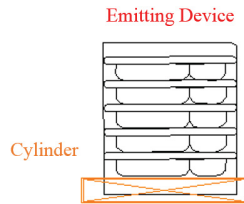


Fig.2 Structure of the emitting device

• Principle and structure of the receiving device

We designed a non-electrical automatic receiving box of consumption elasticity, which is arranged at the bottom end of the elastic element. Once the element receives dish from the conveyor belt, the elastic element plate on the upper end of the tank begins to work to receive the dish. So that the height difference between all the dishes and transmission at the top of the device can hold in a safe range, which ensures no loss, keeps safe as well as reliable and reduces the labor required. The structure of receiving device is shown in Fig. 3.

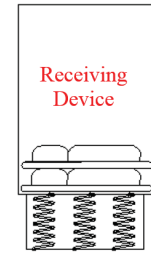


Fig.3 Structure of the receiving device

C. Slag removing device

This device with fixed loofah brush heads to remove slag on the conveyor belt plate and enhance cleaning effect of the dishwashing system. Basic structure of the slag removing device are shown in Fig. 4.



Fig.4 Structure of the slag removing device

D. Main cleaning device

This device is a main cleaning unit, which contains a rotary cleaning part and a conveying cleaning part. The upper rotary cleaning loofah part contains rotary brush head, flushing nozzle and baffle; the lower conveyor cleaning part is a conveyor belt, which is covered by clean loofahs^[4].

Spin rinse distributes on the top of the main nozzle cleaning device, with the loofah brush on the rotating nozzle. When this device is working, nozzle-sprayed water wets loofah brush head, loofah cleaning belt and dishes, which keeps the water spraying in the cleaning process.

The belt is made of biodegradable bamboo fiber and loofah pad, which replaces the traditional rubber belt. Removable loofah cleaning belt is sheathed on the bamboo fiber belt, while loofah brush is located on the rotating nozzle to achieve convenient disassembly of loofah cleaning pad and rotating loofah brush head.

The cleaning process is as follows: firstly, cleaning module detects lower part of the baffle plate, with the rotating loofah brush heading down, after the baffle plate is fixed, the system starts timing; and then the dish is fixed to the cleaning unit, with loofah cleaning belt movement through the conveyor belt to clean the bottom of dish, later the groove of dish part is cleaned by rotating loofah brush head; finally, the timing is out, and under the condition of no baffle fixed, the rotating baffle, loofah brush heading up, dish with this conveyor belt effect gets into the washing device. Basic structure and principle of the main cleaning device is shown in Fig. 7.

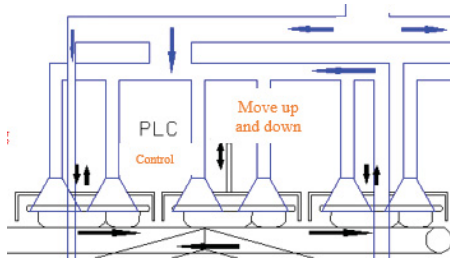


Fig.5 Basic structure and principle of the main cleaning device

E. Control method of dishwashing System

When we need to clean dishes, dishes are on the emitting device. PLC with time delay relay function^[5-6]. Firstly, press the start button and then dishes get into the main cleaning conveyor belt. Dishes begin to move forward successively. The first sensor senses a dish, and the photoelectric switch feeds the signal back to the PLC. PLC receives the signal and orders the block cylinder to drop to block the dish and prevent the dish from moving forward; PLC has another delay, the cleaning cylinder drops. When delay is end, the PLC will order cleaning cylinder and block cylinder to move up in turn. Then dishes continue to move forward along with the conveyor belt. Thus, a complete cleaning ends. Repeat above process to clean a large number of dishes.

F. Flushing device

The flushing device contains shower heads, and dishes are cleaned through water. And then waste water passes through the diverter valve. It can control whether to reuse the wastewater according to degree of the cleanliness of the actual washing wastewater. Once cleaning effect is satisfied, the device can make full use of water resources. Structure of the flushing device is shown in Fig. 6.

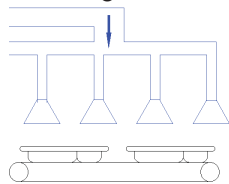


Fig.6 Basic structure of the flushing device

G. Drying and sterilizing device

This device contains a turnover part, a water absorption part and a heat drying part^[7].

Considering residual water in the groove of the dish, the turning part of dishwashing system is designed. Under the action of reversal, remaining water in the groove is removed. The water absorbing part is made of coral sponge. And the coral sponge can be replaced periodically. The heat drying part is composed of the electric heating wire. The remaining water on the dish is evaporated and dried, and the dishes are sterilized at high temperature through the device. Tap water is injected into waste heat utilization pipe to absorb heat of the water vapor at the upper part of the dryer to condense the steam. The condensed water is discharged to the main cleaning pipe

through the pipeline. Thus it not only realizes the drying of the dish, but also the utilization of the waste heat and water. Basic structure of the drying and sterilizing device is shown in Fig. 7.

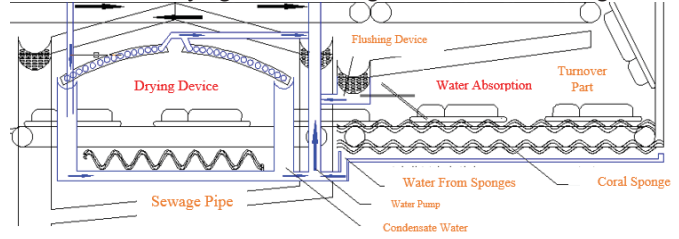


Fig.7 Basic structure of the drying and sterilizing device

H. Water supply and drainage device

This device is composed of stainless steel trough and water delivery pipes. Stainless steel is waterproof and airproof. It can prevent sewage from splashing during cleaning process. Water pipelines include sewage pipes, water circulation pipes and waste heat utilization pipelines.

The sewage pipe will discharge the waste water and sludge produced during main cleaning, and it is connected with the degradation device.

Water circulation pipelines realize two times utilization of flushing wastewater. For the reason that the main cleaning device has washed away main residue and oil from the dishes, the waste water produced by the flushing device still has a high cleaning performance. The flushing waste water is passed into the water circulation pipelines by sewage flushing water device. Through the control of the shunt valve, the waste water can be selectively imported into the main cleaning water pipe, which realizes two times utilization of flushing wastewater and saves much clean water resources. The design agrees with notion of energy saving and emission reduction.

The waste heat utilizing pipeline is arranged at the upper end of the drying device. And the cold washing water is passed through the pipes to absorb the heat of the water vapor. Therefore the steam is condensed and discharged to realize the function of absorbing the waste heat and drying the box body. Basic structure and principle of the water supply and drainage device are shown in Fig. 1.

I. Monitoring interface

Through screening, we design a software using six representative indicators which are commonly used in analysis of dishwasher washing effect. They include cleaning index, drying index, labor cost, loofah consumption, electricity consumption and water consumption^[8]. And then we make a monitoring interface which is shown in Fig. 8.

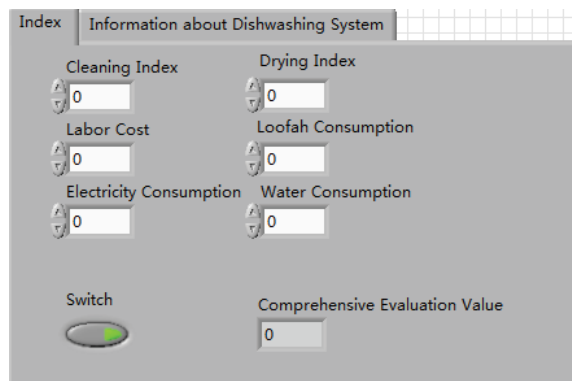


Fig.8 Monitoring interface

III. THREE-DIMENSIONAL GRAPH AND PROTOTYPE

Overall three-dimensional graph and prototype of the dishwashing system based on loofahs are shown in Fig. 9 and Fig. 10, respectively.

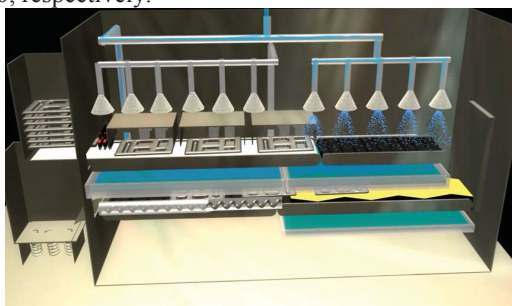


Fig.9 Overall three-dimensional graph of the dishwashing system



Fig.10 Prototype of the dishwashing system

IV. CONCLUSION

This paper presents a new type of environment-friendly dishwashing system. Environment-friendly and biodegradable loofah is used in the system. And a new type of mechanical structure is designed and prototype is developed.

Cheap loofah is used as cleaning materials in the dishwashing system, because loofah can adsorb fat. It avoids environmental pollution caused by the washing dish powder which is used in the traditional dishwasher, and it also eliminates the harm of residual washing powder to the human body. At the same time, water needed for washing dish powder is omitted, and a large amount of water resources are saved. The traditional rubber belt is replaced by degradable bamboo fiber belt. The bamboo fiber belt made of environmental protection material is connected with the transmission device. Removable loofah cleaning belt is sheathed on the bamboo fiber belt. And it is convenient for replacement. The loofah brush is fixed on the head, which makes it convenient to replace rotary loofah brush head. The transceiver device reduces the use of labor in the process of washing the dishes. In addition, we develop a monitoring interface, which is integrated with various display functions and it can reflect the dishwasher cleaning effect and sewage components in real time. This design guarantees cleaning effect. The water temperature of the main cleaning device is improved by utilizing the residual heat of the drying device; the cleaning effect is enhanced and the washing efficiency is enhanced. Outer surface temperature of the drying device is reduced, and safety of the dishwashing system is enhanced; at the same time, power consumption of traditional dishwashers used to heat water is reduced.

Our dishwashing system accords with concept of energy saving and emission reduction. It is of great significance for environmental protection and consumption reduction, and it also has broad application prospects and market space.

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