

# *Research and Development of Automatic Small and Medium-sized Restaurant-kitchen Waste Disposal Machine*

**Chunguang Wang, Xue Dong, Aiju Li, Hongwei Zhang, Da'an Zhou**

*Shandong Transport Vocational College, Weifang, Shandong, China  
wcg5219@qq.com*

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**Abstract:** Taking small and medium-sized kitchen waste treatment equipment as the research object, based on the analysis of the advantages and disadvantages of the crushing type and the microbial decomposition type, the existing treatment equipment is improved, and the treatment process is reorganized. This study designed and developed waste treatment equipment. It includes automatic feeding device, solid waste crushing device, solid-liquid separation device, oil-water separation chamber, weighing device, fermentation device, water purification circulation system, cleaning device, electrical control system and so on. A water purification and circulation system is designed. The treated water can be controlled by PLC through the circulation system into the crushing chamber for desalt or into the solid-liquid separation chamber and fermentation chamber for cleaning, so as to realize the reuse of treatment water. The control system redesigned based on PLC technology can realize the whole process of intelligent control of food waste disposal. The control panel can realize the opening, closing, cleaning and other functions of the kitchen waste processor, and the whole process of food waste treatment can be monitored through the LCD screen, and the operation is simple.

## **1. Preface**

Restaurant-kitchen waste is part of municipal waste, which refers to the catering waste produced after food processing and consumption. The source of the production is mainly the catering industry and the canteen of schools, enterprises, and institutions. Restaurant-kitchen-garbage is easily rotted and deteriorated, pollutes the environment, and endangers human health [1]. For restaurant-kitchen waste, you can use restaurant-kitchen waste disposal to achieve low-cost harmless treatment.

According to the investigation, at present, the existing garbage storage equipment in many restaurants or office canteens in Weifang is still mainly stored in garbage cans or garbage bags, with poor sealing, and cannot be clearly classified, as shown in Figure 1.

The reason is that the disposal of kitchen waste suitable for the commercial catering industry and the environment of schools and institutions is not perfect. On the market, the kitchen waste processor mainly has crushing and biological fermentation [2]. The rush garbage disposal machine

is simple to operate, the garbage disposal capacity is strong but high energy consumption, and will cause secondary pollution. Although the restaurant-kitchen waste processor type with fermentation biological bacteria can better achieve harmless treatment, it cannot deal with the substances with large volume and hardness of kitchen waste. It has become one of the important reasons why the kitchen waste processor cannot be widely used.



Figure 1: Kitchen waste storage equipment

Therefore, in view of the above problems, this paper, relying on the combination, chooses the school canteen, small and medium-sized restaurants as the research object. In this paper, based on the analysis of the types of crushing and fermentation of biological bacteria, on the basis of improving the existing treatment equipment and technology, through the crushing of kitchen waste, and then adding suitable for fermentation of biological bacteria, so that the treatment of kitchen waste faster and more efficient. This study meets the current situation and market demand of food waste disposal, improves the utilization rate of food waste disposal, protects the safety and health of residents, reduces the harm to the environment, and enhances the image of a civilized city.

## 2. Automatic design of small and medium-sized kitchen waste disposal system

### 2.1 Demand analysis of kitchen waste processor for small and medium-sized businesses

According to the survey, restaurants have the following requirements for small and medium-sized commercial dining and kitchen waste processors:

- ① The equipment has a small size and covers a small floor area;
- ② Long service life of the product, less energy consumption, low processing cost;
- ③ Convenient operation, safe and reliable, fast processing time;
- ④ The effect of the treatment capacity is good, there is no secondary pollution;

### 2.2 Work flow of the kitchen waste disposal machine

According to the use requirements, prepare the workflow of the restaurant-kitchen waste processor as shown in Figure 2.

Restaurant-kitchen waste is transported to the crushing device through the automatic feeding device, crushing and adding water and removing salt. The broken solid-liquid mixture enters the solid-liquid separation chamber through the hose. The liquid after separation is separated from the oil and water to obtain the oil and sewage to be treated. The water after the standard can be discharged or recycled. The isolated solids are first put into the collection box for weighing and then

dumped into the fermentation chamber, where the controller adds bacteria to the isolated solid for stirring and fermentation. Fermentation residues can be used as fertilizer or feed, and the gas produced during fermentation will be discharged through the air purifier purification standard.

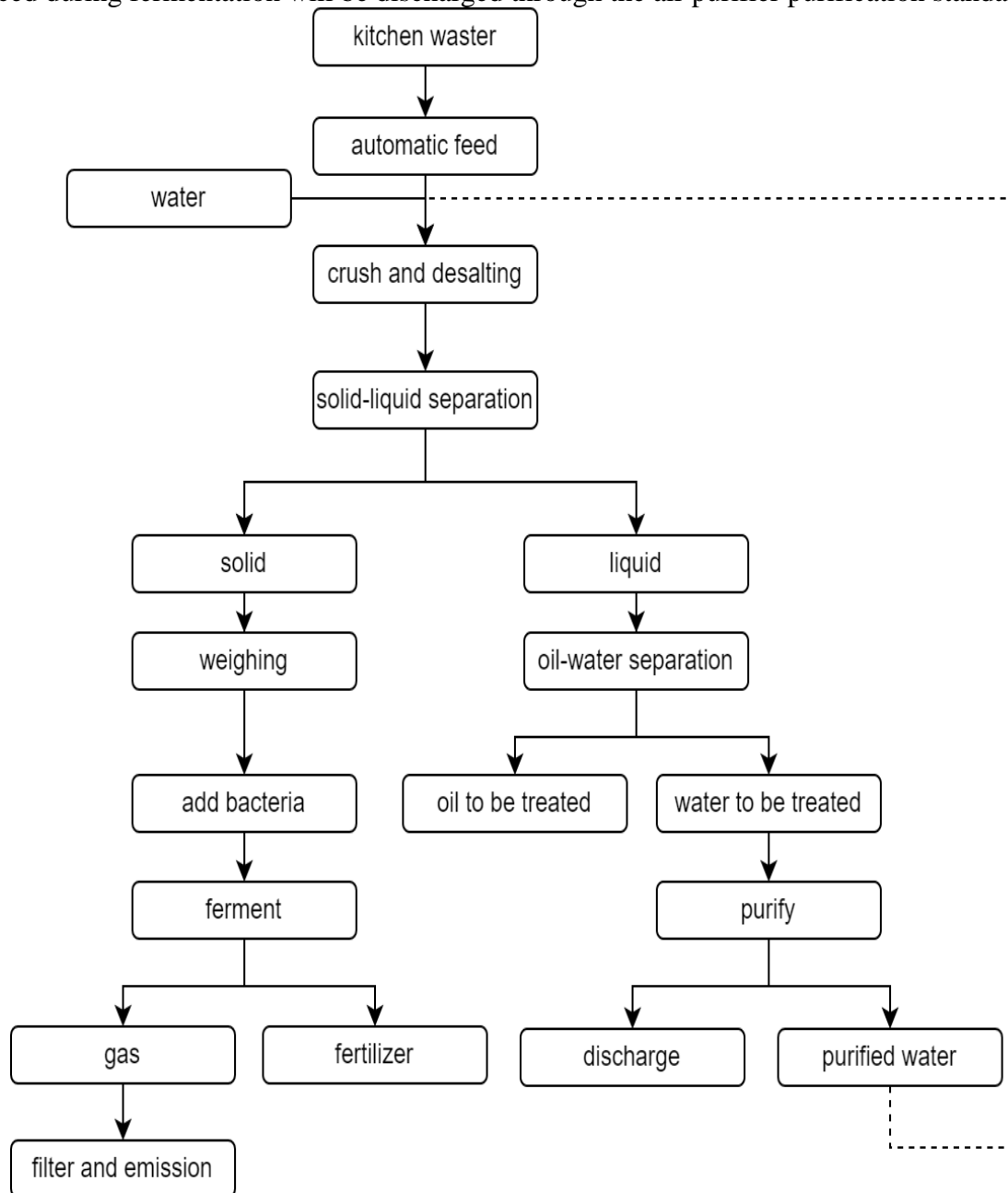
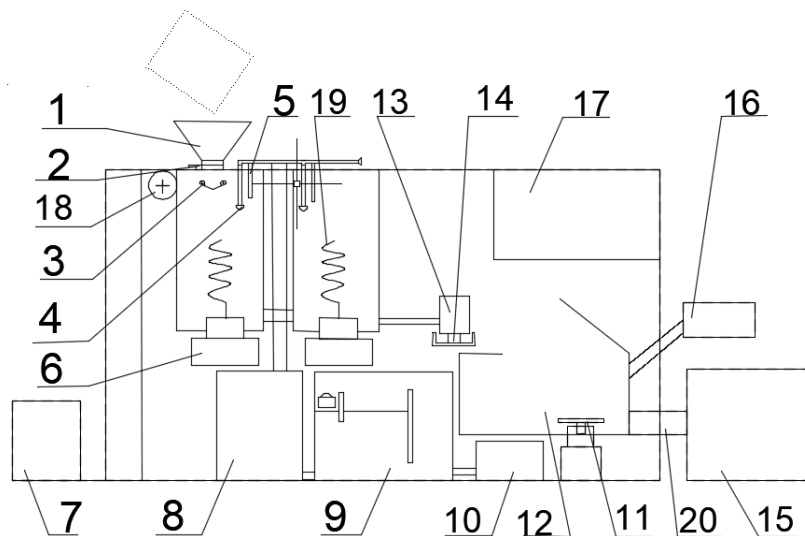


Figure 2: Workflow of the Restaurant-Kitchen-Waste Processor

### 2.3 Structural design

Based on this workflow, the basic structure of the machine in kitchen waste includes an automatic feeding device, solid waste crushing device, solid-liquid separation device, oil-water separation room, weighing device, fermentation device, water purification and circulation system, cleaning device, and electrical control system. The overall scheme design is shown in Figure 3.



1. funnel 2. adjust valve 3. cut the device 4. clean the head 5. water injection pipe 6. motor 7. garbage bag 8. oil and water separation room 9. oil retention plate 10. storage tank 11. blade 12. fermentation box 13. weighing box 14. electronic scale 15. collecting box 16. Air purifier 17. Console console 18. rotation gear 19. crushing blade 20. feed hose

Figure 3: General scheme design drawing of the kitchen waste processor

(1) Automatic feeding device

The main objective is to complete the transport and disposal of garbage. Put the kitchen garbage can on the base of the feeding mechanism and fix it. Through the lifting rod, the garbage can will rise on the rail and finally complete the dumping process through the change of the track [3]. Simulation plots are shown in Figure 4.

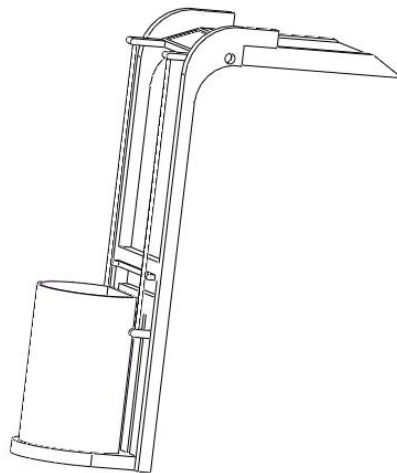


Figure 4: Simulation diagram of the feeding device

(2) Solid-state waste crushing device

The solid waste crushing device of the restaurant-kitchen waste treatment equipment is located under the funnel and the crusher adopts a physical grinding method to achieve crushing. The device is equipped with a water injection mouth; when the garbage is crushed, water is added to reduce the salt concentration in the garbage. The broken waste is transported to the solid-liquid separation unit through the gear pump.

(3) Solid-liquid separation device

The solid-liquid separation device mainly separates broken kitchen waste from restaurant waste. The broken oil kitchen waste is filtered out of the oil and water mixture through the screw extrusion action, and the separated oil and water mixture is pumped into the oil and water separation chamber by the gear. The separated solid oil kitchen waste is squeezed into the weighing device for the next treatment.

#### (4) Decantor

The multistage oil-water separation device for the filter chamber, oil-water separation chamber, and oil-free sewage chamber is designed to automatically separate the mixed oil in the oil-containing wastewater according to the different proportion of water and oil, and discharge the separated oil through the oil collecting tank.

#### (5) Weighing device

The weighing device includes a solid-state kitchen waste collection box and a bottom weighing device to weigh the separated solid-state waste and transmit the data to the controller. After being weighed, the collector box is flipped sideways to dump the solid waste into the fermentation chamber.

#### (6) Fermentation device

According to the weight of the separated solid waste, the bacteria are added to the fermentation bin, the fermentation bin is driven by the motor to fully mix the kitchen waste with the bacteria, and the filling amount of bacteria can be adjusted in real time according to the fermentation situation. After fermentation, the fermentation chamber of the rotation extends beyond the residue to form green organic fertilizer and completes a control system cycle. The waste gas formed in the fermentation process will be discharged after being treated to reach the standard to reduce the impact on the surrounding environment.

#### (7) Water purification and circulation system

The water filtered through the oil-water separation device enters the water purification and circulation system, and the sewage purification system is designed for three-stage filtration: coarse filtration, fine filtration, and fine filtration. The filter is the first filter device, which is used to intercept the impurities of larger particles in the sewage. The filtered sewage goes to a second filter to further filter out small waste impurities. Finally, through the third device, the activated carbon filter is filtered, and the water after the three levels of treatment can be discharged or returned to the crushing chamber for recycling.

#### (8) Cleaning the device

Because the oil or small residues in the kitchen waste are easily absorbed in the inner wall of each cabin, after each treatment, the equipment must be cleaned out of each cabin. The device mainly includes the nozzle, water valve and water pipe, which is used to clean the crushing cavity, solid-liquid separation chamber and fermentation chamber. The water used for cleaning can be connected to external tap water, and it can also be used to purify the treated water after the purification system, in order to achieve the purpose of recycling and water saving.

#### (9) Electrical control system

To ensure the stable and reliable operation of the equipment, the electromechanical gas control system adopts a PLC system to control and concentrates all electronic control units in the control box for easy operation and maintenance. The operator can perform the opening, closing, cleaning, and other functions of the restaurant and kitchen waste disposal machine through the control panel.

### **3. Technological Innovation and Main Indicators**

#### **3.1 Technological innovation**

(1) optimize the garbage processing workflow, in the analysis of crushing and microbial

decomposition, on the basis of improving the workflow of the existing processing equipment, by crushing meal waste first, then adding appropriate bacteria for biological fermentation, making meal waste disposal faster, more efficient, and does not produce waste residue, will not produce secondary pollution.

(2) The water purification and recycling system is designed for the kitchen waste processor. After treatment, the water can be controlled by PLC and sent to the crushing room through the recycling system for desalination or into the solid-liquid separation room and the fermentation room for cleaning, to realize the reuse of processing water.

(3) The machine can realize the entire process intelligent control based on PLC, can realize the opening, closing, cleaning and other functions of the kitchen waste disposal machine through the control panel, and can monitor the entire process of the waste disposal process through the LCD screen display, the operation is simple.

### 3.2 Main Technical Indicators

Equipment treatment range: all food and kitchen waste.

Equipment processing capacity: 200-400kg / hour, the garbage degradation rate is more than 95%.

Equipment running time: according to the material type and added quantity, the decomposition can be completed in 2 hours and 10 hours.

Service life of the equipment: not less than 100000H.

### 4. Conclusions

This machine improves the existing kitchen waste treatment equipment and process, with the characteristics of small volume, small area, convenient operation, safe and reliable, fast processing time, good treatment effect, no secondary pollution, waste into treasure, save resources, reduce pollution.

### Acknowledgement

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