An intelligently controlled tilting drum type kitchen waste in-situ processing device

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Abstract: Aiming at food waste, this project designs a set of innovative equipment based on real-time monitoring of biochemical processes, high-efficiency microbial aerobic fermentation and intelligent control of scenes to realize the resource utilization of food waste in situ. Focusing on the temperature and oxygen concentration in the fermentation process of kitchen waste, the two major parameters in the biochemical process will be monitored and intelligently controlled by the monitor on the cloud platform to solve the main problems in the process of resource utilization of kitchen waste. The indicators of parameters are not monitored in time, the production cycle of aerobic fermentation is long, and the traditional experience is mainly based on manual problems. In the later stage, it can be made into a vehicle-mounted mobile device to carry out community services.

1.Introduction

As a country with a large population in the world, China has experienced rapid social and economic development, and the living standards of urban residents have greatly improved. They produce astonishing food waste every day. The annual growth rate is as high as 7%-9%, but the harmfulness rate is less than 20%, 1/3 The city fell into a "garbage siege". At the same time, due to the characteristics of Chinese catering, the moisture content of kitchen waste is as high as 74%. There are mainly two traditional ways of processing food waste: incineration and landfill. The food waste is incinerated, which is easy to produce harmful gas, dioxin, etc.; while the landfill method is easy to cause soil and groundwater pollution. With the development of science, technology and society, more environmentally friendly and efficient composting methods have gradually replaced traditional kitchen waste treatment methods. Takr the most technologically advanced developed countries Germany and the United States as an example. In Germany, with a large number of personnel and funds invested in research on composting equipment, composting reactor technology has become increasingly mature. Usually the reactor system is relatively large and has strong productivity; In the United States, the composting of food waste is mostly in sealed containers. Sealed container composting is an environmentally controllable composting method, and its biggest feature is that it has little impact on the surrounding environment. Since food waste contains a large number of pathogens, sealed composting mostly adopts aerobic methods to kill pathogens by using the high temperature generated by the pile.

At present, the main microbial inoculants used in composting are single inoculum and compound inoculum, and the single inoculum is mainly bacillus and actinomycetes with strong heat resistance. Based on the mutually beneficial symbiosis effect between the strains, the compound inoculum has a strong ability to adapt to the high-temperature composting environment, and the application effect is significantly better than the composting treatment of inoculating a single inoculum. It can kill a large
number of parasite eggs and pathogenic microorganisms, greatly shorten the composting time, and improve the yield and quality of organic fertilizer.

At the same time, domestic and foreign researchers are developing intelligent high-temperature aerobic fermentation equipment, including stirring systems, ventilation systems, heating systems and automatic control systems. The automatic control system can detect the environment and fermentation conditions in the tank through the temperature and oxygen content sensors installed on the tank, and automatically turn on the stirring, ventilation and heating systems according to the set values. This not only reduces the amount of labor, reduces labor costs, but also better guarantees the smooth progress of the fermentation process. The fermentation equipment includes ventilation and heating systems, and is equipped with oxygen and temperature detectors, which can automatically keep the fermentation environment in the set optimal fermentation environment. But the shortcomings of most of the current devices are: (1) The device failed to achieve simultaneous monitoring of multiple indicators during the actual harmlessness process; (2) The concentration of odors (hydrogen sulfide, ammonia, volatile organic compounds) was not achieved. Real-time monitoring of water content and moisture content affects the accuracy of basic data acquisition.

Therefore, based on the existing research, we focused our research on temperature and oxygen, and designed a new integrated sealed aerobic composting device through improvement and innovation. At present, our device can realize the integrated operation from crushing, stirring to reaction and fermentation. The entire device basically realizes intelligent operation, and uploads the data obtained during the composting process to the cloud in real time through the cloud platform, further optimizing the reactor structure in the future. Improving the composting efficiency of municipal solid waste has a certain guiding role.

2. Device
The working system proposed in this paper is an improvement based on the traditional ultra-high temperature composting device [1]. This device is mainly composed of five systems: feeding and crushing system, mixing system, aeration and temperature control system, and deodorization system. The whole device realizes real-time monitoring of oxygen and temperature indicators during the reaction process, and responds in time. The power of the whole device comes from traditional electric drive. The device structure diagram is as follows.

![Figure 1 Device structure diagram](image)

1-Blower 2-Air inlet pipe 3-Material inlet 4-Fixed cutter head 5-Rotary shaft 6-Crushing cavity 7-Motor 8-Inner warehouse 9-Outer warehouse 10-heating resistance wire 11-heat preservation coating 12-heating 13-Rotary shaft 14-Cutting blade 15-PT100 temperature probe (red part) 16-Fixed gas detection transmitter (blue part) 17-Motor 18-Discharge port 19-Fertilizer collection device 20-
Exhaust Tube ② 21-Biological filter gas reaction tank 22-Exhaust pipe ②

2.1. Feeding and crushing system
The feeding and crushing system is mainly composed of a feeding device and a crushing chamber. The operation of the device is started by manual start. The material enters the crushing cavity and performs crushing work in it. The main component of the crushing chamber is the cutting and crushing mechanism [2], and the degree of crushing of the material is the prerequisite for determining whether the subsequent reaction can be carried out efficiently.

2.2. Mixing system
The mixing system is mainly composed of a double-layer cylindrical reaction chamber [3] and a fixed cutter head. The biochemical chamber is inclined at a certain angle in the form of a cement tanker, which can make the material agitate more fully and improve the reaction efficiency.

The mixing system has two forms: manual and automatic start. Manual start is mainly used to add materials to make the distribution of composite bacteria in the materials more uniform through mixing; and to deal with unexpected situations during the mixing process, the machine cannot be stopped, and it can be stopped by manual intervention. The automatic start is carried out in conjunction with the intelligent monitoring system, and the stirring starts at the same time as the air is introduced, so that the oxygen temperature distribution is more uniform.

The inner wall of the inner silo is welded with double spiral guide vanes, which is more conducive to automatic discharging [4]. A set of fixed cutting knives are installed on the spindle at a fixed distance obliquely, and each set of cutting is composed of three cutting knives. Realize the rotation of the inner bin, increase the contact surface of the material and oxygen, and improve the reaction efficiency.

2.3. Temperature control system

2.3.1. Temperature detection device
Temperature detection uses corrosion-resistant high-precision German PT100 temperature probe and paperless recorder for temperature detection and recording: PT100 is a new type of thermal resistance temperature sensor acquisition module, which is mainly converted by platinum resistance, annunciator, AD converter and single-chip temperature conversion The composition of the device.

2.3.2. Temperature control device
The main function of temperature control is to provide suitable temperature guarantee for compost fermentation. The work is mainly completed by blowers, PTC heaters, temperature detection and feedback devices, and cloud platform data centers.

2.4. Aeration system
The aeration system consists of an oxygen detection device, a ventilation device and an exhaust device. Deeply ventilate the biochemical chamber, adopt all stainless steel pipelines, and adjust the air volume through automatic valves.

2.4.1. Oxygen monitoring device
The oxygen monitoring device uses the MG02 series of online fixed gas detection transmitters (probes) to perform oxygen monitoring records: MG02 series of online fixed gas detection transmitters (probes) use imported electrochemical sensors for oxygen concentration in the biochemical warehouse Detection. The instrument adopts explosion-proof structure design, 4-20mA standard signal two-wire system output, can be output at a long distance, can directly enter the DCS system, and transmit data to the cloud platform. The probe has high sensitivity, rapid response, long life, and short polarization time. Features.
2.4.2. Ventilation device design

The aeration device of the aeration system is composed of a fan, an air inlet duct and small holes on the inner wall of the biochemical chamber. When the oxygen concentration in the detection biochemical chamber reaches a certain threshold, the valve is closed and the ventilation is stopped; otherwise, the valve is opened and the ventilation is started. After the cloud platform analyzes and processes the data received from the oxygen detection device, according to the ventilation purpose of different stages of the biochemical reaction, the air volume is intelligently adjusted through the valve to improve the efficiency of aerobic fermentation and save resources.

2.4.3. Exhaust device

The exhaust device of the aeration system is composed of an exhaust air pipe and the outer bin of the biochemical bin. The exhaust air pipe is connected with the outer warehouse of the biochemical warehouse. Eliminate the pressure difference between the inner and outer chambers of the biochemical warehouse.

2.5. Deodorization system

2.5.1. Landfill leachate

A large number of experiments have shown that the output of landfill leachate, which should have occupied most of the weight of the material, is basically zero after adding corn stalks, and most of the water is lost in the form of evaporation, avoiding odor pollution in the form of leachate.

2.5.2. Gas

This device will adopt biological treatment method for the remaining waste gas, and use microorganisms to transform and absorb harmful gases. After review, sawdust with good ventilation, strong adsorption and a certain degree of water retention is more suitable for microbial growth and reproduction, and is a better microbial carrier. Therefore, adding appropriate nutrients can be used as the filling material of the exhaust gas reaction device.

3. working principle

After the materials are manually screened and corn stalks are added, they are slowly transported by the conveyor belt to the feeding inlet and enter the crushing chamber. At this time, the motor ① drives the rotating shaft and the cutting cutter to cut and crush the materials, and then enter the tank through the lower valve to tilt in the biochemical warehouse.

The inner warehouse is equipped with a central shaft to connect with the external motor ②, while the shaft is equipped with a fixed cutter, and the fixed gas detection transmitter and the PT100 temperature probe are placed on the shaft crosswise, and multiple detection points are set. When the material enters the inner in the warehouse, the motor ② starts to operate to drive the central shaft and the inner warehouse to rotate slowly and in opposite directions to stir the materials and improve the fermentation efficiency. At the same time, the outer warehouse is fixed.

There are aeration holes on the upper part of the inner chamber. The detection device located on the central axis will monitor the oxygen concentration and temperature in the chamber in real time and feed it back to the cloud platform, and control the blower and heater into the device according to the most suitable fermentation conditions. Oxygen at a suitable temperature is delivered, and the air pressure in the silo rises at the same time to form a pressure difference, so that the gas produced by internal fermentation is discharged from the exhaust pipe at the other end to the biofilter gas reaction tank. When the work of the biochemical warehouse is finished, the discharge port valve at the bottom is opened, and the waste material automatically enters the collection device.

4. conclusion

Relying on the cloud platform big data center, this work builds a "detection-analysis-feedback-
processing" system, and applies the feedback adjustment mechanism to the kitchen waste composting device, which can flexibly and accurately control the function of each part. Effectively improve the rate of composting and the yield and quality of organic fertilizers. At the same time, the realization of integration and intelligence saves labor costs and simplifies operations, while reducing the risk of negative effects of filtrate and harmful gases generated in the reaction on the environment, which is conducive to the green development of the city.

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