

Research on Kitchen Waste Disposal System based on Arduino Development Platform

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Abstract

This paper notes that the traditional kitchen waste treatment method is time-consuming and laborious, and the links are scattered and disorderly, which is easy to cause waste of human and material resources, and will harm the environment. Under the background of realizing carbon neutrality and low-carbon economy, it can not only protect the ecological environment, but also achieve energy conservation and emission reduction. It is necessary to innovate the traditional treatment methods. This paper describes an automatic kitchen waste disposal system based on Arduino development board, using temperature, air pressure, pressure and other sensors to obtain real-time data of fermentation system, and using raspberry PI terminal unified intelligent control. These include a comminution system, a three-phase solid-liquid separation system, a bio-anaerobic fermentation system, a gas treatment system using a combination of biofiltration and membrane, and a wastewater treatment system.

Keywords

Carbon Neutralization, Arduino Development Board, Three-Phase Separator, Biological Fermentation.

1. Research Status at Home and Abroad

Statistics show that restaurant kitchen waste accounts for 37% to 62% of urban household waste in China, and major Chinese cities produce no less than 60 million tons of restaurant kitchen waste every year. In 2020, the production of restaurant waste in China exceeded 120 million tons. On the one hand, such a huge amount of waste is a huge challenge for both restaurants and waste treatment plants. On the other hand, the disposal of such a large amount of garbage is also a difficult problem, which will inevitably cost a lot of manpower and material resources and consume a lot of energy such as electricity. Under the condition of garbage harmless and green treatment, how to reduce the cost and intelligent integrated treatment is a common problem.

This paper notes that the traditional kitchen waste treatment method is time-consuming and laborious, and the various links are scattered and disorderly, which is easy to cause waste of human and material resources, and will harm the environment. Under the background of realizing carbon neutrality and low-carbon economy, it can not only protect the ecological environment, but also achieve energy conservation and emission reduction. It is necessary to innovate the traditional treatment methods. In the field of waste treatment, there are mainly German Rekmorse LOUTLOS, Shanghai Glaida Electric Co, LTD Samsung Group and so on. After a thorough investigation in this paper, the waste processors of the above companies are mostly used in family kitchens, that is to say, they can deal with a small amount of kitchen waste, but not a large amount of waste.

2. Advantages of Meal Waste Disposal

Because the green treatment of garbage is an essential part of ecological environment construction, kitchen garbage accounts for the largest proportion in the total amount of garbage. Food waste contains starch, food fiber, fat, protein and other organic matter, easy to rot, fermentation, stink, if not properly managed, it is easy to produce environmental pollution, impact on human health. In this context, an efficient and environmentally friendly intelligent kitchen waste treatment system to achieve efficient utilization of kitchen waste is an important research direction.

On the other hand, as kitchen waste is rich in resources and can be treated in a green way, this paper actively responds to the call of "carbon neutrality" while reusing resources. Promoting carbon neutrality will not only improve the environment, but will also force changes in the energy and industrial sectors, driving economic growth and building competitive advantages.

This article is based on Internet of things platform of eat hutch garbage intelligent processing system has realized the eat hutch garbage intelligent environmental treatment, recovery and recycling again, can not only solve the problem of garbage to, and can realize resource can be recycled, is the inevitable requirement of development of low carbon economy become carbon neutral, is the inevitable developing trend of the future of eat hutch garbage disposal technology.

3. Application Prospects

With the proposal of carbon peak and carbon neutral "30·60" targets during the two sessions, China's energy sector will usher in a fundamental change. Low-carbon economy, as a green and sustainable economic development model, is an inevitable choice for high-quality development of resource-based cities' economic transformation under the carbon neutral target.

The background of this paper is based on the city. First, it is to respond to the call of "developing low-carbon economy to achieve carbon neutrality" and realize the green treatment and reuse of resources. Second, in the city, the centralized distribution of kitchen waste, easy to collect and integrated treatment; Thirdly, the intelligent disposal of kitchen waste has not been promoted and applied on a large scale in cities, so it has a good market prospect. Of course, companies specializing in household kitchen waste disposal have more technical accumulation and production experience in waste treatment. This paper needs to keep up with the technology of The Times and innovate to improve its competitiveness.

According to the global Banking Outlook report recently released by bank of China, the scale of green finance business in China is expected to reach about 16 trillion yuan in 2021. The scale and market potential of green finance cannot be underestimated. In China, many cities are in urgent need of transformation, especially the 262 resource-based cities, which face more severe challenges. The third energy revolution aimed at carbon neutrality has begun, with the minister of science and Technology saying on April 18 that reaching peak carbon neutrality will bring a major change in the economic and social environment caused by the scientific and technological revolution.

Based on three-phase processor implementation of the solid liquid gas separation processing, the system of exhaust gas residual waste oil for further treatment and utilization, such as processed into again use of solid fuels, ecological resources, such as chemical fertilizers, methane gas in the extent, save costs, also has realized the energy conservation and emissions reduction, promote the sustainable development.

4. Implementation Plan

In this paper, based on sensor recognition technology and ONENET cloud platform, based on the formation of sensor network technology, the design of an automatic intelligent food waste treatment system.

The system first uses the crushing system is the kitchen waste crushing, and then uses the biological anaerobic fermentation system in the container fermentation, at the same time in the fermentation

using temperature sensor, pressure sensor, pressure sensor and other sensors to obtain real-time data of the fermentation system. The oil phase is then separated by a three-phase sefat-solid-liquid separation system to be used as raw material for industrial diesel oil extraction or solid fuel processing. Finally, the residual substances are classified by a combination of biofiltration and membrane gas treatment and wastewater treatment system.

To separate the eat hutch waste water and residue of this system will be further anaerobic fermentation, produce gas, methane can be recycled, used for restaurant or a family, the rest of the harmful gas such as carbon monoxide, sulfur dioxide, nitric oxide will be safely disposed into water and oxygen substances such as standard after discharge, the remaining residue also can be made into farmyard manure is used for fertilizer.

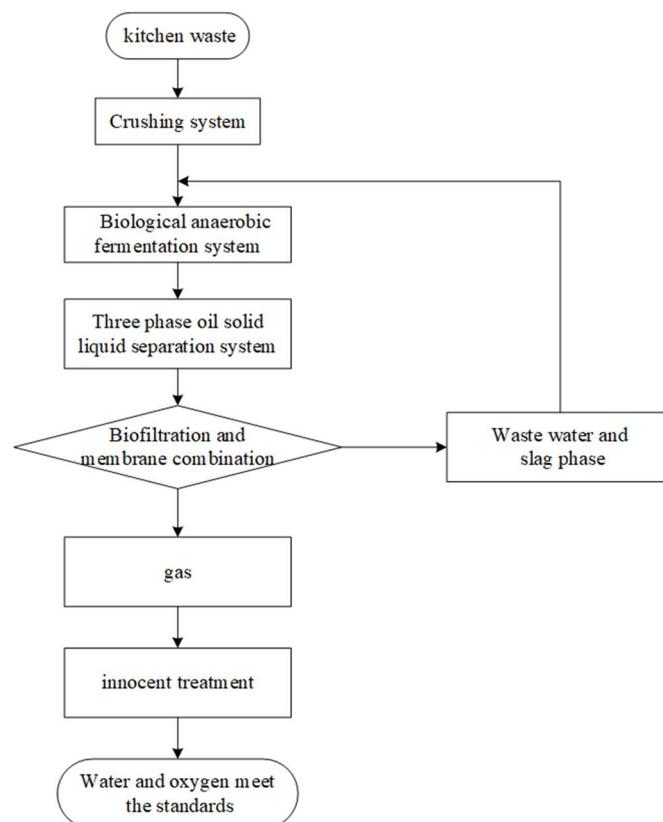


Figure 1. Flow chart of system functions

5. Working Principle of Three-Phase Separator

When the acquisition of produced fluid mixture after corresponding imported into the three-phase separator, mixed with a certain velocity will and separator imported baffle at the entrance of corresponding collision occurs, then the liquid will pass the entrance to the drainage pipe to the interior of the separator, according to the principle of the corresponding physical enables the mixture gas floating at the top, this completes the primary separation process. Using the density differences of the different liquids, the underlying oil-water mixture is also preliminarily separated, and further separation occurs through a settling chamber inside the separator. In order to further deal with the mixture of oil and water liquid, the three-phase separator is provided with a corresponding automatic adjustment device of constant flow of liquid, so as to control the speed of liquid flow, slow down the flow rate of liquid, and further promote the separation of oil and water. In this process, the liquid flow is treated with coalescence demulsification to separate the small oil droplets mixed with water in the oil layer, thus effectively improving the purity of oil layer and water layer. Through the separation device of oil and water liquid treatment, the oil in the upper layer will enter the oil chamber and

eventually discharged from the oil outlet, and the water in the upper layer will be squeezed into the water chamber, and finally discharged from the corresponding outlet.

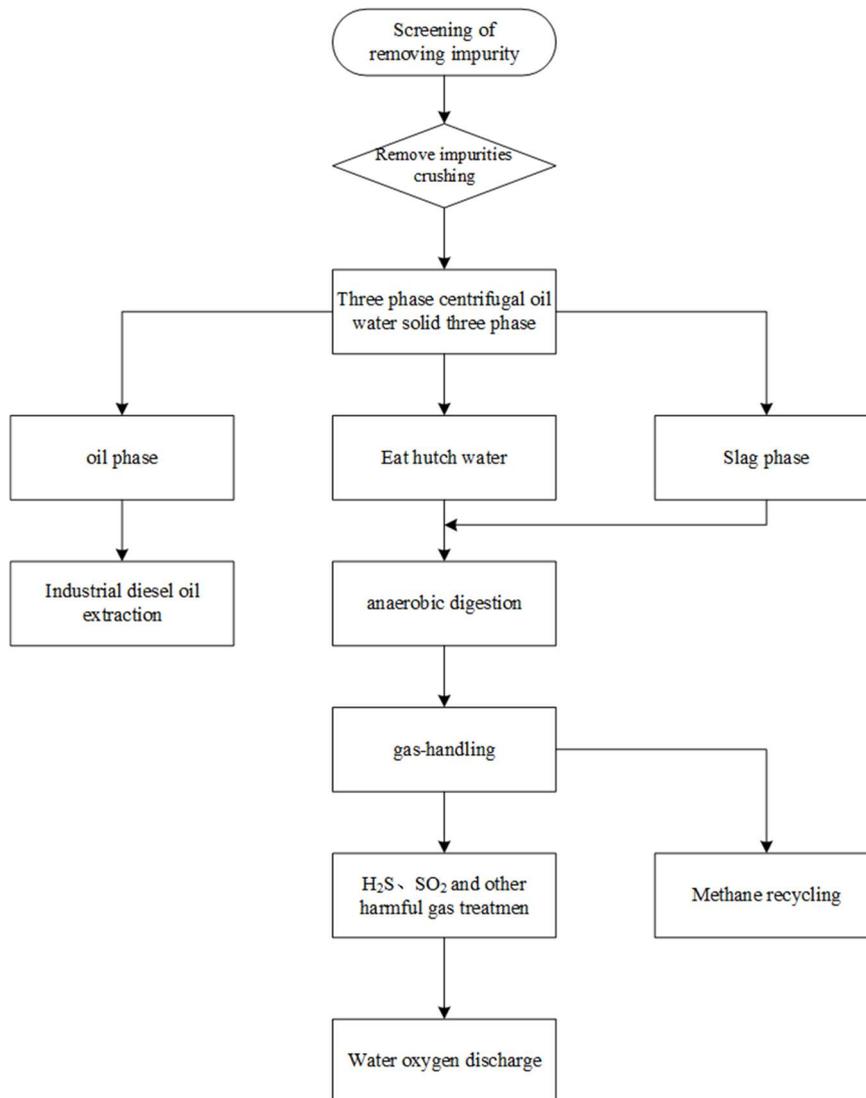


Figure 2. Working principle of three-phase separator

6. Fermentation System Design

Through the previous crushing, solid separation, oil separation, gas separation technology, etc., a layer of stainless steel metal mesh is set at the top of the fermentation mixing tank, and an appropriate amount of activated carbon package is placed to prevent odor pollution of the air caused by food fermentation process. Then turn on the constant temperature heating device to heat the kitchen waste rapidly and evenly, so as to reach the appropriate temperature of aerobic composting as soon as possible. At this time, the mixture of bacteria is automatically put in, and the strain combination of *Bacillus amylophilus*, *Bacillus cereus*, *Candida tropicalis* and *Candida albicans* is 2:2:1:1. The fermentation conditions were as follows: adding quality of kitchen waste and bran was 80:20, inoculation amount was 5%, fermentation temperature was 36°C, and fermentation time was 72 h. After that, the moisture content is reduced by heating, and the moisture content is controlled by about 30%. Turn on the blender and turn it to the proper setting to keep the food in constant contact with the air and prevent it from entering the anaerobic state. Finally, through heating, the finished fermentation products are dried, exported from the outlet and sent to the farm for fertilizer.

7. Oil Degradation Treatment Design

The organic waste is heated to 380°C under high pressure, and the fuel oil is produced by pyrolysis or hydrogenation for 20 minutes. One ton of dung can be made into half a ton of fuel oil, whose calorific value is equivalent to 75% of petroleum. All municipal organic waste can be refined into fuel oil. Using kitchen waste oil as raw material, a mixture of stearic acid and solid paraffin was used to prepare solid fuel with good combustion performance by catalytic esterification. By optimizing the conditions, the optimal preparation conditions of the fuel block were as follows: mixing fixative, kitchen waste oil, and the optimal reaction ratio with ethanol was 0.16:1:5; The optimum amount of NaOH was 7.5 g, the reaction temperature was 45°C, and the reaction time was 50 min. Under the optimal conditions, the solid fuel block with good performance was successfully prepared by using the kitchen waste oil from the canteen. The highest yield was 103.6 g, the combustion residual rate was 6.5%, and the average combustion time was 94.0 s/g, which were better than the common alcohol block in the market.

8. Design of Gas Treatment System

With the high temperature of the waste processor, a large amount of kitchen waste will produce CH₄, H₂S, NH₄ and other irritating organic gases will be released after the mixed strain fermentation technology, causing pollution to the atmosphere and bringing discomfort to the human body. The composition of malodorous gas is mainly ammonia, hydrogen sulfide, methyl thiol, methyl sulfide, trimethylamine and other fatty substances, the composition is more complex. Using the method of biofiltration and membrane combination to control the odor of kitchen waste, the results show that the removal rate of volatile organic gases (VOCs) is the highest, reaching 97%.

9. Design of Wastewater Treatment System

After a long time of kitchen garbage accumulation, garbage osmosis liquid will be produced. These garbage osmosis liquid contains high concentration of organic matter and ammonia nitrogen, and also contains a large number of acid and alkali substances and bacteria, which is easy to emit odor and breed mosquitoes. At the same time, it has the risk of pollution to surface water, groundwater, soil and atmosphere. The removal rates of chemical oxygen demand (COD) and ammonia nitrogen (NH₃-N) reached 70% and 88.6% respectively in the treatment of kitchen waste wastewater by airlift loop reactor. The concentration of NH₃-N and COD in the effluent can meet the requirements of GRADE B of GB/T 319622015 "Water Quality Standard for Sewage Discharged into Urban Sewer".

10. Conclusion

In this paper, the integrated intelligent treatment of kitchen waste is achieved by combining the pulverizing system, three-phase solid-liquid separation system, bio-anaerobic fermentation system, and gas treatment system using bio-filtration and membrane combination with raspberry PI for unified terminal intelligent control. Based on the innovative use of microbes in the process flow and type of operation, biological fermentation system in a comfortable temperature automatic devotion, mixed bacteria strain combination for solution of waxy starch bacillus, bacillus, tropical candida reconciliation fat candida for 2:2:1:1, using microbial fermentation with the method of avoiding the chemical agents for response to pollution to the environment; The biological method of biofiltration and membrane combination was also used to control the odor of kitchen waste. The removal rate of volatile organic gases (VOCs) in this method was the highest, reaching 97%. Different from traditional incineration and landfill, the system uses oil phase separated by three-phase separator to extract industrial diesel oil or process it into solid fuel. For the separated kitchen wastewater and slag phase, the system will undergo further anaerobic fermentation, producing gases: The methane can be recycled, used for restaurant or a family, the rest of the harmful gas such as carbon monoxide, sulfur dioxide, nitric oxide will be safely disposed into water and oxygen substances such as standard after discharge, the remaining residue can also be made into farmyard manure for fertilizer, truly

achieve the green processing and recycling utilization of resources, has reached the requirement of energy conservation and emissions reduction, In response to the concept of "lucid waters and lush mountains are gold and silver mountains".

This paper uses Arduino and the Internet of Things platform to realize the intelligent environmental protection treatment, recycling and recycling of kitchen waste, which to a large extent alleviates the pressure of kitchen waste treatment and achieves green and sustainable development. Not only can achieve environmental protection, but also can realize the recyclable utilization of resources, is the inevitable requirement of developing low-carbon economy to achieve carbon neutrality, but also the inevitable trend of the development of kitchen waste treatment technology in the future. With Arduino and the Internet of Things platform, it has realized the intelligent environmental protection treatment, recovery and recycling of kitchen waste, realizing green and sustainable development. Not only can achieve environmental protection, but also can realize the recyclable utilization of resources, is the inevitable requirement of developing low-carbon economy to achieve carbon neutrality, but also the inevitable trend of the development of kitchen waste treatment technology in the future.

References

- [1] Zhongjing Huicheng Planning and Research Institute. Summary of experience on core problems of urban ecology!
- [2] China Solid Waste network -- Food waste treatment attention as early as possible.2020.
- [3] Sun Hongwei, XIAO Zhenghong. Principle and Application of Open Source Hardware Arduino UNO [J]. New Campus Journal, 2013(9):45-45.
- [4] Liang Jing-bo, Yang Wei, SONG Zhen-yu, Yuan Shan-shan, ZHANG Jing-hui, Chen Guan-Yi.
- [5] Runlin WANG, Ge Le Li, Yuxuan Ying, Linlin Yang, Huifang Qin, Zhiyinghong ThIM.
- [6] Wang Pan, Ren Lianhai, Huang Yanbing. Journal of environmental science and technology, 2014, 37(7): 157-161. Wang P, Ren L H, Huang Y B. Source profiles of odors from the plant of converting food waste into feed [J]. EnvironSciTechnol, 2014, 5 (7): 157 - 161.
- [7] Lelicinska-Serafin K, Rolewicz-Kalinska A, Manczar- ski P. VOC removal performance of a joint process Cou- pling biofiltration and membrane-filtration treating Int J Environ Res Public Heal, 2019, 16(17): 300 9.
- [8] Wang Han, WANG Chen, Tian Xing, et al. Treatment of greasy kitchen waste wastewater by airlift loop reactor [J]. Industrial safety and environmental protection,2014,40(9):23-26. Et al. Expremental study on treatment of degreased food waste wastewater by AIR - LIFT LOOP REACTOR [J]. Ind Saf Environ Prot, 2014, 40 (9) : 23 - 26.
- [9] Wang HUAxiang, ZHANG Shuying. Principle and Application of Sensor (Revised Edition)[M]. Tianjin University Press, 1999.
- [10] Wang Shan, SA Shixuan. Introduction to Database System (5th edition)[J]. China University Teaching, 2018, No.333(05):100.
- [11] Sun Weiqin, Li Hongcheng. Tomcat and Java Web Development technology in detail [M]. Publishing House of Electronics Industry, 2004.