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HANDLING OF RESTAURANT WASTE IN CHINA

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ABSTRACT

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In developed countries such as the United States, Japan and South Korea, recycling of restaurant waste has long been on the track of legal development and has become a relatively comprehensive environmental protection industry. However, China's recycling of restaurant waste is still in its infancy. It is of major practical significance to choose a scientific way to deal with waste.

This thesis introduces several kinds of restaurant waste treatment technologies, and compares them to identify the advantages and disadvantages, operating costs and comprehensive income of each technology, and then According to China's national conditions, identify the restaurant waste treatment methods suitable for China. According to the above analysis, there are anaerobic digestion technology, aerobic biochemical treatment technology and biodiesel extraction technology suitable for restaurant waste treatment in China.

Key words

Aerobic biochemical treatment, anaerobic digestion, biodiesel extraction, microbial degradation, restaurant food waste

CONCEPT DEFINITIONS

list of Abbreviation

CH_4---- Methane

CO_2---- Carbon dioxide

FWD--- Food waste shredder

H_2---------- Hydrogen

H_2S----- Hydrogen sulfide

NH_3---- Ammonia

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1 INTRODUCTION

In China according to the latest population statistics, the total population of mainland China at the end of 2019 was 140.5 million, with about 9 million restaurants. The resulting food waste increases every day and the ingredients become more complex. According to the relevant data provided in the 2012 China Statistical Yearbook, the weight of urban household waste in China in 2011 was about 164 million tons. When the proportion of Chinese restaurant waste is about 25 % to 30 %, accounts for about 40 % to 60 % of the total amount of organic waste (Wang, Guang & Meng 2005) .Therefore, it can be concluded that China's urban restaurant waste reaches 40 ~ 50 million tons per year, which is much larger than 26 million t in the United States and 20 million tons in Japan (Li C. 2012). In addition, some statistics show that as early as in 2000, the annual total amount of restaurant waste in China was as high as 45 million t, with an annual growth rate of about 10 % and by 2012 it had exceeded 100 million t (Zhang, Wang & Xu 2007). It is estimated that more than 150 million t of food waste will be generated each year by 2020. If such a significant amount of restaurant waste is not solved in time, it will cause serious environmental pollution. Therefore, effective disposal of restaurant waste has become an important part of China's ecological and environmental protection. Based on the characteristics of Chinese food culture and residents' lifestyle, this thesis work analyzes these components and analyzes the disposal of Chinese food and restaurant waste.

In China problems such as "administrative obstruction" and "technical obstruction" have emerged in how to deal with waste. The solution to "administrative obstruction" is to improve the management and treatment system. Government departments at all levels are attaching importance to and increasing the investment in this aspect, and compulsively implement waste classification and release. As for other "technological obstacles", apart from the comprehensive utilization of various existing treatment technologies, it is imperative to develop new technologies to improve the recycling rate of restaurant waste. (Zhang, Wang & Xu 2007)

The theoretical significance is as follows: first, deepen the understanding and cognition of restaurant waste and realize the importance of promoting the management legislation of restaurant waste in China. Secondly, with the development of society and economy, the catering industry develops accordingly. Restaurant waste may cause a series of environmental problems. This is of great significance to the theoretical research on its prevention mechanism. The practical significance is as follows: first, environmental protection benefits not only the current generation, but also the generations to come. The study

of the environmental problems caused by restaurant waste is not only beneficial to the protection of the interests of the current generation, but also beneficial to the protection of the interests of future generations. Second, in order to carry out the concept of circular economy development, this need to be in the process of economic development should pay attention to environmental protection. With the vigorous development of the catering industry, restaurant waste damage caused to the environment has been significantly more serious, this needs us not only to ensure the steady development of food industry, but also should pay attention to scientific management of restaurant waste, must set up sustainable development view, so as to promote sound and rapid economic development of china. It is imperative to explore the legal regulation of environmental problems caused by restaurant waste. Thirdly, through the exploration of the legal countermeasures for the management of restaurant waste, the public's understanding of restaurant waste can be improved, leading them to start to reduce the amount of restaurant waste by themselves, thus reducing the amount of restaurant waste from the source.

Research purpose: Objective of the study: to propose three key governance strategies based on an analysis of economic, environmental and social benefits and to establish a hierarchy. Analytical model for comprehensive evaluation. The food waste treatment method suitable for China was obtained (Hu, Zhang, Yu & Zhang 2011)

2 INTRODUCTION TO CHINESE RESTAURANT WASTE

Restaurant waste comes from a wide range of sources, mainly in the household life of residents, the catering industry and the internal canteens of enterprises and institutions. The amount of restaurant waste produced by each household is small but impressive. One restaurant produces several times as much food waste per day as several households. The rapid growth of the catering industry has brought economic development and a large number of workers, as well as a large amount of restaurant waste. About 50 million tons of restaurant waste are generated in Chinese cities each year, and about half of the total is from urban household waste. These numbers show the amount of food waste produced. (Zhao S. 2019)

2.1 The composition of restaurant waste

Restaurant waste refers to the leftover materials dumped by residents during the process of daily food processing and the food waste formed after food consumption (also known as "bath water") (Zhao Z. 2003).Restaurant waste involves restaurant waste and swill. Its sources mainly include the following three aspects, residential communities for urban residents, social restaurants (all kinds of hotels, restaurants, snack bars and food stalls), colleges and universities, enterprises and institutions, government agencies and other collective dining restaurants (Qiao, Guo & Li 2012). When Chinese restaurant waste refers to the seeds of melon and fruit skins, vegetable roots, egg skins and leaves discarded by residents during washing and cooking, these wastes are generally solid without being heated. Slop is the leftover scraps left over after a resident's meal., metamorphic food and scorched the food. The cooking ingredients consist mainly of rice flour food scraps, shark fin soup, meat, bones and shells, dried small shrimps, waste oil and some wooden tableware, paper towels and many kinds of composition of the mixture. There may also be a larger scale bar bone, glass, pottery and porcelain pieces, small metal vessels (such as steel spoon, fork) special substances, such as general solid-liquid mixed state. Taking a city as an example, the following TABLE 1 shows the components of restaurant waste in detail (Zhao Z. 2003).

TABLE 1. Composition analysis of restaurant waste in residential communities, social restaurants, enterprises and institutions (adapted from Zhao 2019)

	Residential district	Social restaurant	Enterprise restaurant
Total amount of sampling Kg	35	30	10
Of restaurant-waste Kg	65.88	80.18	71.15
plastic Kg	12.13	5.88	6.73
ash Kg	4.26	0.2	0
Paper napkin Kg	8.03	5.23	4.81
Table linen Kg	2.03	1	0
metal Kg	0.22	0.3	0
glass Kg	2.04	0.35	9.62
wooden Kg	0.21	0.35	0
other Kg	5.20	6.51	7.69

The TABLE 1 shows that a large proportion of the rubbish produced in these places is food waste, which is extremely perishable. Dry waste is about 46 % carbon, 6.5 % hydrogen and about 3 % nitrogen. Among the waste in hotels, restaurant and restaurant waste in hotels accounts for about 80 % of the total waste, and food and beverage waste in residential areas accounts for about 65 %, indicating that food and restaurant waste accounts for a high proportion in these areas (Zhao Z. 2003).

TABLE 2. Ingredients of restaurant waste (adapted from Zhang2015)

Average water content	87 %
Average solid content ratio	13 %
Protein accounted for	15 g/100 g
Salt proportion	0.2 %-1.0 %
Carbon ratio	360 g/kg
C/N ratio	15 %
Organic acid ratio	1500 mg/L

According to the table, the key components of restaurant waste are water, bone, oil, meat, grain, vegetables, and a few toothpicks, tableware, napkins. The key chemical components include cellulose, lipids, starch, proteins, inorganic salts, etc., while containing few trace elements such as N, P, K, Ca, Na, Mg.

2.2 Features of restaurant waste

Different regions of China have different levels of economic development, different living habits and dietary structures, and different seasonal changes directly lead to differences in waste types and elements, as well as differences in quantities. (Wang, Ma & Tu 2004), but restaurant waste composition has great similarity with the physical and chemical properties in terms of the total. For example, Lin Weiying (Lin 2012) sampled and analyzed the canteen swill of Beijing University of chemical technology, and the results showed that the content of organic matter in the restaurant waste was about 92.25 %, mainly composed of four categories, namely starch, crude protein, crude fat and crude fiber. The contents were 36.82 %, 15.34 %, 16.19 % and 8.62 % respectively. Wang Mei (Wang M. 2008) sampled the waste from the student canteen of tsing hua university and found that the contents of key nutritional elements in the food waste ranged from 16.58 % to 27.85 % of crude protein, 19.85-41.78 % of crude fat, 2.61-4.64 % of crude fiber, 0.28 %-2.17 % of calcium, and 0.44 %-1.38 % of phosphorus. Ma lei (Ma, Wang & Xie 2009) analyzed the restaurant waste in the canteen of south China agricultural university, and the results showed that Hydrocarbon ratio was about 16.58, phosphorus content was 1.96 %, and potassium content was 0.33 %.In order to further explain the physical and chemical characteristics of restaurant waste, the data of physical and chemical characteristics analysis of restaurant waste in relevant literature on regional distribution in China are listed for statistical. Some results are shown in TABLE 3.

TABLE 3. Statistical table of chemical properties of food and restaurant waste disposal (2008-2012) (adapted from Lan 2004)

Sources of food waste	Water accounted for %	Organic matter ratio %	C/N ratio %	PH	The author	The annual

(continues)

TABLE 3.(continues)

China Pharmaceutical University	72	93.9			Xiyi Zhuang (Zhuang, Chu, & Ma 2012)	2012
Nanjing University,	84.78	92.95	20.1	6.9	Qiaoling Wang (Wang, Chen & Gong 2012)	2012
Suzhou Industrial Park	75.8	96.1	22.8	5.3	Jing Li (Li & Li 2012)	2012
Beijing University of Chemical Technology	77.7	82	14.16	5.13	Qilong Zhong (Zhong, Li & Li 2012)	2012
Yingkou city, liaoning province	77.64	93.27	17.22		Tie Li (Li, Li & Zhang 2012)	2012
Guangxi University,	89.45	92.29	17.78	4.85	Yang Liu (Liu, Huang & He 2012)	2012
South China Agricultural University (SCAU)	79.81	90.69		4.23	Yunqin Lin (LinYunqin, Wang & Li 2011)	2011
Central South University (CSU)	83.2	93.7		5.7	Longsheng Yi (Yi, Rao & Wang 2011)	2011
Qinghua University, Beijing	79.01	80.21		6.58	Lianhai Ren (Ren & Nie 2009)	2009
Huazhong Agricultural University	83.93	92.3	22.36		Yanchang Wang (Wang , Yuan & Xie 2009)	2009
Beijing Business and Economics University (BBU)	73.34	96.88	32	3.9	Xiao Meng (Meng, Han & Ren 2008)	2008

Through the analysis of the composition and physicochemical properties of restaurant waste determined by the above researchers, it is found that although the sources of restaurant waste are different and the components are complex, they are mainly starch, fat, protein and cellulose (Fan, He & Shao 2003), showing higher moisture content and higher organic content. According to Chinese cooking habits, it also has the characteristics of high salt content and high fat. In general, restaurant waste has the following characteristics, High moisture content. In general, since there is often super-saturated soup water in the restaurant waste, the content of free water is far more than the content of organic matter, reaching more

than 90 %. As a result, the restaurant waste that has not been pretreated almost shows fluidization. Meanwhile, the high salinity of restaurant waste is mostly in free water. Higher water content directly leads to the disposal of waste, collection and transportation are facing many problems, leachate and other contaminants can easily form if left untreated, waste leachate can rely on surface runoff and infiltration of surface water and groundwater, etc. to produce greater pollution.PH value is lower than 7, which is acidic. Under normal circumstances, People place their slop buckets directly into the outdoor environment, restaurant waste vulnerable to microbial contamination of the environment. As long as the temperature, humidity condition is appropriate, such microbes began to grow and form many of the elements of the food enzymes, make rubbish component broken down into small molecular weight peptides, organic acids and cause waste of decaying, at this time will produce ammonia smell and sour; And fruit, vegetable, fresh meat enzyme activity is very strong, in the absence of microbial conditions can also be decomposed. So when you stay away from it for a while., the pH level of restaurant waste will drop. In the dry matter of restaurant waste, the quality fraction of organic matter is more than 80 %. In addition, it is rich in N, P, K and other trace elements that can be used as important nutrients of plants. C/N is between 10 and 30, which is rich in nutrition and easy to be degraded by microorganisms. (Lan 2013)

2.3 The dangers of restaurant waste

Compared to other wastes, eating litter is extremely nutritious, contains fewer inert substances and toxic and harmful substances, and has less long-term storage of bacteria. The virus in turn attracts a large number of flies and mice, a "breeding ground" for bacteria and viruses. If they are not treated in a timely and effective manner, they will cause the massive spread and multiplication of germs, which will be detrimental to the ecological environment and human health The impact can even reduce its recycling while making the duality of eating nesting material both wasteful and resourceful (Qi, Sun & Li 2012) .

Chinese residents usually used to mix restaurant waste and living waste bags, and then delivered to a trash can designated by the sanitation department. Due to the high content of moisture and organic matter in the food waste, the food waste has a high content of moisture and organic matter, so on waste collection, implantation, during carrying, short-term decay can easily occur, releasing odors into the atmosphere., deteriorating urban environment health, bad influence on human vision and the sense of smell. At the same time, a mixture of both change the composition and characteristic of the living waste, if using the method of incineration to treat the living waste, and low calorific value and high moisture content of restaurant waste not only to meet the waste burning power generation of calorific value. the

requirements of the relevant even due to incomplete combustion dioxin emissions into the air by lead to environmental damage (Qi, Sun & Li 2012) .

In the process of storage and transportation of restaurant waste, due to the poor sealing effect of equipment, the swill in the waste is easy to leak and pollute the road. If the untreated waste leachate flows into the urban sewer, it will increase the concentration of organic matter in sewage and increase the burden and treatment cost of the sewage treatment plant. At the same time, due to the low temperature in the sewer pipe, the waste oil in the leachate is easy to condense in the pipe, which affects the patency of the drainage network of the city. When the displacement is high, sewage backflow is likely to occur, which will hinder the sanitation of the city. If the leachate infiltrates into the surface and then mixes with groundwater along with the runoff and flows into rivers, it will also pollute the water environment, causing the deterioration of water quality and causing the death of organisms due to hypoxia and asphyxia (Zhang A. 2011).

A lot of restaurant waste is dumped in the countryside, which takes up a lot of land. However, the salt contained in restaurant waste can easily cause the salinization of the soil after accumulating in the soil for months. When the restaurant waste with high water content and oil content is covered on the ground, it will lead to the formation of anaerobic zone in the soil of the region, damage the soil biodiversity, deteriorate the soil structure and cause hardening (Zou 2010).

Harmful to human health. In China, restaurant waste has long been used as feed for livestock and poultry. But without any pretreatment, most of the cent restaurant waste has ferment in storage and transportation process, and develop a variety of pathogenic bacteria such as staphylococcus aureus, campylobacter and salmonella, hepatitis virus, swine fever germs. after being livestock and poultry meat, germs will produce harmful substances through the digestive system to accumulate in the body, and induce a variety of diseases. After people eat these animals, the toxin will be transferred to the human body through the biological chain and accumulate, causing cross-infection, leading to chronic poisoning or various zoonotic diseases. At the same time, there are also potential safety risks of protein homology (Hu, Zhang & Yu 2012).The harm that causes to natural human health basically is acute, chronic harm, acute harm Irritant gases such as H_2S and NH_3, which are produced in the process of food waste corruption, can directly cause respiratory diseases. According to the survey, children born near waste plants have been found to have higher-than-normal rates of birth defects, and the main culprit is the long-term effects of pollution. (Zou 2010)

Influence food safety restaurant waste management is the main way of Chinese restaurant owners to door-to-door to collect processing. untouched its processing, so restaurant waste in the waste oil may appear by some illegal workshops to buy or collected from sewers. through a series of processing, be refined into the so-called "gutter oil", mixed with oil for sale, back to the table. In recent years, the "illegal cooking oil" events occur frequently in major cities in China, and cause the important attention of the whole society, "gutter oil" containing heavy metals, toxins, bacteria, etc., is likely to cause physical discomfort after eating, cause illness, and even cancer, threat to food safety, endanger human body health, cause great hidden losses to the society. At present, China's population is growing year by year, the catering industry is thriving, people's living standards are changing with each passing day, and the proportion of restaurant waste is increasing every year. Is as a kind of high development value of the biological resources, to standardize management of restaurant waste and recycling use effectively, not only can prevent the damage to the environment, also can realize resource waste reuse, thus promoting the tense situation of materials and energy, promote the prosperity of society became more, and to society, economy and environment, can produce profound effect. (Hu, Zhang & Yu 2012)

3 TRADITIONAL DISPOSAL OF FOOD WASTE

A great deal of basic and applied research has been done around the world on the scientific and rational treatment of food waste. Landfilling, shredding, incineration, and simply adding work feed are still used to varying degrees for food waste. In the next section, we will detail several traditional food waste disposal methods. (Li, Jin & Li 2011)

3.1 Landfill of restaurant waste

The landfill of kitchen waste is based on the metabolism of microorganisms. The bacteria decompose the biodegradable organic components into landfill gas, and the remaining parts are stabilized to humus. At the same time, leachate is formed. The key elements of landfill gas are CH_4(methane) and CO_2(carbon dioxide), which respectively account for 50 % ~ 65 % and 30 % ~ 40 % of the landfill gas volume (Wei 2015).Both CH_4 and CO_2 are greenhouse gases. If they are not collected and released naturally, they will have a negative impact on the atmospheric environment. Methane is a renewable energy source with high calorific value, which can be used efficiently and reduce carbon emissions through effective management of landfills. However, the output and elements of landfill gas are limited by the performance of restaurant waste and the way of landfill. It has also been reported that the carbon emission of landfill disposal of restaurant waste is different due to the different disposal methods. Generally speaking, aerobic pretreatment plus landfill and anaerobic landfill will cause a gradual increase in carbon emissions in the sequence (Li, Jin & Li 2011).

Nowadays, there are relatively many mixed landfills of restaurant waste and other waste. This objective reality is mainly due to the convenience of home disposal and municipal transportation, which is also an important reason for the low output of landfill gas, and the reason why most landfills in China are reluctant to collect landfill gas (Liu & Zhang 2011).Although the mixed landfill disposal of restaurant waste and other waste has its historical significance in the process of urbanization, it will cause many adverse effects on the environment. Due to its high moisture content and high organic composition, when waste is disposed of in landfills, large quantities of leachate with high organic content are inevitably produced., and failure to properly treat it will inevitably lead to secondary pollution of groundwater and even surface water. Landfill gas, if not used, increases carbon emissions. What is more prominent is that the emission of volatile organic compounds (VFAs) during landfill will directly pollute the air and pose a

direct threat to human health.In addition, landfills often occupy a large area of land, and the space suitable for landfill is very limited, which leads to the embarrassing phenomenon that landfill disposal cost is not the lowest. At the same time, landfill usually takes the elimination and reduction of volume as the fundamental goal, and most of them are difficult to make reasonable use of, which is contrary to the situation of waste utilization in China and doomed to be eliminated in the future. (Li, Jin & Li 2011)

3.2 The shredding of restaurant waste

Comminution direct row refers to the assembly of food and restaurant waste comminution equipment (FWD) through the kitchen sewer interface, which is directly discharged to the municipal sewage pipe network after comminution. FWD disposal method is to avoid restaurant waste discarded and transport cause the secondary pollution phenomenon, can increase the advantages of the carbon source for municipal sewage treatment plant, however, restaurant waste in the utilization of the role of big discounts, into the shattering of the sewage treatment plant organic matter is basically stable directly to the CO_2 (Md, P & C 2008), only incremental excess sludge can be used as anaerobic digestion for energy conversion, recycling. Therefore (P, F & D 2007), FWD is not a sustainable option for large and medium-sized cities, and only areas with relatively dispersed populations may have the need for application. Although the allowable installation rate of FWD in American cities is more than 94 %, and the cumulative installation rate at home is more than 50 % (N & M 2005), this does not mean that it is an international trend of application, because the preconditions for the installation and application of FWD are quite strict everywhere (Protection, New York City Department of Environmental 1997).FWD has also started to be applied in some communities in China (Xu H. 2015), but neither the sewage acceptance nor the adaptability of sewage treatment plants have considered the additional load brought by FWD. In addition, the use of FWD requires electricity and water consumption, which raises questions about its further application and sustainable disposal of restaurant waste.

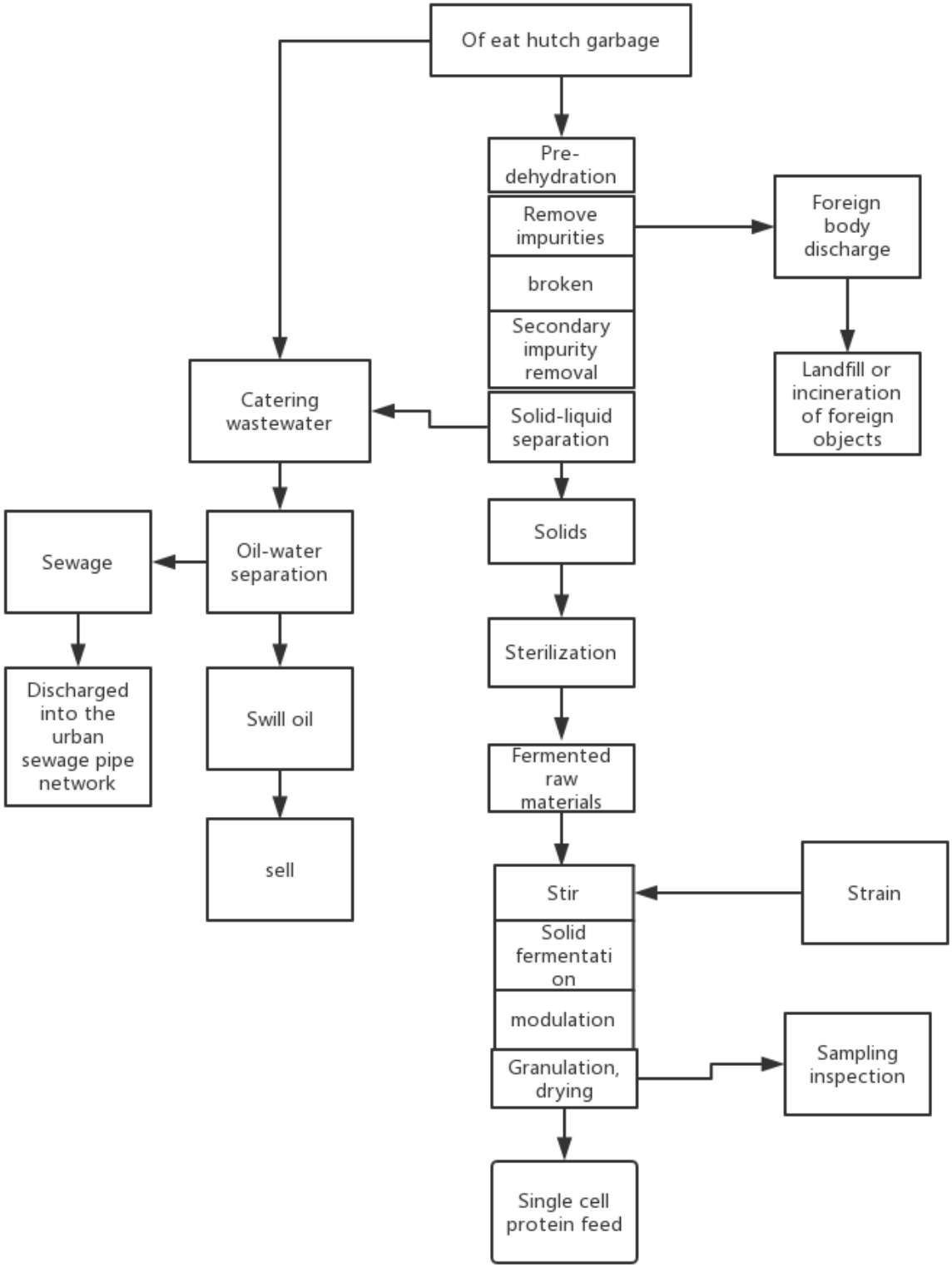
3.3 The burning of restaurant waste

Today, many areas with loose waste management tend to burn both restaurant waste and household waste together, which can reduce waste by more than 90 %. However, in regions where waste management is relatively strict for some technologically developed people, waste combustion enterprises are often established to generate electricity with the heat energy obtained from waste combustion. However,

because restaurant waste contains so much water, it is usually more than 90 %, with a calorific value of between 2,100 and 3,100 kj/kg. In addition, when burning at the same time with other wastes, it is usually difficult to meet the thermal energy demand of waste burning for power generation, which leads to a large amount of investment. Meanwhile, waste gas treatment is also a difficulty. The combustion process will lead to a lot of harmful gases, leading to environmental damage. (Dong 2007)

3.4 Feed disposal of restaurant waste

Feed processing technology essentially use high temperature heating and other methods to heat restaurant waste, through drying, sterilization and other operations, salt removal. can finally generate protein feed additives, swill oil and other substances that can be used by people. The process flow chart is as follows (GRAPH 1).



GRAPH 1. Feed processing flow chart (adapted from Dong 2007)

The process includes impurity removal, crushing, screening system, solid-liquid separation system, feed production system, cooling and screening system, and fine crushing system. The advantage of secondary processing technology is the high level of mechanization, small area, and the efficient use of resources. The downside is that protein feed additives re-penetrate the food chain and eventually return to the human body. Now various sectors of the country are also beginning to analyse the risks of waste disposal. (Dong 2007)

3.4.1 Safety of single - cell protein feed

As a kind of animal feed, the safety of single cell protein feed must be evaluated strictly. The Food and Agriculture Organization of the United Nations (FAO), the World Health Organization (WHO) and other agencies have set up special committees to assess the waste problem in order to determine whether single-celled proteins can be used as feed, food and other problems. Among them, the specific requirements of the product to ensure that there is no raw materials, no living cells, no bacteria and so on. The final product has to be tested on animals, such as mice, and the FOOD and Drug Administration (FDA) mandates that carcinogenic substances, such as mycotoxins, polycyclic aromatic compounds, heavy metals and the heritability of bacteria, must be fully evaluated (Zheng, Xue & Jin 2004).

3.4.2 Single cell protein feed problem

Single-cell protein contains a variety of nutrients and has a high utilization rate. It is used in "artificial meat", food additives and feed. As far as single-cell protein feeds are concerned, the following issues need special attention, high nucleic acid content (Luan 2004).The content of RNA in yeast protein ranges from 6 % to 41 %.In bacterial proteins, RNA is only 13 to 22 %. The nucleic acid absorbed by the livestock through feeding will evolve into the insoluble uric acid (due to the lack of uricase in the livestock, which cannot be neutralized with uric acid) and deposit in the animal's joints through the blood circulation. Over a long period of time, animals can develop a variety of joint diseases, such as gout. It was observed that the metabolic rate of purine in the liver would increase with the production of uric acid, which would easily cause urinary stones and metabolic imbalance. In order to avoid livestock diseases caused by high accounting content, the proportion of total protein should be strictly controlled (no more than 15 %). Bacterial proteins can damage animal bodies, so microbial matrix should be strictly selected. Compared with conventional protein, if the feed contains single-cell protein, the digestibility

of animals will be 10 %~15 % lower. Because when the feed protein is mixed with a single cell protein containing a toad or mannose, the animal's ability to digest the protein is reduced. If single-cell protein feeds are fed to livestock, the animals will be deficient in amino acids. In order to balance the proportion of amino acids in feed, it is advisable to add arginine and methionine to single cell protein. Single - cell protein has special nutritional function, in some aspects of nutritional value than soybean meal, fish meal. There are many defects in the bacteria. However, as long as the scientific solution to the single-cell protein problem is proposed in the following treatment process, the advantages of single-cell protein feed can be fully exploited (Zheng, Xue & Jin 2004).

3.4.3 The production process of single cell protein feed

Because restaurant waste contains a lot of plastic bags, one-time tableware, bottle cap to wait in, if this kind of impurity does not undertake eliminate, can affect the quality of final product. The removal should be arranged before the crushing operation, so as to prevent the large pieces of impurities from forming a large amount of debris and those useful substances mixed together. If so, it will be difficult to screen the restaurant waste behind the crushing. If you do not remove impurities, the final feed will contain a lot of indigestible substances, which will cause harm to the animal's body. Pre-dehydration steps should be performed prior to screening of restaurant waste. That is, through the free flow of water out of the restaurant waste, to achieve the goal of early dehydration. Generally speaking, in order to better deal with restaurant waste, a multi-step process is required. First, break away most of the crap. Secondly, break away the broken garbage. After that, enter the re-screening process. Remove impurities from the sieve. After impurity removal, the sieve will be broken several times. The aim of the first screening is to break away impurities with relatively large particle size. Through re-screening, small particle size waste can be eliminated, and then all kinds of inedible impurities can be maximized. Compared with the later classification, the source classification can reduce the difficulty of the later work and speed up the processing of restaurant waste. Therefore, it is necessary to negotiate with the first staff to deal with food and restaurant waste in advance, and inform them to sort and pile food and restaurant waste, and not to mix impurities in the waste. This will make the process easier. (Yang & Xiong 2004)

For materials such as broken bones, leftover food and peel, it is necessary to improve the fluidity of waste through crushing treatment, so as to facilitate the separation of solid and liquid. In addition, after the residue is broken, the gap between them will be reduced, the density will be increased, and the storage

space will be saved, so that it can be compressed. The choice of crushing means should be made according to the end product specification and waste type. According to the difference of crushing force, the crushing method of mechanical energy and non-mechanical energy can be obtained. The former needs to be torn under crushing tools, impact, extrusion, friction solid waste to achieve crushing. The latter includes ultrasonic, thermal and low-temperature crushing methods (Yang & Xiong 2004).If the crushing effect is to be improved, two crushing methods can be used in combination.

Since restaurant waste has a large water content, if the liquid is not separated in advance, it will have a serious impact on waste distribution, crushing and fermentation. Pre-dehydration only allows the liquid to flow out of the restaurant waste by itself. The dehydration effect is far from the requirement, and the waste still contains a large proportion of water. Therefore, reliable solid - liquid separation method should be adopted to completely remove the water from the waste. (Yang & Xiong 2004)

Separation of oil and water in food and beverage waste, generally with high oil content and sufficient mixing with water and garbage. In addition, the operation content of restaurants and eating habits vary greatly from place to place, so the composition and proportion of oil in the recycled restaurant waste are not fixed. After separating the waste from the liquid, most of the grease exists in the liquid in various ways. For example, floating, dissolving, dispersing, (Jia & Tang 2002). The difference of oil distribution has an effect on the selection of oil and water separation method. In the oil and water, 50 %~60% of the oil is the oil with a particle size of more than 30. Oil particles or oil films can be seen floating on the surface of the liquid after standing. In the restaurant waste water, 35 %~45 % of the oil is dispersed oil with particle size of 1~30.In the water phase, the oil is suspended and dispersed. The dispersed oil will not remain in this state for long, but will produce different changes. For example, the oil collects by constantly gathering and then floating on the surface of the water, or the particle size may also become smaller. If the oil particle size is less than 1, it is called emulsified oil. In oil and water, this kind of grease accounts for 3 %~5 %. It exists in the form of suspension and dispersion in the aqueous phase in the form of water-in-oil. In the oil, there are also dissolved oil dispersed in the water phase in the molecular state, and its content is 0.5 %~1.5 %.Such oils have a very stable relationship with the water phase (the two form a homogeneous system), similar to mixing with each other. So, a particular approach to elimination is needed. On the surface of solid restaurant waste, it can also adhere to a lot of grease and the formation of oil-solid. This kind of grease accounts for 2 %~6.5 % of oil wastewater. Because of the crushing operation, the proportion of oil already in this form will obviously be reduced. The degree of difficulty in treating oily wastewater is related to the existence form and stability of grease in contaminated water sources (Xu & Zeng 1991).The separation effect of coarse particle purification method

is about -2 meters, which can completely eliminate the oil fraction with particle size between 5 and 10.In this method, a special coarse-grained medium is used, which facilitates the bonding of oil beads. The structure is relatively compact and can remove oil efficiently. The oil - solid, dispersed oil and floating oil can be effectively removed from the waste water. Coarse granulation method does not need to add chemical reagents, high separation efficiency, simple facilities, low infrastructure costs, the choice of coarse granulation materials including ceramsite, anthracite, polystyrene spheres. However, it should also be used in a way that avoids its shortcomings. For example, the presence of trace surfactants makes it difficult to break away emulsified oil effectively.

Naturally stored restaurant waste is prone to deterioration, which can lead to food poisoning and food waste quality change. When food spoils, it produces all kinds of harmful bacteria, such as bacillus, staphylococcus and streptococcus. Some of the bacillus species are toxic and can cause food poisoning. Staphylococcus can cause suppurative infection, toxic shock and scald-like skin syndrome. Streptococcus can cause purulent verification and scarlet fever, rheumatic fever and other diseases. Restaurant waste contains complex ingredients that, if left untreated for a long time, will become a major health hazard. In high temperature pretreatment, the water in the waste can be heated. Under the action of hot and humid steam, it can coagulate the protein and realize the effect of disinfection and sterilization. If the raw material of single-cell protein feed is restaurant waste, the sterilization temperature should be set at 121 ℃ and maintained for 20min in order to effectively eliminate all kinds of pathogenic bacteria in the waste. After many experimental observations, it was found that the treatment temperature and duration could achieve the following effects (Wu S. 2004). First of all, under the high temperature environment for a long time, effectively destroys bacteria, viruses and microorganisms in food waste. This also can avoid inoculating bacterium, miscellaneous bacterium appears the phenomenon that competes for food nutrition. Secondly, under the high temperature environment, it can effectively decompose the protein and starch sugar in the waste, and improve the fermentation effect of microorganisms after full absorption. Mix and stir after oil and water separation, disinfection and sterilization of restaurant waste, it is necessary to mix it with the pre-cultured vaccine effectively. The fermentation effect can be improved on the basis of mixing materials and seedlings (Xu & Zeng 1991).

Solid fermentation Fermentation has applications in food, chemistry, biology and other fields, and is an important method for preparing biological bacteria. The solid fermentation process has low energy consumption, low investment and simple medium, which has been applied in soy sauce production, compost, cheese processing and other fields. Compared with liquid fermentation, solid fermentation is more suitable for fungi. It is difficult to detect and regulate fermentation parameters, and substances cannot

be added uniformly. The productivity is relatively low. However, solid fermentation can produce special products with low yield per unit area, no waste, no foam, simple fermentation process, and different flavors of food can be obtained. In addition, solid fermentation does not have special requirements for machinery, which is very suitable for ordinary families. From the perspective of fermentation cost, there are more available raw materials in solid fermentation, less facilities needed, fewer fermentation steps and lower cost. However, liquid fermentation has strict requirements on the fermentation equipment and technology, so the operation risks are large. If contaminated by miscellaneous bacteria, can almost scrap. Solid fermentation can basically use large-scale production, can be small scattered growth, but also can be partially mechanized or mechanized centralized production, production means are the key fermentation pool method, winding method, fermentation machine, etc. (Wu S. 2004)

Tempering, granulating and drying the surface area of feed is directly related to the pulverized particle size. If the content of moisture infiltration in the material is increased to speed up the gelatinization and granulation of the material, the particle size can be reduced .Considering the change of feeding environment, in order to ensure that the physical structure of the feed will not be damaged in the humid environment, many manufacturers will process single-cell protein into feed grains. Usually, the processing method and feed prescription have important influence on whether the granule can keep its original state after being exposed to water. According to the research, among all kinds of factors affecting the grain quality, the strongest one was the feed prescription, which was 40 %.The proportion of modulation and grinding is 20 % respectively, the film pressing method is 15 %, and the remaining 5 % is cooling and drying effect (Behnke & Qing 2005). The performance of feed material in pelletizing difficulty determines the pelletizing efficiency and quality. For single-cell protein feeds, granulation is less difficult because they contain a large amount of protein. The granulation obtained is difficult to melt in water (Yang & Jiang 2003).Tempering and tempering is also an important means to improve the quality of pelletizing, which can speed up the conversion from starch to cooked powder. The speed of pelletizing and the effect of pelletizing are related to the conditioning facilities and process. Studies have shown that the quality of particulate material can be greatly improved and the feed characteristics can be optimized by optimizing the latest technological equipment and conditioning process (Wang Y. 2005). In order to facilitate the long-term preservation of protein feed, prevent the feed from moisture, it is necessary to use strict drying process when leaving the factory to exclude feed moisture. After the drying process is completed, the protein feed needs to be treated with cold steam. If the lack of cooling process and direct packaging feed, even if the feed moisture is dried, will be placed in the packaging because it is difficult to dissipate heat and affect the quality. It should be noted that in the tempering and drying

processes, the higher the temperature, the better, and both should be controlled within 60℃.If the temperature is too high, it may damage the fermentation enzymes. The presence of enzymes can also promote the absorption and digestion of feed, effectively promoting the growth of animals (Wu W. 2004).

4 FOOD - RESTAURANT WASTE EMERGING RESOURCE UTILIZATION

Restaurant waste is a kind of available resource. If restaurant waste is treated in a scientific way, it can be used effectively. The large amount of gas generated in the process of disposing of restaurant waste can generate electricity, and the large amount of waste heat generated can supply the production of factories and the life of residents. The oil extracted from restaurant waste can be made into raw materials by chemical engineering. Through recycling technology, the residue of restaurant waste can be composted after dehydration, which can improve the soil fertility. The main methods for the disposal of restaurant waste include earthworm treatment technology, biodegradable plastic technology, biodegradable plastic technology, anaerobic fermentation. (Qi, Sun & Li 2012)

4.1 A brief introduction to emerging methods of food - restaurant waste disposal

Earthworms can secrete a variety of enzymes to decompose organic matter for their own or other bioavailable nutrients and reproduction. Earthworms, which can break down more organic waste, have been used in some developed countries. This technology has been applied in the fields of sewage, crop straw and solid waste disposal. High content of organic waste restaurant waste, the use of this technology can achieve good results. (Qi, Sun & Li 2012)

Recent analysis results show that food waste fermentation can produce lactic acid, thus synthesizing poly (lactic acid) which can biodegrade plastics, such as restaurant waste recycling, which provides a new idea for reducing the production input of lactic acid. The first of the household restaurant waste products is installed under the kitchen sink and then transferred to the drainage system under the housing, where the solid and liquid are separated. After the liquid is separated, it is mixed with waste water and discharged into the sewage treatment enterprise. During the storage of solid materials, there are naturally fermented lactobacillus (initial fermentation), and the putrid bacteria are inhibited to prevent the waste in the putrid. When a certain amount is accumulated, it is transported to the lactic acid fermentation (re-fermentation) lactic acid production enterprises. After fermentation, the solid materials can be separated, refined and polymerized by lactic acid bacteria, and the degradable plastic (poly (lactic acid) can be used for the fermentation residue as animal feed, fertilizer and food waste, so as to achieve the goal of "zero emission". (Wang M. 2008)

Bio-fermentation technology for hydrogen production: as mineral resources are gradually decreasing, the search for clean alternative energy sources has become a particularly prominent problem to be solved. Hydrogen is widely regarded as the most attractive alternative energy source. Because H_2 is not only a high calorific value, but also a kind of green energy (burning only generates water).The traditional chemical method of producing H by electrolysis of water or pyrolysis of crude oil or natural gas, which consumes a lot of electricity or mineral resources, is usually very expensive to produce. The reaction of biological hydrogen production requires mild conditions and low energy consumption, which has attracted people's attention. The raw material of biological hydrogen production is used in urban sewage, waste, animal manure and other organic wastes, and hydrogen is produced at the same time when water quality is purified. Therefore, in terms of environmental protection, new energy development or perspective, hydrogen production from biomass has a huge development prospect. (Li, Li & Zhang 2012)

The anaerobic fermentation treatment is to create anaerobic conditions to provide anaerobic organisms with the nutrients they need to survive, relying on amphibious bacteria and anaerobic bacteria. The degradation of organic matter is achieved by metabolism. During this period, microorganisms break down the organic matter in the food waste and eventually produce CH4 and CO2. anaerobic digestion itself is a Relatively complex process, which produces CH4 with no feed demand compared to aerobic biological treatment, and has a significant impact on industrial wastewater, water quality, and water quality. Municipal wastewater is well treated. In an anaerobic reactor, anaerobic organisms are able to acquire the various conditions necessary for their survival and gradually aggregate into microbial populations. In general, anaerobic technology produces odors and it is difficult to remove ammonia nitrogen. However, it has low energy consumption, low sludge production and can degrade most organic matter. (Ma, Wang & Xie 2009)

The advantage of anaerobic fermentation technology is to reduce restaurant waste efficiency is higher, recycling, treatment effect is very good, the formation of biogas can be used to generate electricity. During anaerobic fermentation, after fermentation, there will be no peculiar smell and no secondary pollution, which is a problem generally recognized by the public. This technology is relatively perfect and has been widely used in China and overseas countries. (Ma, Wang & Xie 2009)

4.2 Comparison of restaurant - restaurant waste disposal process

Nowadays, there are many ways to deal with restaurant waste, but each method has a different cost and impact. Next, several methods of treating food waste are compared to find the most efficient method, and then their technical techniques and Strengths and weaknesses. (Wang X. 2013)

4.2.1 Comparison of the main techniques for the disposal of restaurant waste

According to the previous description of the current technology of food waste treatment and the actual status of our cities and the practical application of the above technology A comprehensive analysis was carried out and a comparison of key technologies yielded the TABLE 4 (Wang X. 2013).

TABLE 4. Table of comparison of major techniques for the disposal of restaurant waste. (adapted from Wang 2013)

The parameter name	Anaerobic digestion	Aerobic composting	Feed technology
Degree of harmless-ness	high	On the high side	high
Degree of reduction	high	On the high side	On the high side
Degree of resourcing	best	better	best
Technical safety	highest	higher	highest
Technological ad-vancement	best	best	general
Technical reliability	highest	highest	highest
The project covers an area of ㎡ (200 t/d)	25000~35000	25000~60000	12000~20000
Investment amount (ten thousand yuan/ton)	30~50	12~35	10~25
Operating cost (yuan/ton)	45~150	80~120	200~500
Product revenue (ten thousand yuan/day)	4~8	0~3	6~8

(continues)

TABLE 4.(continues)

Product output (in terms of processing capacity of 200 t/day)	Gas 2800 cubic meters	Nutrient soil 150 t/day	Feed 50 t/day
	Oil and grease 75 t/day	Protein powder 30 t/day	Oil and grease 75 t/day
The quality of the product	best	better	general
The product application	much	much	many

As can be seen from the table, these three technologies are environmentally friendly, with high technical safety, slightly less advanced forage technology, the largest footprint of aerobic composting technology, the largest investment in anaerobic digestion technology, the highest operating cost and the highest revenue of forage technology. Aerobic composting technology has the highest yield and anaerobic digestion technology has the best quality (Wang X. 2013).

4.2.2 Recommended process

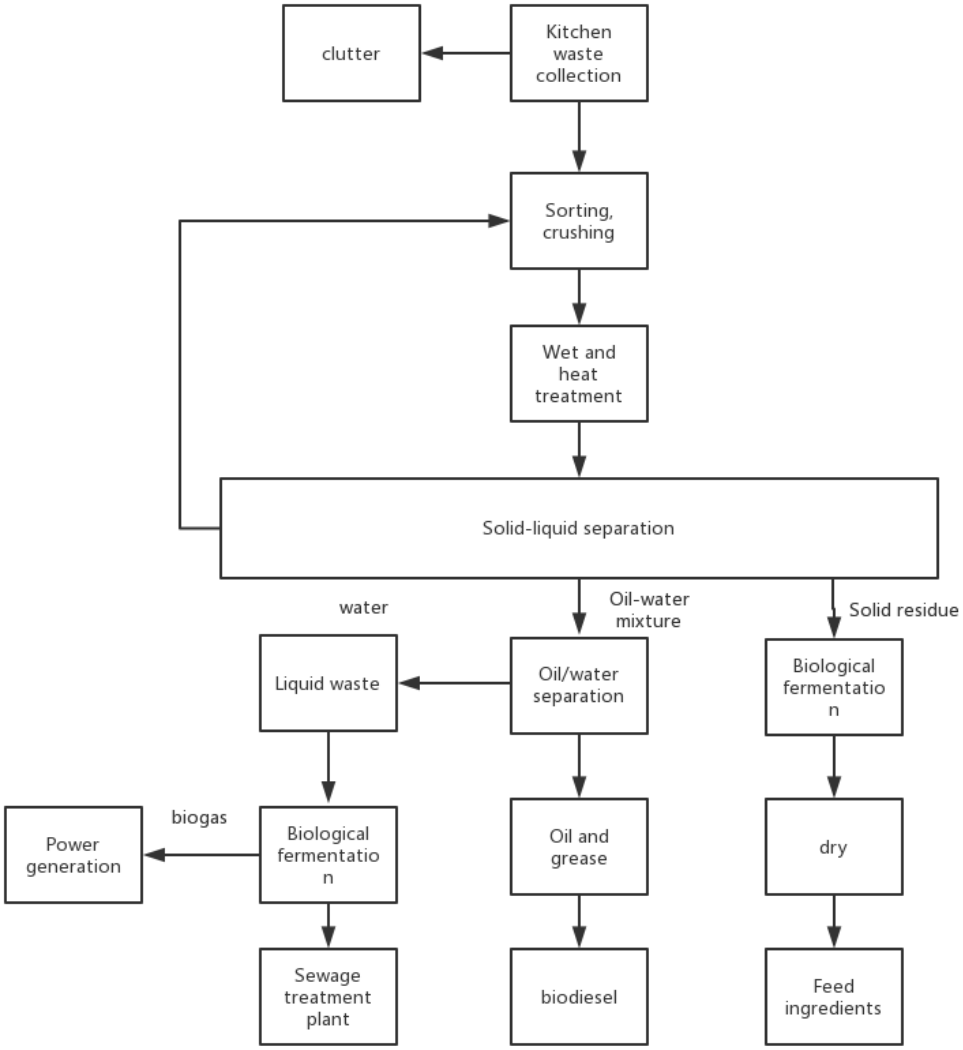
After the comparison of several mainstream processes mentioned above, combining the advantages and disadvantages of each treatment technology, we choose to treat restaurant waste with the help of comprehensive treatment technology: biodiesel production process, anaerobic digestion treatment, aerobic biochemical treatment (Xie, Liang & He 2008).

Waste grease is separated from restaurant waste and passed through the oil and water separator in the pretreatment stage. Such oils can be recycled as "trench oil", waste cooking oil and mixed together, which can be chemically modified into biodiesel or other chemical raw materials to achieve better economic results. (Xie, Liang & He 2008). Biogas produced after fermentation contains methane, carbon dioxide, hydrogen sulfide and other gases. Methane gasIt is flammable, usually at a concentration of 60-75 %, and goes into a cogeneration of heat and power for a gas turbine, where the remaining heat is used for the waste disposal equipment itself. According to foreign experience, for existing projects, the annual processing capacity is 200 t/day waste anaerobic treatment plant, and the daily production of biogas can reach 25,000 cubic meters and 30,000 cubic meters (Xie, Liang & He 2008). The biogas slurry produced after fermentation can be used for organic fertilizer in agriculture through the process of denitrification,

salt and sulfur, landscape greening and other fields. Utilization of biogas residue: the remaining residue after dehydration can be sold as finished product through aerobic compost. Aerobic composting usually involves adding straw and other materials to reduce moisture and supplement nutrients. Composting through compost takes about 15-25 days (Wang X. 2013).

4.3 Comprehensive processing process

According to the actual situation of Chinese cities and based on the comprehensive analysis, the re-source-based technology process for the comprehensive treatment of restaurant waste is proposed in GRAPH. 2.It mainly consists of anaerobic digestion process, aerobic biochemical treatment process and biodiesel production process (Wang X. 2013).



GRAPH 2. Process flow chart of comprehensive utilization treatment technology. (adapted from Wang 2013)

Restaurant waste is first collected, then shredded by a waste crusher, then treated with heat and humidity, then separated from the liquid, and then treated in three ways. The first is biogas produced by fermentation, a step that will be covered in detail in a later article. The second, which will be detailed in a future article, USES oils from waste to make biodiesel. The last is the production of feed, which will be described in detail later in this article (Wang X. 2013).

4.3.1 Anaerobic digestion process

When using anaerobic technology to dispose of restaurant waste, restaurant waste is usually stored in a fermentation tank. Therefore, the effect of fermentation is directly related to the parameters of the reactor. From the perspective of the reactor, different treatment processes can be obtained, such as two-phase and single-phase processes, dry and wet processes, high-temperature and medium-temperature processes, etc (Zhao & Yan 2007).The following are introduced one by one, their advantages and disadvantages are analyzed, and the anaerobic treatment process of restaurant waste in this project is obtained after summarizing.

Under different temperature conditions, the activity of anaerobic bacteria will inevitably show differences, which will affect the quality of degradation. In order to achieve the optimal activity of anaerobic bacteria, the temperature in the reactor was controlled within a certain range. As shown in TABLE 5. (Wang X. 2013)

TABLE 5. Comparison of medium and high temperature processes. (adapted from Wang 2013)

	Medium temperature process	The high temperature process
Temperature range	More than 35 ℃, less than 38 ℃	Greater than 55 ℃, less than 60 ℃
Technology advantage	Degradation process stability	
	Fungi are diverse	Fast degradation rate
	Ammonia has little inhibition on anaerobic degradation	High natural gas production
	Low energy consumption	
Technological disadvantage		High energy consumption
	The process is slow	The degradation process is unstable
		Ammonia inhibits the anaerobic degradation of substances

It can be seen from the table that the available temperature range of high-temperature process is greater than that of medium-temperature process, and the degradation rate of high-temperature process is fast-erand the natural gas yield is high. However, the degradation process was more stable with more fungi and less consumption. The two processes have their own shortcomings, such as slow process at medium temperature, high temperature process consumption and instability. Although the high temperature process is superior to the medium temperature process in gas production rate, the degradation process is less stable due to the high temperature. Therefore, the medium temperature process is more widely used in practical engineering cases abroad. (Wang X. 2013)

According to the dry matter content of waste, the anaerobic process can be divided into wet process and dry process. As the dry matter content of restaurant waste exceeds 40 %, the anaerobic degradation will be inhibited due to the low water content. Therefore, the dry matter of restaurant waste can not exceed 40 % when the dry matter content of restaurant waste exceeds 40 %.When using a wet process, if the dry matter content of the feed is more than 15 %, water dilution can be used to reduce the dry matter content of the feed at the same time, or recycled water can be used. Due to the high technical difficulty and complex process control. The specific comparison is shown in TABLE 6. (Wang X. 2013).

TABLE 6. Compared to wet and dry processes. (adapted from Wang 2013)

	Wet process	Dry process
Dry matter content	Less than 15 %	More than 20 %, less than 40 %
Technology advantage	Feed simple	
	Hybrid reactor technology is easier to operate	Pretreatment is easy to implement
	The heat exchange and mass exchange laws of the reactor are relatively high	
	They tend to give off a lot of gas	
Technological disadvantage		Process complex
	Covers an area of big	Higher equipment price
	Complex pretreatment	Control the transfer of material

As can be seen from the TABLE 6, dry process dry matter content is higher. The wet process is simpler and more efficient. The dry process is difficult to operate and complicated, but the pretreatment is easy to implement. The wet process covers a large area and the pretreatment is relatively complex. Due to the

high technical difficulty and extremely complex process control, dry process technology is not widely used in developed countries in Europe, and wet process technology is often used in practical projects. (Wang X. 2013).

The anaerobic degradation of organic matter in single-phase and two-phase processes is usually divided into four stages, namely, hydrolysis, acidification, acetoylation and CH_4 generation. These four stages can be further simplified to the acidizing phase and the methane-producing phase, in terms of the optimum environmental conditions for each stage to participate in the anaerobic bacteria. Table 7 shows the different characteristics of anaerobic bacteria. (Wang X. 2013)

TABLE 7. Comparison of hydrolytic acidizing bacteria and methanogens. (adapted from Wang 2013)

	Hydrolytic acidifying bacteria	methanogens
species	more	less
Growth rate	fast	slow
To adapt to the pH	5.2 to 6.3	6.8 to 7.5
Suitable temperature range	30℃ to 35℃ (medium temperature)	35℃ to 38℃ (medium temperature)
		55℃ to 60℃ (high temperature)
Sensitivity to hydrogen	sensitive	Not sensitive

As can be seen from the TABLE 7, relatively speaking, bacterial acidification has more types and is not very sensitive to changes in pH value. Acidifying bacteria play the most appropriate activities in an acidic environment. On the contrary, there are not many CH_4 seedlings involved in the generation of CH_4, which have a longer growth cycle and need to go through a long-term adaptation process. Methanogens are pH sensitive, and the most suitable methanogens are active in a neutral environment, with a small range of pH fluctuations. In the previous single-phase period, the hydrolysis and acidification periods and the CH_4 production periods were in the same reactor, and different anaerobic bacteria could not achieve the optimal environmental conditions by exerting their best activities, so the degradation time was long and the methane production rate was low. In addition, due to the acidification and rapid growth of various types of bacteria, the content of the reactor is liable to lead to acidification, resulting in the inhibition of the subsequent CH_4 generation process. During the whole phase of the two-phase process, the hydrolysis, acidification and CH_4 phases were promoted in a separate and different reactor. The reactor could reach the most suitable environment and the growth conditions of methanogens in the

two phases respectively, thus improving the stability during the anaerobic degradation and increasing the yield of CH_4 at the same time. TABLE 8 lists the characteristics of single-phase and two-phase processes (Zheng M. 2004).

TABLE 8. Comparison of single-phase and two-phase processes. (adapted from Wang 2013)

	Single phase process	Two phase process
Whether anaerobic degradation is performed in the same reactor	YES	NO
Technology advantage	Equipment less	Stability is good
	Easy to control	High volume
	Small investment	High automation efficiency
Technological disadvantage	Stability is poorer	Equipment is various
	Prone to acidification	Control of complicated
	Low gas production	Investment is larger

It can be seen from the TABLE 8 that single process is carried out in the same reactor. Single process equipment less, less investment, easy to control. The two-phase process has good stability, high gas production and high automation efficiency. However, the stability of single process is relatively poor and the gas production is also low. Two - phase process also has many problems, such as more equipment, more investment and more complicated control. Although the process is divided into two stages, the technical advantages of single-phase process than single-phase process, but because the single-phase process operation control is relatively simple, small investment, there are still a lot of such single-phase process examples. As the technology matures, more and more projects begin to use both processes at the same time. (Zheng M. 2004)

A certain amount of restaurant waste is regularly poured into the reactor, and it is allowed to stay in the reactor until it is completely decomposed, and then the organic degradation method of anaerobic degradation products is cleared out, which is known as sequential batch process. The process also involves cleaning and sterilizing the reactor. The continuous process is that the waste products after anaerobic degradation are discharged into the continuous reactor for anaerobic degradation. The reactor does not need to be cleaned and disinfected. A comparison of the two processes can be seen in table 9. (Wang X. 2013)

TABLE 9. Comparison of sequential batch process and continuous process. (adapted from Wang 2013)

	Sequential batch process	Continuous process
Feeding way	cycle	continuous
Technology advantage		Small number of reactors
	Simple control	Small footprint
		Lower operating costs
		High automation efficiency
Technological disadvantage	More reactors	
	It takes a lot of investment	
	It takes up a lot of space	The control process is complex
	There is a lot of running cost involved	

It can be seen from the table that the sequence batch process adopts the periodic feeding mode and the continuous process adopts the continuous feeding mode. The number of continuous process reactors is small, the floor area is small, the cost is low and the automation efficiency is high. Sequence batch process control is relatively simple, but the number of reactors is large, which requires a lot of investment. Compared with these two processes, from the perspective of economic feasibility, continuous processes offer clear advantages and are increasingly used in practical engineering applications.

Currently, there are many anaerobic processes available, which can be selected according to operating cost, degradation cycle, treatment speed, number of facilities, control difficulty and other indicators. China has a large population and produces a huge amount of food waste every day. In order to carry on the effective degradation, most will choose the medium temperature, the wet method, the continuous type, the two phase anaerobic process. The advantages of these processes are summarized in detail in the following TABLE 10 (Wang X. 2013)

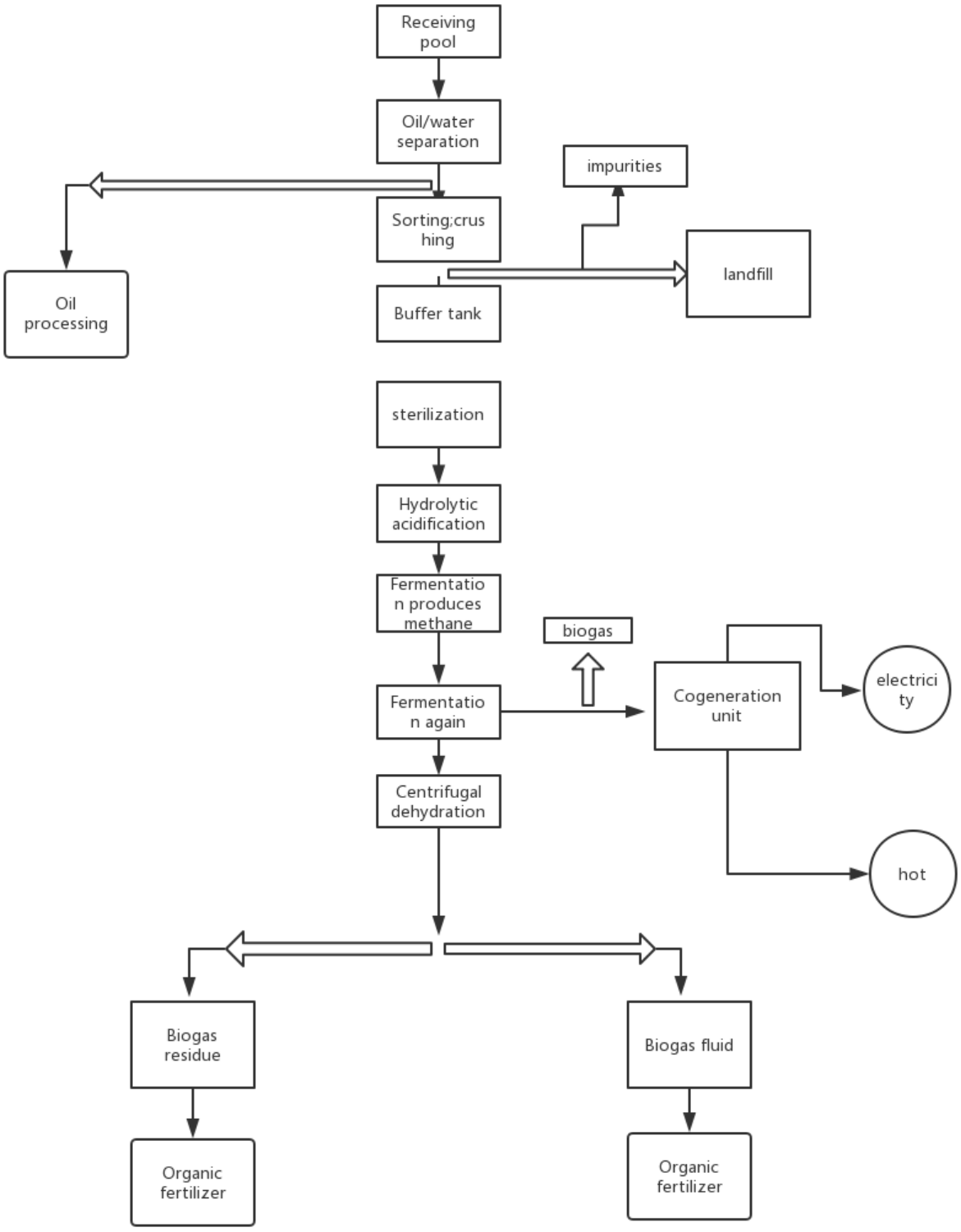
TABLE 10. Characteristics of anaerobic process. (adapted from Wang 2013)

Process name	The main advantage
Medium temperature	Stable degradation of organic matter
	There is almost no inhibition of ammonia nitrogen during degradation
	There are diverse species of fungi
	Have the advantage of energy conservation
Wet	Small technical difficulty, easy feeding
	It can be quickly stirred in the reactor
	Material exchange, heat exchange effect is good, can quickly release gas
Two phase	Mature process, strong operability
	CH_4 can be generated to achieve efficient utilization of energy
continuous	Few facilities required
	Small footprint
	Low investment
	High level of automation

As can be seen from the table, the main advantages of the medium temperature process include stable degradation of organic matter, almost no inhibition of ammonia nitrogen during degradation, and there are a variety of fungal species, which are relatively energy-saving. The main advantages of wet process include low technical difficulty, convenient feeding, rapid agitation in the reactor, good heat exchange effect, and rapid gas release. The main advantages of two-phase process include mature process, strong operability, methane generation and efficient utilization of energy. The main advantages of continuous process are small floor space, less facilities, less investment, high level of automation.

4.3.2 Selected anaerobic treatment process requirements

Detailed process flow is, he mechanical pretreatment, hydrolysis acidification - gas - biogas fermentation using -- fermentation biogas slurry renewal - processing - use waste oil. The process flow of anaerobic treatment can be referred to GRAPH 3. (Wang X. 2013)



GRAPH 3. Anaerobic process flow chart. (adapted from Wang 2013)

Mechanical pretreatment process is after the collection and transportation of food and restaurant waste arrives at the processing enterprise, the food and restaurant waste will be poured into the material collection pool and transferred to the crushing sorting device via the spiral conveyance device. During the transportation, bags can be broken and coarse crushing can be realized. According to the different process design, the restaurant waste after the broken bag of oil separation treatment. To swim in the solid and free state of the existing food waste fat, and the free fat can be removed by the separator, using high temperature can be separated out of the solid fat. The extracted oil can be used as industrial raw materials with high economic value, and the remaining wastewater still has high organic components, which can enter the fermentation system and form biogas after fermentation (Xing, Wu & Wang 2006) .In the classification and crushing period, the substances in the restaurant waste are separated according to the weight of the mass, and impurities are removed. The particles of the restaurant waste are reduced. These three goals can be achieved at this stage, which can greatly improve the processing efficiency, optimize the processing output and reduce the operation cost. After crushing, the sorted impurities were separated into the sanitary landfill, with a year-on-year increase of 99 %, and impurities were removed. The serious materials are basically metal objects, organic matter, etc., which can be recycled and reused to create good economic benefits, realize the recycling and recycling of materials, and basically achieve the desired waste recycling. The purpose of this operation is to ensure that the treated biogas slurry and biogas residue can be treated as organic fertilizer (Wang X. 2013).

The hydrolytic acidification process is carried out through an extensive mechanical pretreatment operation and the slurry makes up the food waste, which is pumped into the hydrolysis tank to complete the hydrolysis and acidification operation. Hydrolysis is the beginning of anaerobic degradation of organic matter in restaurant waste. Large organic matter will be changed into small organic acid through hydrolysis, accompanied by the release of some gas. Anaerobic bacteria class participation of restaurant-waste anaerobic hydrolysis acidification, because exert the activity of the best hydrolysis acidification fungi of external conditions, and the environmental conditions under which the most optimally active CH_4-producing bacteria perform are significantly different, thus hydrolysis acidification, the methanation process for the design of two phase independently, in order to avoid in the process of single-phase anaerobic degradation process is restrained, so as to improve the stability of the anaerobic fermentation process. (Xing, Wu & Wang 2006)

Biogas production process is organic acids formed during acidification are piped to fermenters, where CH_4 is converted by methanogenic fungi that break down the number and shape of the molecules at the right temperature, pH, and other conditions. This process is a particularly important part of the whole

stage of anaerobic fermentation of restaurant waste. From a technical point of view, whether the methane production process can be effectively controlled will determine the success or failure of a restaurant waste disposal project (Tang & Xiong 2007)。

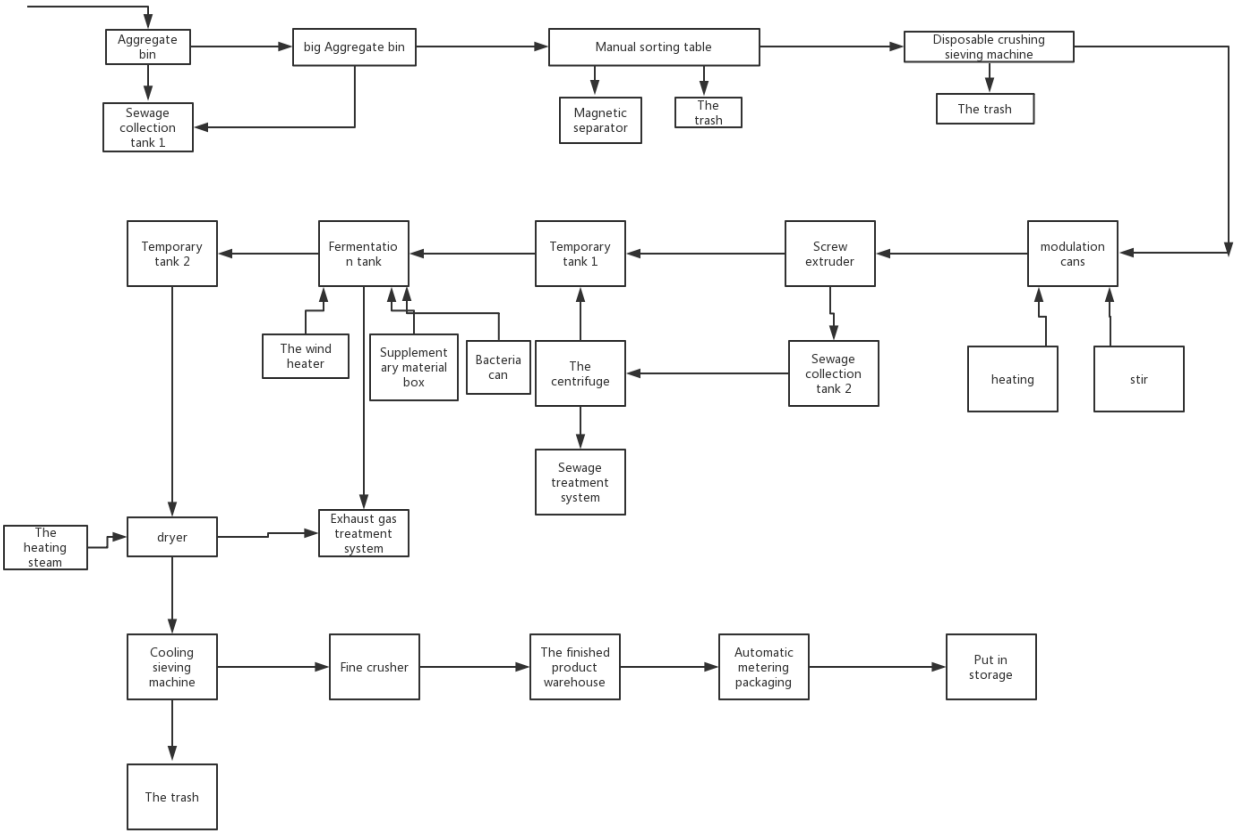
Biogas power generation process is designed to produce about 5,000 cubic meters of anaerobic methane per day and is expected to produce 8 million kilowatt-hours per year for electricity generation. Besides being used for power generation, the resulting biogas can be cleaned and treated to reach the national standard, and can be used as natural gas in the municipal gas pipeline of the city, or can be added to the natural gas vehicle. (Tang & Xiong 2007)

Anaerobic microbial fermentation products still contain some organic matter, and a lot of N, P, K and trace elements. Such elements are especially critical in growing crops and can be wasted if given up. Dehydration resulted in a strong water content slurry (99 %) and a relatively low water residue (65 %). Biogas can be directly denitrified, and other post-discharge treatment compliance may continue to provide solid residue fertilizer or nutrient soil, which can be widely used in agriculture, forestry, vegetable planting, fruit, municipal gardens and other different fields. (Tang & Xiong 2007)

Considering the harmfulness of "gutter oil", this process includes the process of disposing and recycling waste oil. The process will separate the waste oil and "gutter oil" together. Restaurant waste grease are free and solid, the free oil and fat are usually mixed with water in the first stage, this may depend on the oil and water separation approaches the grease separation. considering the density of water and oil, using the way of temperature change, agreed by the effect of water phase to separate grease; And the solid fat often refers to the fat included in meat, which is difficult to be separated by means of oil and water separation in solid form. By means of high temperature precipitation, the solid oil is transformed into a free state and then separated with oil and water for easy removal. The extracted oils and fats can be used as industrial feedstocks with high economic value, such as biodiesel. The separated wastewater has the characteristics of higher organic composition, and can be re-entered into the fermentation system, where it ferments and forms biogas. From the analysis of chemical principle, oil substances belong to the glycerides of high fatty acids, which can be converted into biodiesel through the synthesis of biological enzymes and the reaction of chemical ester group transfer. Biodiesel is a green and renewable energy source with low sulfur content, less sulfur emission, good combustion performance, good safety, etc. It can be used as a fuel such as boiler, turbine, diesel, etc. It can be said that it is inexhaustible and has a very broad application prospect. (Tang & Xiong 2007).

4.3.3 Aerobic biochemical treatment process

In order to distinguish the restaurant waste into two parts, press material and press liquid, the restaurant waste with high water content can be separated by sorting, tempering, screw pressing and centrifugal separation. The pressing material is transported to the pressing material warehouse for temporary storage through crushing and screening. The pressed fluid enters the oil and water separation system and is separated into two parts, oil and water. After the pretreatment of food waste, supplementary materials and press liquid were added for ingredients. The mixed materials were successively processed through aerobic biochemical reaction, sterilization, cooling and drying, and other processes, and finally the feed protein powder was obtained. Feed protein powder production process (aerobic biochemical treatment process) GRAPH 4. (Wang X. 2013)



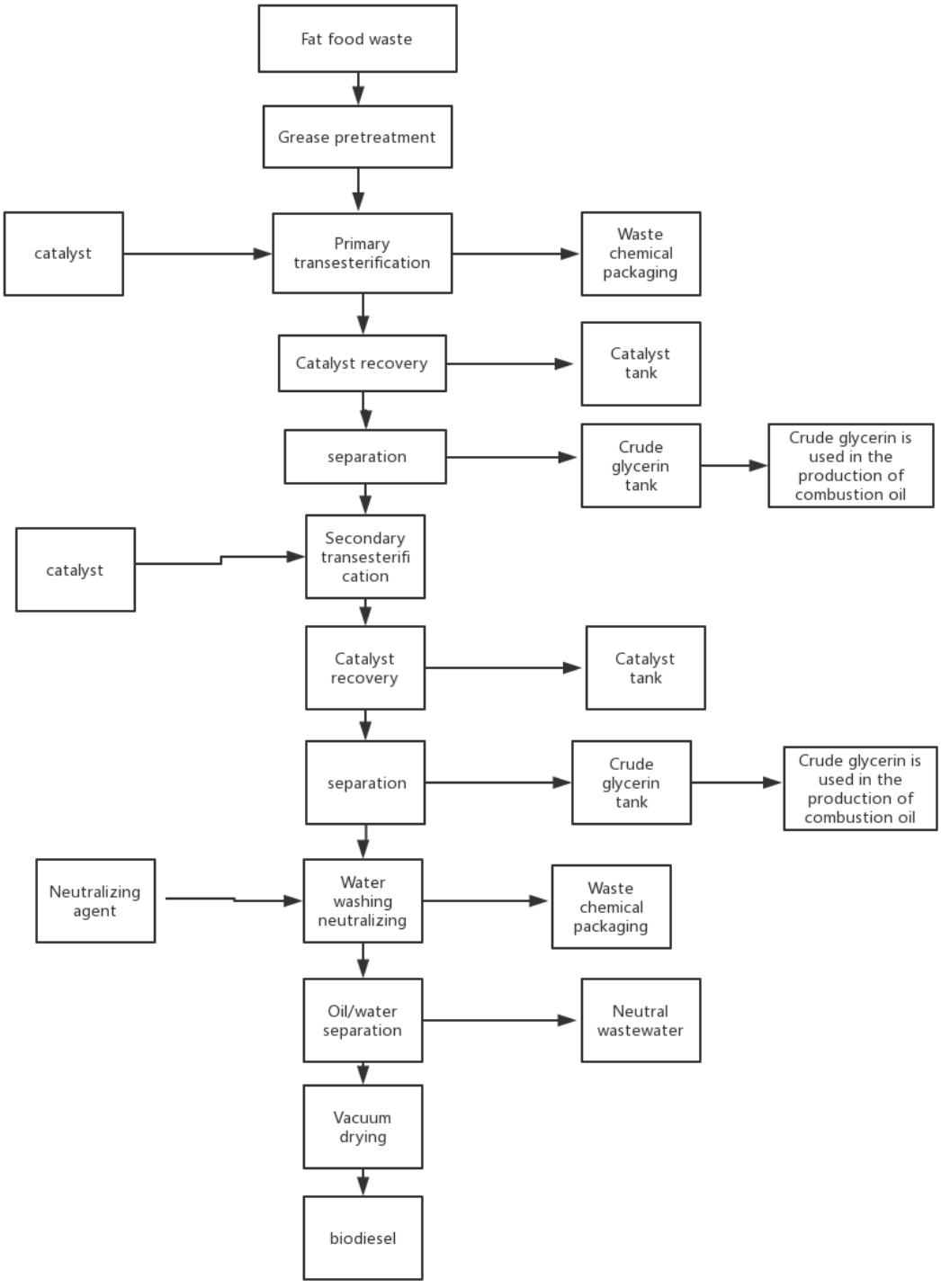
GRAPH 4. Production technology of feed protein powder. (adapted from Wang 2013)

First of all, the collected restaurant waste is poured into the hopper, and the sewage is discharged into the large hopper. Then, metal impurities are manually put into the magnetic separator and some other

non-food impurities are put into the waste can.The rest of the restaurant waste is then put into a crusher to be ground up. The ground waste is then heated, stirred and dehydrated.Then it is sent to the fermenter for fermentation, during which excipients and various strains are added.After the completion of fermentation, it is sent to a dryer for drying, and then it is sent to a filter to filter out large pieces of material, and then it is sent to a fine crusher, and finally into the finished product warehouse (Wang X. 2013).

4.3.4 Biodiesel production process

Biodiesel, also known as fatty acid methyl ester, is made from waste cooking oil, animal fat oils, etc. and alcohols through transesterification. The project makes the grease of restaurant waste as raw material, because its chemical composition mainly contains (free) fatty acids and fatty acid glycerides, so in a special catalyst medium and technological conditions, the esterification of fatty acids and methanol, and the transesterification of fatty acid glycerides and methanol can be rapidly and efficiently reacted. High quality biodiesel can be obtained through the preparation of subsequent steps (Zhang, Hu & Li 2010). The production process flow GRAPH 5.



GRAPH 5. Biodiesel production process. (adapted from Wang 2013)

The specific process is as follows, the catalyst (methanol) and potassium hydroxide were added in the hot water and heated to 45 ℃. The catalyst was fed to the first-stage catalyst recovery tank after 15 minutes of cyclic reaction. heat it up to 65 ℃ with hot water, and after 15 minutes, recycle methanol feed to the first stage separation tank. the separator was used to separate the fatty acid methyl ester from

the glycerin substance in the reaction mixture after completion. The fatty acid methyl ester was transported to the secondary reaction tank, and the crude glycerin was transported to the crude glycerin tank. After the first reaction, the methyl ester of fatty acid was reacted in the second reaction tank, heated to 45 ℃ by circulating hot water, and then the catalyst (methanol) and potassium hydroxide were added, and sent to the secondary catalyst recovery tank after 15 minutes. recycle methanol with hot water to 65℃. After 15 minutes, recycle methanol is transported to the secondary separation tank. The mixed material fatty acid methyl ester and glycerin after the reaction were separated in a separator. The fatty acid methyl ester was sent to the washing neutralization tank, and the crude glycerin was sent to the crude glycerin storage tank. In water wash and neutralize tank, add oxalate water, neutralize acid and base, and then transfer to oil and water separation tank. The oil-water mixed material fatty acid methyl ester and water were separated in a separator, and the fatty acid methyl ester was sent to the residual water reaction tank, and the neutral wastewater was sent to the waste water treatment tank (waste water treatment system).Semi-finished fatty acid methyl ester is heated to 85 ℃ in the residual water reaction tank by vacuum treatment technology to remove residual water, and the product biodiesel is obtained and transported to the finished biodiesel tank. The circulating heating of hot water is a sandwich heating system, the hot water is heated by the atmospheric pressure hot water boiler, and the water is recycled without discharge. Hot water boilers use diesel fuel (Wang X. 2013).

The project construction to restaurant waste collector of standardization in our country, using the seal of the professional delivery of restaurant waste shall be unified car collector, can effectively eliminate in the process of the collector to the urban road, the city environmental health of secondary pollution, and can effectively protect the municipal facilities, protect the surface water system, protect the ecological environment, realize the city sanitation infrastructure planning, to promote China's urban image. (Wang X. 2013)

5 CONCLUSION AND PROSPECT

With the vigorous development of China's economy and the deepening process of urbanization, people's living standards are gradually improving, and the quality of life and Food quality is becoming more and more demanding. At the same time, it will significantly increase the production of settlement waste. The food waste produced daily in our country is not properly and effectively disposed of. Therefore, how to standardize management, harmless disposal and resource utilization is an important issue for China. Based on the principles of harmlessness, reduction and recycling, this study found a suitable method for food and beverage waste treatment in China.

Based on the comprehensive process analysis of restaurant waste, the process lines suitable for Chinese cities are: anaerobic digestion, aerobic biochemical treatment and biodiesel extraction. The project is technically advanced, with a high degree of automation and strong technical reliability. Each environmental protection index can meet the national standard, which can essentially deal with the environmental pollution caused by restaurant waste. In essence, it is a good project for the renewable use of resources and the reduction of environmental damage. After the completion of the project in cities at all levels, it can not only essentially solve the problem of safe and hygienic disposal of restaurant waste, but also promote the improvement of urban restaurant waste disposal technology, with distinct social and environmental benefits. According to the original plan, after the normal operation of this project, about 5000 m^2 of landfill land can be saved every year, and the re-pollution of leachate from restaurant waste to the local water environment can be fundamentally solved. The biochemical transfer method adopted -- namely, the integrated treatment technology integrating pretreatment, feed production and fertilizer production, etc. in a one-stop way, and the harmless comprehensive treatment of food and restaurant waste. In order to obtain better economic benefits in the operation of the project, it is not enough to rely on government subsidies alone. It is also necessary for the enterprise to fully exploit the advantages of the disposal process and increase the economic benefits of the enterprise by making use of the abundant income from downstream products.

To straighten out the division of duties, strengthen the department cooperation, all levels of government to make relevant administrative rules and regulations. Clear detailed the food and drug supervision, urban management enforcement, environmental protection, public security, commerce, animal husbandry and veterinary, health, division of duties of quality supervision, industry and commerce and other related departments, strengthen cooperation with various functional departments, form the restaurant waste

management together. The restaurant waste treatment in China, there is no absolute standard demonstration project, most of the work have groped in searching process. Organize relevant personnel are advised to take the time to investigate all restaurant waste disposal relatively successful cases, according to the living habits of different district residents difference analysis of restaurant waste disposal work, absorbs the essence, alert to copy it. Since this project is a comprehensive and harmless treatment plant for solid waste, it is recommended to adopt advanced technology to avoid secondary pollution as far as possible, and pay attention to the effective control and prevention of various pollution factors formed in this project, in order to meet the standards of emission requirements. In order to accurately grasp the composition, ratio, practicability and safety of feed and compound fertilizer, it is suggested to timely investigate and make an in-depth analysis of the characteristics of the composition of food and restaurant waste in cities and the ratio of different types. To further supplement and improve some basic process parameters; To assess the safety of protein feeds in order to provide technical parameters for design, production and marketing services. When the project is staffed after completion, the operators must take up their posts after strict training. In addition, the project should be equipped with certain researchers to analyze the restaurant waste and the processing technology of restaurant waste, so as to find relevant resources in the restaurant waste as much as possible, and maximize the application of restaurant waste resources.

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