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Research paper

Food Waste Treatment by High-Temperature and High-Pressure Steam

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Abstract

Background/Objectives: There were many limitations in the processing of food wastes, such as immaturity and salt excess. After processing, recycling to compost or feed requires faster processing times and reduced odor and leachate. A recycling apparatus of organic wastes by using direct steam heating is proposed in this paper for composts and animal food.
Methods/Statistical analysis: There are many processes to treat food waste, but in order to reduce the odor, a method of circulating the steam in a closed space and cooling and discharging is used. In this case, the solid material is effectively dried and the liquid component is discharged to about 20,000 ppm.
In the case of animal food, saturated steam of 3.2 atm. and 135℃ was used in order to decompose to water. Also, saturated steam of 16 atm. and 200℃ was used in order to hydrolyze, to acidhydrolyze, to prolyze, to carbonize the food waste. Condensed water can be used to liquid compost, the organic waste can be totally recycled.
Findings When food waste is dried with high-temperature high-pressure steam at 200°C and 16 atmospheres, the 1 ton scale can be treated in one hour. However, careful attention should be paid to the high-pressure machine management.
Improvements/Applications: Effective ways to reduce salinity should be considered when using small-scale machines to effectively dry garbage. Salinity-rich composts can damage crops

Keywords: recycling, organic waste, steam heating, food waste, animal food.

1. Introduction

Recycling of sewage sludge and food waste is an urgent problem, but feed conversion is a toxic problem, and composting is becoming a new waste because it is not activated due to salinity, immaturity, lack of nutrients. In the case of producing and distributing by-product fertilizer as a raw material of food wastes, a revised Control Act has been promulgated to supply by-product fertilizer in accordance with the process standard of the fertilizer production registration and fertilizer management law. Since 1995, As a result of the implementation of the mass-production system, the amount of municipal waste decreased considerably, but the waste of food was not significantly decreased due to the traditional culture of food, requiring separate management measures. Generally, food waste is crushed, dehydrated, sorted and recycled as compost or feed, but the problem is that it takes a lot of money to dispose of the waste. In this paper, we propose a method to hydrolyze organic wastes by using high - temperature high - pressure water vapor to reduce composting.

The problems of existing organic waste drying apparatus are summarized as follows. That is, in the case of the indirect heating type drying method, a long time is required, stirring and crushing are required, mechanical failure occurs due to stickiness during processing, and odor is generated in the case of hot air drying. Also, since a large amount of water is required to be evaporated, the operation cost is high, the initial investment cost is high, the processing is acidic, and the durability of the machine is a problem. Figure 1 shows the policy trends related to the treatment of organic wastes. Ultimately, all organic wastes will have to be treated on land.

Research on food waste has been widely used to separate solid and liquid through crushing, compression and solid-liquid separation processes. However, problems such as odor and immaturity have arisen and need to be improved. On the contrary, a method of discharging condensed water through a heat exchanger by dryly condensing water vapor has been studied. This method has evolved into a method of effectively treating general organic wastes as well as food waste. It was found that the solids produced by this method can be used as feed or compost, and the liquid can be used as deodorant, liquid compost, and the like. The resulting condensate contains 20,000 ppm of organic acids and can be used as an external carbon source in sewage treatment plants[1-7].

Fig. 1: Organic waste treatment policy trend

2. Principle of Recycling Treatment

Among the methods of recycling organic wastes, a method of making condensed water and dried carbide by a high-speed fermentation drying apparatus has been developed. At present, the processing unit installed in the C County Office has developed a method of reducing the energy burden by using the waste heat of the incinerator as a heat source and finally burning the treated solid material. This is a method of direct treatment using high-temperature high-pressure steam. Since the birth of the Earth, the natural recycling system has created new problems by destroying the balance of ecosystem with the development of civilization. As a result, highly chemical substances and chemicals are generated and the microbial ecosystem is destroyed. And mass production and mass disposal caused the lack of microbial decomposition activities to prevent the treatment of harmful substances. The logging of trees led to the desertification and reduced the places where microbes could live.A number of common methods of disposal of food waste have been introduced [8]. The addition of previously studied methods to food waste composting and composting methods using the high-temperature high-pressure steam introduced here can produce additional effects [9,10].

2.1. Hydrolysis of High-Temperature High-Pressure Steam

It is a basic idea that the recycling rate of organic waste can be increased by using decomposition method by high-temperature high-pressure steam, which can replace microbial decomposition activity. First, the treatment time can be drastically reduced and the amount of condensed water due to evaporation can be drastically reduced. Organic waste that can be used in this method is food waste, sewage sludge, waste paper, and waste wood. When saturated steam of high temperature and high pressure is put into organic wastes and stirred, carbohydrates are decomposed into glucose, etc., proteins are amino acids, and fats are decomposed into fatty acids and alcohols. Bacteria are sterilized. Without using microorganisms or chemicals, There is an advantage of being able to feed.

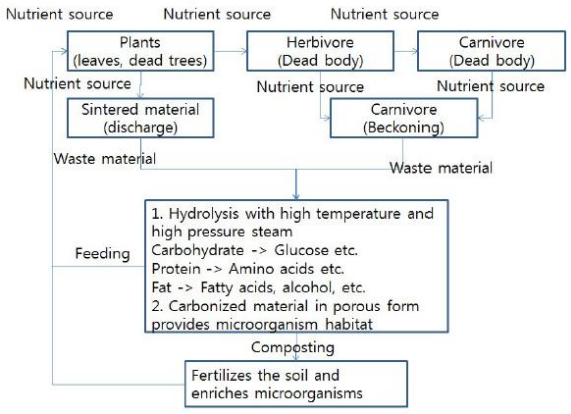

Fig.2: the concept of recycling of organic waste by high-temperature high-pressure steam

In addition, this method can suppress the emission of nitrogen oxides, sulfur oxides, or carbon dioxide, contributing to prevention of global warming, and does not generate dioxin. Figure 2 shows the concept of recycling of organic waste by high-temperature high-pressure steam. In other words, the carcasses and the excretions of plants and animals are organic waste materials, which can be hydrolyzed through high-temperature high-pressure steam to replace the fermentation process with microorganisms for composting or feedstuff formation in a short time.

2.2. Hydrolysis Device of High-Temperature High-Pressure Steam

The principle of general fermentation aging is to keep organic wastes at a proper temperature, so that the microorganisms inhabit them, the carbohydrates are decomposed into glucose, the proteins are decomposed into amino acids and the like, and the fat is decomposed into fatty acids and alcohols. Devices that can replace organic matter decomposition by microorganisms include basically a device capable of withstanding high temperature and high pressure, a cooling tower to counteract the exhausted steam, and a deodorizing tower capable of removing the offensive odor of the exhaust gas.

The microbial sludge generated in the process of food waste disposal is formed with natural polymers to form microbial flocs which increase the viscosity of the sludge to lower the digestion efficiency of the sludge by the microorganisms, And the amount of sludge in the final stage is increased. Flocs made up of these polymers and microorganisms turn into a wide membrane when mechanical pressure is applied and turn into a waterproof In addition, this method can suppress the emission of nitrogen oxides, sulfur oxides, or carbon dioxide, contributing to prevention of global warming, and does not generate dioxin. Figure 2 shows the concept of recycling of organic waste by high-temperature high-pressure steam. In other words, the carcasses and the excretions of plants and animals are organic waste materials, which can be hydrolyzed through high-temperature high-pressure steam to replace the fermentation process with microorganisms for composting or feedstuff formation in a short time.

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the sludge is the limit of mechanical dehydration and digestion. Therefore, we developed a thermal hydrolysis process that thermally degrades naturally occurring polymers and decompose the cell membranes of microorganisms. In the next process, the polymer and the cell membrane are mechanically mixed with the degraded sludge, and the bacteria use sludge as a nutrient and energy source, By developing a highly efficient digestion process that produces volatile acids and transforms the produced fatty acids into carbon dioxide and methane gas, the wastewater treatment process can be transformed from simple waste treatment to energy recovery.

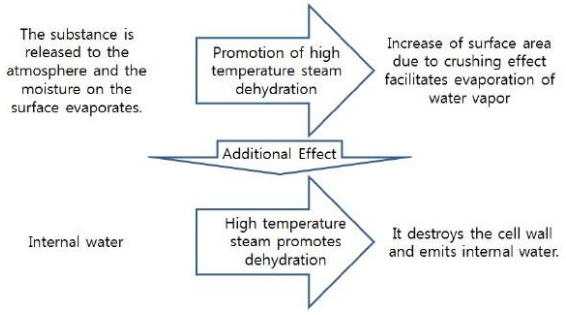

Fig. 3: Concept of organic waste recycling

Mechanism of improvement of drying characteristics by high-temperature high-pressure steam is as follows. In other words, as shown in Figure 3, when using high-temperature high-pressure steam, it is possible to obtain an effect of increasing the surface area for moisture evaporation due to the crushing effect due to

high-temperature high-pressure steam. It is possible to induce drying of the internal water.

Utilization of untreated high-function organic waste as an energy source is uneconomical. Figure 4 shows the relationship between water content and available energy. In order to make organic waste of high function, it is necessary to increase the available energy by decreasing the moisture content at the cost of pyrolysis.

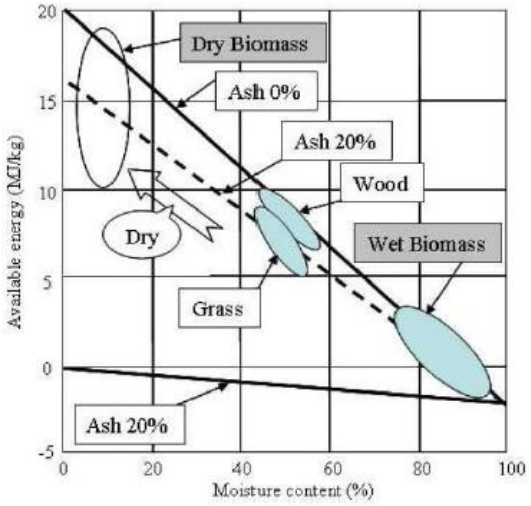

Fig.4: Correlation between water content and available energy

Figure 5 shows a schematic of the hydrolysis facility, and Figure 6 shows an example of the hydrolysis device installed. The hydrolysis equipment is required to have a durability structure capable of withstanding high temperature and high pressure, and it is known that there is a lack of legislation in Korea besides the laws of the boiler.

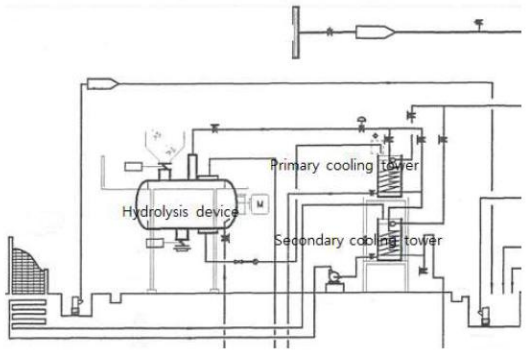

Fig.5: High-temperature high-pressure hydrolysis carbonization device design drawing

Fig.6:.High-temperature high-pressure hydrolysis carbonization equipment (AandA Ltd.)

In Korea, sludge recycling studies have operated laboratory-scale facilities, but no examples have been reported on the site where food waste is disposed.

3. Operation and performance of recycling system

The success or failure of the high-temperature high-pressure hydrolysis device depends on safety and treatment efficiency. Storage tanks that can withstand high temperatures and pressures and dramatically shortened processing times play a central role. In the case of composting, it is possible to complete treatment at 16 atm and 2 hours at 200 ℃. This is a breakthrough compared to the conventional high-speed fermentation drying device which takes 12 hours to operate.

3.1. The Function of the Recycling System

When food waste is made into feed, it is processed with saturated steam around 3.2 atm at 135 ℃ to reduce nutrient destruction, sterilization and hydrolysis to produce digestible feed. When making compost, 16 atm, 200 ℃ The hydrolysis, acid hydrolysis, pyrolysis and carbonization are performed by stirring with the saturated steam before and after, thereby making a compost having good warmth, bobbing and air permeability, containing the vinegar solution and activated carbon. Condensate can be used as potting so it can be completely recycled**.**

3.2. Performance of Recycling System

Component and performance tests were carried out using the dehydrated samples prepared at the laboratory scale.The contents of composted samples are shown in Table 1. It is processed in a short time, but it is good quality compost. Table 2 shows the constituents of the liquid from the treatment process. Table 3 shows the germination test data. In the germination experiment, the basal area, the standard area, the double area, and the triple area mean that the liquid fertilizer was applied to the dry soil of 500 ml, 0, 119, 238 and 357g, respectively. Only the nitrogen component of the liquid fertilizer was mainly changed.

Table 1:. Composition content of composted sample

	TN %	TP %	TK %	TCu mg/kg	TZn mg/kg	TC %	C/N	Moisture content
Before drying	1.86	0.82	0.32	22	64	1.54	11.6	56.04
after drying	4.22	1.86	0.73	51	146	3.51	11.6	

Table 2:. Liquid compost component

Test Items	result	Analysis method
moisture	88.1%	
Fe	26.4ppm	Spectrophotometric method
Ca	2,150ppm	Potassium permanganate capacity method

Na	1,100ppm	Atomic absorption spectrometry
Mg	280ppm	Atomic absorption spectrometry
Cl	1,880ppm	Xiaoshan Silver Prize recipe
Cu	0.05ppm	Atomic absorption spectrometry
Zn	4.25ppm	Atomic absorption spectrometry
TN	0.42%	Debarasta alloy - lactic acid law
TP	0.01%	Ammonium ammonium vanadate
TK	0.3%	Atomic absorption spectrometry

Table 3: Liquid utilization performance

Test section	Germination			Growth performance				Abnormal symptoms
	One day	Two days	three days	Leaf length cm / 1leaf	Leaf length cm	weight g/1Root	Weight Index	
Foundation mound	95%	95%	95%	251	47.7	0.268	100	N
Reference volume	90%	95%	95%	2.39	45.5	0.263	98	N
Double dose	85%	95%	95%	2.66	50.5	0.279	104	N
Triplicate	95%	95%	95%	2.36	44.8	0.258	96	N

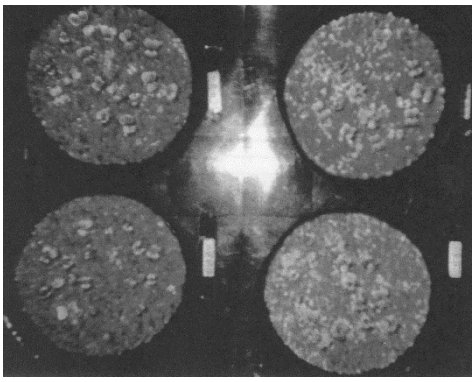

Fig. 7: Germination situation (upper left: reference volume, lower left: basal ganglia, upper right: triplicate, right: double triplet)

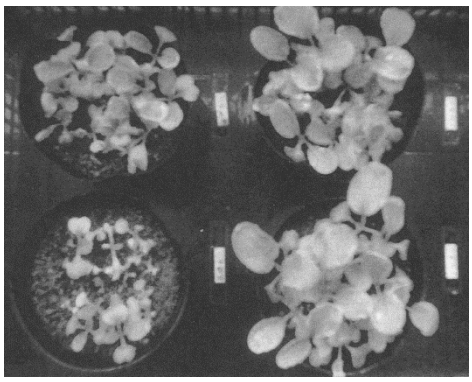

Fig. 8: Immediately before harvesting (upper left: reference volume, lower left: basal ganglia, right upper: 3x, lower right: 2x)

4. Conclusion

It is the desire of everyone to recycle food waste. Numerous studies on the conversion of feedstuffs, composting, and fuel have been conducted. When the dried food waste is used as fuel, the machine can be operated without using external energy such as electricity or oil. In the meantime, the removal of sewage sludge or food wastes was dependent on marine dumping. However, as the marine pollution became serious, the water content became more than 95% since 2007, and marine dumping banned since 2013. In this case, it would be necessary to have a device that completely processes or significantly reduces the desalination liquid. A suitable device for this purpose is a high-speed fermentation drying device and a hydrolysis device using the high-temperature high-pressure steam introduced by the present invention.

Acknowledgment

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