

# A Recycling Method of Rotten Fish Wastes

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## Abstract

In this paper, we proposed perfect recycling method of rotten fish waste. The rotten fish wastes (rotten sea fish, rotten shell fish etc.) have bad smell and generate waste water, so these waste materials must be treated quickly. If we use speedy dryer, these rotten fish waste can be changed to useful feed and liquid composts. Also this study relates to a method for drying a variety of untreated waste materials in a hermetically sealed state, and subsequently carbonizing the dried waste materials under a reduced pressure, thereby achieving a more stable and economical treatment for the waste materials, and an apparatus for performing the method. This effect of preventing generation of contaminants and environmental pollution while reducing fuel costs, and a carbide, obtained via the drying and carbonization of the waste material, are available into feed for poultry. The condensate water can be used to deodorants or external carbon sources.

**Keywords:** Condensate Water, Fish Waste, Organic Waste, Speedy Dryer

## 1. Introduction

Landfills are undesirable solutions to the problem of waste disposal. The philosophy of landfill diversion is rapidly expanding its influence<sup>1</sup>. Filling in the ground, fermenting and drying treatment, drying or incineration and the like are generally used for disposal of waste. Among them, filling in the ground contaminates the vicinity of landfill or produces leachate or bad smell and the like. So, it is allowed on an extremely limited basis. Accordingly, it cannot become a fundamental solution for waste treatment. Besides, a lot of time and efforts are required for enabling the waste to be utilized as compost by fermentation treatment method. And harmful gas or bad smell is severely emitted in the fermenting and drying process. Thus, it is difficult to solve external contamination problem. And a large amount of salt is contained. Therefore, there is a problem of being unsuitable for immediate utilization as compost. In particular, there is a weak point of a limit to types of wastes to which this fermenting and drying treatment can be carried out, among these untreated wastes as materials to which the fermenting

and drying treatment can be given. Furthermore, drying method includes hot air drying, aeration drying with floating device, rotary kiln drying, micron spray drying, and the like. However, in all of these, outside air is mixed, and injected into the inside, and the exhaust gas of inside air current accounts for a large portion. So, it is difficult to treat the exhaust gas. Accordingly, exhaust pollution spreads. And there is a big fuel loss due to direct exhaust to outside. And dried materials cannot adsorb the inside floated air current due to supply of outside air during dry. Thus, there is a weak point of very low burning rate as solid fuel. And a drying operation is carried out by using a separate external heat source. As a result, high fuel cost is imposed. Consequently, it is uneconomical. And the imbalance of appearance is created. So, it is difficult to recycle this. And materials polluting the outside, which is emitted in the process of drying treatment like this, pollute the surrounding environment. Therefore, there is a problem of being recognized as NIMBY facilities. This paper introduces a perfect recycling method of utilizing a solid as stock feed and utilizing the condensate as deodorant or external carbon source in sewage treatment

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plant after drying fish waste abundant in fat and protein in a hermetically sealed state and carbonizing the dried waste under a reduced pressure by using continuous drying equipment<sup>2</sup>.

## 2. Improvement in Treatment Procedure

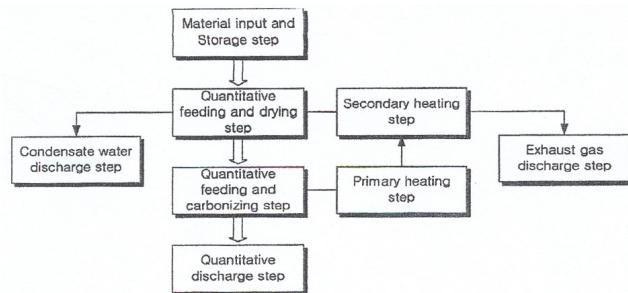
### 2.1 Problem of Previous Treatment Method

In regards to the fish waste generated from fisher's market and others, some of them are collected to be used as raw material of soap and others after separating the fatty substance and solids are sent to the feed factory. Meanwhile, as shells, bones, and others with high content of ash substance after the drying have very low utility value as flesh. Also, useless fish wastes such as starfish disposed from the fishing boat and harbor were easily thrown away due to lack of economics. Although Taean-gun and others conducted experiment to change starfish into powder and condensate water by drying with the use of small dryer, it did not propose measures for recycling and others. Therefore, lungfishes, intestines of fishes, and others with abundant nutrients can be used as great raw material.

### 2.2 Improvement

Instead of batch type which conduct treatment after 1 input, continuous method by weighing feeder was adopted to conduct completely separate treatment for dried solids and condensate water. In this case, fatty substance and protein is maintained as it is thus it is possible to produce condensate water rich in soft dried matters and organic acid. In regards to treatment process, as it uses drying method by compulsory air circulation method with the use of completely sealed dryer, it fundamentally prevents the generation of bad odor. The improvement was made for complete recycle so that dried solids are used as dry feed rich in nutrients and condensate water can be used as deodorant mixed with methyl alcohol and others or utilized as external source of carbon at the sewage treatment plant. It uses sealed distill drying method in general and heat exchanger and condensate water producing device plays a main role in drying. Summarizing the trait of process, it discharges small amount of unnecessary exhaust by externally heated distill drying, does not require exhaust current treatment with the use of combustion air after condensation, and requires low maintenance cost the contaminants are treated with transparent

condensate water<sup>3</sup>. Whole quantity can be consumed with dried solids as the raw material of ingredient feed and condensate water as the deodorant and others thus it can be used as complete recycling device. Operating principle is briefly illustrated in Figure 1. Heat source is a steam boiler using waste heat of incinerator and agitated heating is conducted for food wastes that goes into the bottom of high speed dryer and comes out of storage hopper. The vapor generated at the moment passes through heat exchanger and condensate water producing device and converts into dried air. Then, the circulation begins once again from high speed dryer. Agitation and heating are performed repeatedly until the water content of drying matters fall under 10%. After sufficient drying, it goes through impurities remover by vibration screening method and solids are packaged with 20kg bag and condensate water is saved to storage tank. As it goes through sealed process in general, it does not generate bad odor except the storage hopper. Figure 1 shows the diagram of a treatment method.



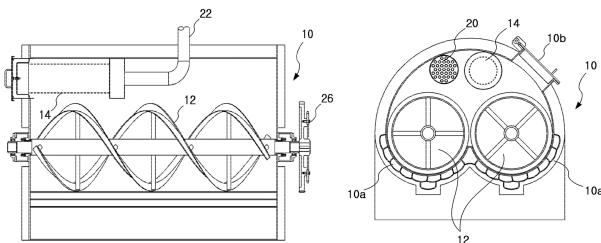
**Figure 1.** Diagram of a treatment method.

## 3. The Dryer

### 3.1 Basic Design

We constructed the sample equipment which has a capability of 10 tonnes per a day. This system is not so large but it contained 8 steps effectively. First trial of dry fermentation system was constructed near the incinerator system. The heating energy was supported by hot water vapor from boiler system of the incinerator. This system is very useful because there would be no fuel fee. Figure 2 shows the diagram of dryer and Figure 3 shows a front view of dry apparatus. This dry fermentation system enabled unmanned operation by low turning speed with batch process and automatic operation. Also there would be environmental benefits; nothing emitted odor by shut distillation dry and decompression, discharging

and recycling of generated condensate with purification, recycling of by-product as an enzyme, forage additives and livestock excreta waste. And economical Benefit are reducing fuel cost with epochal by heating recovery with internal streaming circulation, reducing treatment expense by operating with maximum reduction and none additives extension. This equipment has a safety by long life cycle and convenient replacement with stainless product and compatible spare part and preventing appearance retention by low driving of double line stirrer agitator with operating two times a day.



**Figure 2.** Speedy Dryer (left: front view, right: side view).

10: main body, 14: Dust remover, 20: heat transfer, 12: mixer, 26: rotating wheel.

## 3.2 Rotten Fish Waste Treatment Apparatus

### 3.2.1 Mechanical Characteristics

- Only organic waste 100% concentration dry treatment (Maximum Reduction)
- Enabling unmanned operation by low turning (2~3 rotation/min) with batch process and automatic operation

### 3.2.2 Environment Benefit

- None emitted odor by shut distillation dry and decompression.
- Discharging and recycling of generated condensate with purification.
- Recycling of by-product as an enzyme, forage additives and livestock excreta waste.

### 3.2.3 Economical Benefit

- Reducing fuel cost with epochal by heating recovery with internal streaming circulation.
- Reducing treatment expense by operating with maximum reduction and none additives extension.

### 3.2.4 Safety

- Long life cycle and convenient replacement with stainless product and compatible spare part.
- Preventing appearance retention by low driving of double line stirrer agitator with operating two times a day



**Figure 3.** Sample (Speedy dryer).



**Figure 4.** Equipment components.

The drying process is briefly summarized as follows<sup>4-6</sup>

1. Material input and storage step

This is a step for inputting and storing a material, including a variety of untreated waste materials, into the input storage hopper in readiness for agitation and transfer.

2. Quantitative feeding and drying step

This is a step for feeding a quantitative amount of the material, stored during the material input and storage step, into the drying processor and agitating and transferring the material in the sealed drying processor, so as to allow

the material to be heated and dried in a hermetic state by the secondary heating source.

#### 3. Quantitative feeding and carbonizing step

This is a step for feeding the quantitative amount of material, dried during the quantitative feeding and drying step, into the carbonization processor 3 and agitating and transferring the material in the sealed carbonization processor, so as to be carbonized by the primary heating source.

#### 4. Quantitative discharge step

This is a step for delivering the quantitative amount of material, carbonized during the quantitative feeding and carbonizing step, into the quantitative discharger and subsequently discharging the material to the outside of the quantitative discharger by use of the conveyor.

#### 5. Condensate water discharge step

This is a step for generating condensate water and a high-temperature and low humidity air stream as the high-temperature and high-humidity air stream, generated from the material in the sealed drying processor during the quantitative feeding and drying step, is subjected to condensation and dehumidifying processes by way of the condenser and the dehumidifier, and then discharging the condensate water to the outside after purifying the condensate water by use of the active carbon filter.

#### 6. Primary heating step

This is a step for delivering the high temperature and low humidity air stream, generated during the condensate water discharge step, into the mixer of the burning unit for utilization thereof in the primary heating source, and also delivering the dried gas, generated from the interior of the carbonization processor and the quantitative discharger during the quantitative feeding and carbonizing step, into the mixer of the burning unit for utilization thereof in the primary heating source, so as to heat the carbonization processor by use of heat generated as the high-temperature and low humidity air stream and the dried gas burn together.

## 4. Treatment Analysis

### 4.1 Trial Operation<sup>7</sup>

Actually, rotten fishes and other organic wastes are different. Large quantity of fatty substances in the rotten fish wastes made a trouble, that is, the drying was not successful. Only the intestines of fishes and fish offal was used except what had a solid shell, such as shellfish and turban

shell for trial operation. In case of drying only fish offal, a large amount of fat formed into a lump in the drying process. So, the fish offal failed to be dried. It was possible to dry 1000kg of fish waste only for 5 hours by drying this after being mixed with leaf powder abundant in fiber.

### 4.2 Trial Feed Manufacturing

Impurities were removed by using the vibrating screens, and then the dried materials were temporarily stored. In case there is a large amount of moisture, a solidifying phenomenon occurred. So, a well-ventilated place was required for storage. Figure 5 shows the appearance of dried fish waste.



**Figure 5.** Dried rotten fish waste.

### 4.3 The Trial Application of Feed

An attempt was made to apply the feed to a duck farm among nearby stock raising farms. According to the results of using this for about 1 month, no problem with the growth of duck arose when checked with naked eyes. Table 1 shows the chemical composition of dried fish offal. In case there is a large amount of moisture, a solidifying phenomenon occurred. So, a well-ventilated place was required for storage.

### 4.4 Condensate Water Producing Test<sup>8</sup>

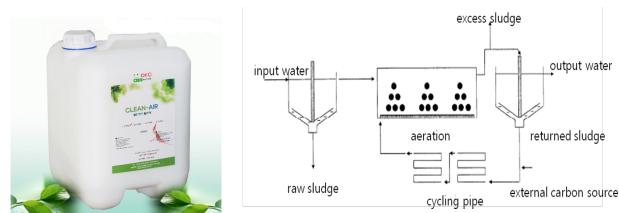
Condenser combined with heat exchanger presented normal operation and it increased the effect of condenser with the function as dehumidifier. Condensate water, an outcome, is particularly outstanding deodorant with

**Table 1.** Chemical components of exhausted gas

Classification	Unit	Exhaust Standard	Average Analysis
CO	ppm	200 below	103.7
NOX	ppm	150 below	40.3
SOX	ppm	70 below	32.9
HCL	ppm	40 below	0.5
F	ppm	2 below	0.27
Hg	ppm	0.1 below	Non detection
Phenol	ppm	10 below	"
NH3	ppm	100 below	"
HCN	ppm	10 below	"
AS	ppm	0.5 below	"
Cr	ppm	0.5 below	"
Cd	ppm	0.1 below	"
Pb	ppm	1.6 below	"
Cu	ppm	10 below	"
Zn	ppm	10 below	"
Dust	ppm	80 below	5.5
Smoke	degree	2 below	Non detection

carbon source rich in organic acid content and it can be utilized as external carbon source for liquefied fertilizer and sewage treatment plant. Considering general circumstances of domestic sewage treatment, if there is a method to observe intensified water quality standard for effluent with using previous facility, it will not only save the cost spent for new installation and operation of advanced sewage treatment facility but also maximize the efficiency of sewage treatment by reusing the previous system with simple improvement works. Condensate can be utilized as external carbon source for sewage and waste water treatment plant which enhanced the conventional activate sludge method of previous sewage and waste water treatment plant and improves the efficiency of removing nitrogen and phosphorous by adding carbon source from the outside. As it can economically and effectively remove the organic matters together with eutrophication causing substances such as nitrogen, phosphorous, and others

without addition of separate advanced treatment process to previous sewage and waste water treatment plant, it can save water treatment cost, propose countermeasure to observe intensified water quality standard for effluent, and contribute to reduction of domestic environmental problems. Figure 6 illustrates external carbon source application models.

**Figure 6.** Applications of condensate (L: deodorant, R: external carbon source).

## 5. Conclusion

We continuously studied the recycling method of organic waste especially food waste<sup>2-8</sup>. In this paper, with regard to the recycling of organic wastes such as food wastes, these were used relatively more as compost. It's the time to need to develop a new alternative feed against an increase in feed price. In case fish and shellfish offal is effectively dried and treated, and then is utilized as good quality feed in conformance with this, water disposal and resource recovery can be accomplished at the same time. Formerly, a lot of petroleum products were used as the heat source of drying equipment. However, those are not appropriate due to the rise in oil price. And drying by steam boiler using the waste heat of kiln incinerator or utilizing relatively cheaper electricity at midnight is useful. We succeeded in effectively making the dry powder through the addition of external fibrous materials to the fish waste by using hermetically sealed high-speed drying equipment. This could prevent an odor from being emitted in the drying process, and showed the possibility that the fish waste could effectively become feed through standard packaging. In the trial breeding of poultry, no remarkable obstacle was found. And the growth status was not insufficient in comparison with when conventional feed was used. It

**Table 2.** Chemical components of the condensate

List	Phenol	Cyanogens	Cr	F	Zn	Cu	Cd	Hg	As	Pb	Cr	Mn	BOD	COD
ppm	ND	ND	0.1	2	1	0.01	ND	ND	ND	0.01	0.1	1.01	5	10

was possible to utilize the condensate as deodorant, external carbon source in sewage treatment plant, and liquid fertilizer, and so on. Therefore, it is possible to accomplish the perfect recycling of fish waste if solid-liquid separation method by evaporation is used, utilizing the hermetically sealed high-speed drying equipment. This has the effects of preventing generation of contaminants and environmental pollution while reducing fuel costs, and finally remained carbide is available into solid fuel having superior burning efficiency.

## 6. References

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