Application Research on Deodorization Effect of Domestic Waste by One Microbial Deodorizer

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Abstract: In order to assess the deodorization effect of the selected microbial deodorizer, one garbage truck and three refuse transfer stations were used for our investigation. The removal efficiency of NH₃, H₂S and odor concentration from domestic wastes was studied. The results showed that the concentration of NH₃ was decreased by 90.9% and the concentration of odor was decreased by 92.8% when spraying deodorant in the garbage truck. In the three refuse transfer stations, the average removal rates of NH₃ and the odor concentration were 66.7% and 34.7%, respectively. Good deodorizing effects of the selected microbial deodorizer were obtained in this research.

1. Introduction
With the rapid development of social economy and the rapid improvement of people's living standards in China, the amount of domestic waste has also increased rapidly, resulting in environmental pollution, and its impact on people's health is more and more obvious. In response to these problems, a variety of technologies have also emerged, including recycling, landfill, incineration and composting. Landfill is an effective way to dispose a large amount of domestic waste, and is also the final treatment method of all waste disposal process residues. In China, landfill disposal accounts for 70%~80% of the total domestic waste disposal [1]). At the same time, there are many problems that cannot be ignored in landfill. During the transportation of domestic waste and with the action of anaerobic microorganisms in landfill, a large number of gases with irritating odor will be produced, which will pollute the surrounding air environment and seriously affect the lives of the surrounding residents [2]. At present, commonly used deodorization measures include chemical deodorization such as combustion, acid/alkali absorption, physical deodorization such as masking and dilution, and biological deodorization such as microbial degradation [3-5]. In recent years, microbial deodorizer is found more and more suitable for waste treatment projects such as transfer stations and landfill sites because of its simple operation, excellent effect, low operating cost and no secondary pollution [6-8]. In this study, a polite deodorant experiment and an application test in refuse transfer station are carried out to evaluate the deodorization effect of a microbial deodorizer, providing a reference and basis for the practical application of this microbial deodorizer.

2. Materials and methods

2.1. Experimental materials
The microbial deodorizer used in the experiment is a compound probiotic deodorizer containing multiple probiotics, and the waste used in the experiment is domestic waste.

2.2. Experimental methods
The experiment is carried out in two stages. The first stage is a pilot test and the second stage is an application test. The setting of test parameters is mainly based on the product information of microbial deodorizer used in the experiment.

Pilot test: The test is carried out in a relatively closed space (garbage truck), which enriches the odor gas produced by domestic waste, thereby increasing its monitoring concentration. Two parallel sampling points are arranged in the garbage truck, and the working liquid, 1:20 diluent of microbial deodorizer, is sprayed. The experimental steps are as follows: (1) After 24 hours of fermentation in the garbage truck, conduct the first sample collection (the test indicators include the concentration of NH$_3$, H$_2$S and odor); (2) after the first sample collection, the waste is sprayed with fluid; (3) after spraying the working liquid for 5 minutes, the second sample collection is carried out (the test indicators include NH$_3$, H$_2$S and odor concentration).

Application test: Three refuse transfer stations are selected as application test sites, namely refuse transfer station I, refuse transfer station II and refuse transfer station III. There are no special meteorological conditions on the test day. Four sampling points are set for each refuse transfer station (A is 5 m upwind outside transfer station, B is 5 m downwind outside transfer station, C is in the transfer station and D is in the transfer station). The working fluid, 1:50 diluent of microbial deodorizer, is sprayed evenly on the waste surface and the ground in the transfer station with the ratio of the working fluid volume: waste volume≈1:1000. The experimental steps are as follows: (1) Waste recycling is carried out at the refuse transfer station from 5:00 to 21:00 on the test day; (2) refuse transfer station no longer receives waste at 21:00, and we carry out the first sample collection at the preset sampling point (the test indicators include NH$_3$, H$_2$S and odor concentration); and (3) spray on the waste surface after the first sample collection is completed; (4) after spraying working liquid for 5 minutes, the second sample collection is carried out at the set sampling point (the test indicators include NH$_3$, H$_2$S and odor concentration); (5) after spraying working liquid for 45 minutes, the third sample collection is carried out at the set sampling point (the test indicators include NH$_3$, H$_2$S and odor concentration).

2.3. Monitoring methods
NH$_3$ is determined by Nessler reagent spectrophotometry, H$_2$S is determined by methylene blue spectrophotometry, and odor concentration is determined by triangle odor bag method.

3. Results and analysis

3.1. Analysis of deodorization effect in pilot test
In the pilot test, the removal efficiency of NH$_3$, H$_2$S and odor concentration by microbial deodorizer is shown in Table 1. The results show that the average removal rate of NH$_3$ and odor is 90.2% and 92.6% respectively. In this experiment, domestic waste does not produce enough H$_2$S gas, and the concentration value after enrichment is still very low. Therefore, the removal effect of H$_2$S cannot be effectively evaluated. The odorous gases emitted from domestic waste mainly come from the gases produced in the process of garbage corruption and the volatilization of odorous gases from the bottom landfill leachate. The main components of domestic waste in different areas are different, so the main odor gases will be different, but there are mainly NH$_3$ and/or H$_2$S [9]. Shao Jun et al. [10] investigated the effect of microbial deodorizer compounded by four strains on odor concentration changes using containers of two domestic waste transfer stations in Shanghai. It is found that H$_2$S is the main gas of odor gas from domestic waste in that test while NH$_3$ is the main gas of odor gas from domestic waste in this test.
Table 1. The detection results of pilot test

|          | Sample A          | Sample B          |
|----------|-------------------|-------------------|
|          | First  | Twice | First  | Twice |
| NH$_3$ Concentration (mg/m$^3$) | 3.19   | 0.29  | 3.24   | 0.34  |
| Removal rate | 90.90% |       | 89.50% |       |
| Average removal rate |       | 90.20% |       |       |
| H$_2$S Concentration (mg/m$^3$) | 0.007  | <0.005| 0.007  | <0.005|
| Removal rate |       |       |       |       |
| odor Concentration | 2855   | 205   | 3524   | 267   |
| Removal rate | 92.80% |       | 92.40% |       |
| Average removal rate |       | 92.60% |       |       |

At present, most of the microbial deodorizers used in domestic market are imported from foreign countries. EM bacteria developed by Professor Bijazov of Ryukyu University in Japan are the earliest microbial agents. After many years of technological development, EM bacteria have been applied in various fields [11]. Mei Rong et al. [12] deodorized mixed domestic sewage by EM flora. It is found that XM bacteria in EM flora can remove 87% of the odor, and the deodorization effect is obvious. In recent years, some progress has been made in the self-selection and compounding of compound microbial deodorizers in China. The highest removal rate of odor concentration can reach 76.3% with the compound microbial deodorizers developed by Shao Jun and others, and 83.6% removal rate of NH$_3$ with the compound microbial deodorizers developed by Zeng Su and others. The highest removal rates of NH$_3$ and odor concentration produced by domestic waste by microbial deodorizer in this experiment can reach 90.9% and 92.8% respectively, which has a promising application prospect.

3.2. Application effect of refuse transfer station

Three refuse transfer stations are further selected for the application test to determine the practical application effect of the microbial deodorizer.

3.2.1. Removal effect of odor concentration

Microbial deodorizer can remove odor concentration in refuse transfer station. After spraying working liquid, the monitoring value of odor concentration decreases significantly. The odor concentration in refuse transfer station I decreases by 22.4%, the odor concentration in refuse transfer station II decreases by 34.7%, and the odor concentration in refuse transfer station III decreases by 34.3%. The odor concentration in the surrounding air is also sampled and monitored at the refuse transfer station III. The data show that the odor concentration in the surrounding air is improved to some extent by spraying deodorizer in the refuse transfer station, and the removal rate is 20.9%. See Figure 1. Compared with other deodorizers of the same type, the deodorizer used in this experiment has good deodorization effect. Cui Yuxue et al. [8] isolated and screened several strains with strong deodorizing ability from sludge and landfill leachate of landfill site, and made a compound microbial deodorizer. The experimental application shows that the deodorization effect of the compound microbial deodorizer is better than that of EM microbial agent, and the removal rate of odorous gas concentration reached 19.1%.
Figure 1. Removal rate of odor in three refuse transfer stations

Comparing the monitoring data of odor concentration inside and outside refuse transfer station III, the concentration value inside the transfer station before deodorization is obviously higher than that outside the transfer station, and the concentration value after deodorization is nearly equal, and the removal rate inside the transfer station is obviously higher than that outside the transfer station. Therefore, the higher the odor concentration value in the air of the original environment, the better the odor removal efficiency of the microbial deodorizer used in the experiment can be reflected. Although the deodorization efficiency is not high due to the low concentration of environmental samples, spraying the microbial deodorizer can significantly improve the odor situation of refuse transfer station, and the odor concentration in the environment meets the requirements of environmental quality standards in the region (see table 2).

Table 2. The odor concentration of three refuse transfer stations

| odor                  | first | twice | third |
|-----------------------|-------|-------|-------|
| Refuse transfer station I | 49    | 32    | 50.5  |
| Refuse transfer station II | 47    | 36.5  | 46.5  |
| Refuse transfer station III | 53.5  | 35    | 49.5  |

3.2.2. Removal effect of NH$_3$ and H$_2$S

From Figure 2, it can be seen that the microbial deodorizer has better removal effect on NH$_3$ in refuse transfer station. The removal rates of NH$_3$ in refuse transfer station I, refuse transfer station II and refuse transfer station III are 67.1%, 76.1% and 56.8% respectively, with an average removal rate of 66.7%. Wang Yingxue [14] used self-made compound microbial agent to effectively solve the odor problem of landfill site of Yanshantou in Zhongxiang City, Hubei Province. The removal efficiency of NH$_3$ can reach 65.9%, which is comparable to the application effect of this experiment.
During the experiment, the monitoring data of $\text{H}_2\text{S}$ pollutants in the surrounding air of the refuse transfer station show that the concentration of $\text{H}_2\text{S}$ in the surrounding air of the refuse transfer station is very low, close to the detection limit (0.005mg/m$^3$) or lower than that. The odor of waste is caused by the decomposition of organic components in waste by microorganisms. The main components and treatment process of domestic waste determine that it produces various odorous gases. From the monitoring data of this application test, it can be seen that the domestic waste collected by the three refuse transfer stations selected in the experiment does not produce a large amount of $\text{H}_2\text{S}$. Therefore, the removal effect of $\text{H}_2\text{S}$ cannot be determined.

3.2.3. Analysis of influencing factors of deodorization effect

Deodorization efficiency of deodorizer is affected by many factors, such as quality of domestic waste, source value of odor concentration, dosage of deodorizer, spraying mode of deodorizer, spraying atomization effect, spraying frequency, sunshine, temperature, etc. [15-16]. Therefore, in the controllable range, the deodorant process should ensure adequate amount of deodorizer spraying, and improve the atomization effect as far as possible. The spraying frequency should be further demonstrated by experiments to find out the optimal spraying scheme, so that the deodorizer can play a full role in the application process and obtain the best deodorant effect. From Figure 3, we can see that if we want deodorizer to continue to play a deodorizing role in the use process, the spraying frequency of deodorizer should be determined according to the time $T$ in the figure.

![Figure 2. Removal rate of NH$_3$ in three refuse transfer stations](image)

During the experiment, the monitoring data of H$_2$S pollutants in the surrounding air of the refuse transfer station show that the concentration of H$_2$S in the surrounding air of the refuse transfer station is very low, close to the detection limit (0.005mg/m$^3$) or lower than that. The odor of waste is caused by the decomposition of organic components in waste by microorganisms. The main components and treatment process of domestic waste determine that it produces various odorous gases. From the monitoring data of this application test, it can be seen that the domestic waste collected by the three refuse transfer stations selected in the experiment does not produce a large amount of H$_2$S. Therefore, the removal effect of H$_2$S cannot be determined.

![Figure 2. Removal rate of NH$_3$ in three refuse transfer stations](image)

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![Figure 3. Deodorization effect diagram](image)
In the process of evaluation of deodorization effect, the experimental data show that (see Table 2 for details): After spraying for 45 minutes, the odor concentration basically rises to the concentration value before spraying deodorization. Therefore, if the selected microbial deodorizer is applied according to the experimental parameters, the biochemical effect of microbial deodorizer after 45 minutes cannot effectively control the increase of odor concentration. The effective bacteria have not yet fully grown to form dominant flora in the environment. At present, the best deodorization effect can be obtained only after 48 hours for the manually screened deodorant strains. The deodorizing efficiency of yeast screened by Tang Weiwei and others reaches the maximum after 72 hours, and that of microbial deodorizer screened and compounded by Zeng Su and others reaches the best deodorization effect in 60 hours. It can be predicted that after 45 minutes, the odor concentration will continue to rise slowly and reach a constant period, thus determining the T value. The optimum incubation time (T) of the deodorizer used in this experiment must be further determined.

4. Conclusion
A polite deodorant experiment is carried out in a relatively closed space with the selected microbial deodorizer. The deodorizer has good deodorization effect on odor gas produced by domestic waste. The maximum removal rate of odor concentration reaches 92.8%, and the maximum removal rate of NH3 reaches 90.9%. In the application test of refuse transfer station, due to the low concentration of odorous gas in surrounding air, the deodorization effect is not fully reflected, but it can ensure that the concentration of odorous gas in the environment meets the requirements of environmental quality standards in the region, and can significantly improve the odorous situation. The odor concentration can be reduced by 34.7%, and the highest removal rate of NH3, the main odorous gas, is 76.1%, which indicates that the microbial deodorizer used in the experiment has a good application prospect.

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