IOP Conf. Series: Earth and Environmental Science **61** (2017) 012142 doi:10.1088/1755-1315/61/1/012142

Biological removal effect for odor in medical waste steam treatment process

Jin Dengchao[1,a], Teng Hongjun[2,b], Bao Zhenbo[1,c] and Li Yang [1,d]

[1]Engineering and Technology College, Tianjin Agricultural University, Tianjin, China, 300384
[2]Clinic, Tianjin Agricultural University, Tianjin, China, 300384
[a]jindengchao@163.com; [b]hongjun-teng@163.com; [c]baozhenbo@sohu.com;
[d]liyang.tjac@gmail.com

Abstract. Malodorous gas will be produced in medical waste steam treatment process, which mainly consist of volatile organic compounds. Biological deodorization is a low cost deodorization technology. In this paper, biological deodorization technology in an actual medical waste disposal project was studied, and its removal efficiencies of VOCs were analyzed. The contents of four volatile organic compounds in exhaust gas were determined by gas chromatography and methylene blue spectrophotometry. The average concentration of them were: methyl-sulfhydryl 0.037mg/m^3, dimethyl sulfide 0.046mg/m^3, methyl disulfide 0.904mg/m^3 and hydrogen sulfide 0.204mg/m^3. After they were treated by biological deodorization, the average removal rates of the four compounds were methyl-sulfhydryl 93%, dimethyl sulfide 92.6%, methyl disulfide 97.6% and hydrogen sulphide 92.6%.The results showed that the four kinds of VOCs had good deodorization effect, and the national standards for emissions requirements can be met well.

1.Introduction

Medical waste steam treatment is one kind of non-incineration technology[1-3], which basic principle is moist heat sterilization[4]. The organic compounds in medical waste will evaporate and cause odor pollution when medical waste is sterilizing by high temperature steam. Therefore, it is necessary to purify the waste gases by removing odor. Biological deodorization is a widely used and low cost technology[5], its basic principle is that microorganisms can absorb and decompose the odor components. In this paper, an actual medical waste treatment engineering was investigated ,which adopted steam treatment technology to dispose medical waste and used patented biological deodorization technology for waste gas purification. According to the national detection standard, the content of four kinds of odor components, which were methyl-sulfhydry, dimethyl sulfide, methyl disulfide and hydrogen sulfide, were analyzed before and after deodorization. The purpose of this research is to verify the deodorization effect of biological deodorization technology.

Medical waste disposal capacity of the project was 5 tons per day, basic operation process of medical waste treatment was described as below: medical waste was put into the sterilizer firstly, after alternate operation of steam injection and vacuum pumping was finished, steam was then injected into sterilizer and the temperature of the medical waste was raised to 134 ℃. Keeping at this temperature for 45 minutes to complete the sterilization, medical waste was then vacuum dried. After drying, sterilized medical waste was pulled out from sterilizer and was shredded outside. At last, they were landfilled.

IOP Conf. Series: Earth and Environmental Science **61** (2017) 012142 doi:10.1088/1755-1315/61/1/012142

In the process above, odor was mainly produced in four aspects: the first was pre-vacuum stage, the second one was drying stage after sterilization, the third was discharging stage of medical waste from sterilizer, and the last was crushing stage. In the first two stages above, exhaust carrying fetor was discharged outward from sterilizer by vacuum pump, it belonged to control emissions. while, in the next two stage, malodorous gases were directly diffused into the operating environment, it belonged to non- control emissions. In order to treat all odor gas, it needed to collect both control and non-control odor emissions together firstly, then to remove them centrally.

To do this, the discharging door of sterilizer was provided with a collecting cover in this study, exhaust gas collected by cover together with the vacuum pump exhaust were drawn into the biological deodorization system.

Odor deodorizing system in this project was one of patented products manufactured by Tianjin greentech environmental technology limited company. Main equipment of the system included four parts: heat exchanger, deodorization tower, draught fan and chimney. Biological deodorization tower was core equipment which was a cylindrical structure with four layers, each layer was filled with biological packing filler, odor gas was firstly absorbed by porous biological filler and then was degraded by deodorizing organisms adhered on the filler. Heat exchanger could regulated the temperature of the gas entering deodorization tower, ensuring the temperature suitable for biological bacteria. Centrifugal fan supplied power to the gas entering the tower, and took the purified gas out to environment through 15 meter height chimney.

2. Detection method and apparatus

2.1. Criterion for testing

(1) GB14554-1993, emission standard of odor pollutants.

(2) GB/T14678-1993, air quality ——determination of sulfuretted hydrogen, methyl-sulfhydryl, dimethyl sulfide and methyl disulfide——gas chromatography.

2.2. Detection method

The method to determine methyl-sulfhydryl, dimethyl sulfide and methyl disulfide were gas chromatography. The method to determine hydrogen sulfide was methylene blue spectrophotometry, which detailed operation based on the reference[6].

2.3. Core testing instruments

(1) Gas chromatography flame photometric detector, manufactured by SHIMADZU, model: GC-2010 Plus-FPD.

(2) Gas chromatography mass spectrometer, manufactured by Agilent, model: 7890A-5975C GC-MS.

(3) Ultraviolet visible spectrophotometer, manufactured by SHIMADZU, model: UV-1800.

3. Results and analysis

Figure 1 shows concentration values of methyl-sulfhydryl in exhaust before and after purification for six times, their average values are shown in Figure 2. Figure 3 and Figure 4 indicates correspondingly values for dimethyl sulfide. Six concentration values and their average values of methyl disulfide are presented in Figure 5 and Figure 6. As for as hydrogen sulfide, its correspondingly values are showed in Figure 7 and Figure 8.

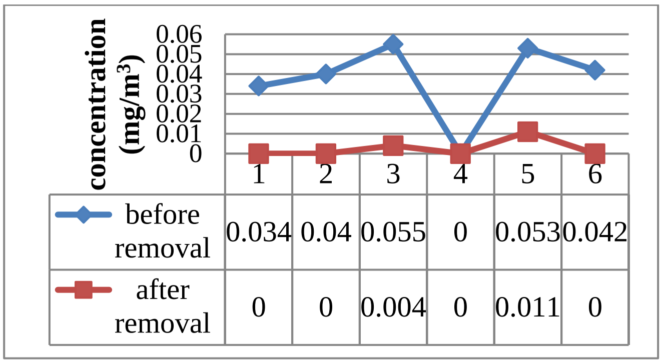

Figure 1. Methyl-sulfhydryl concentration in waste gas

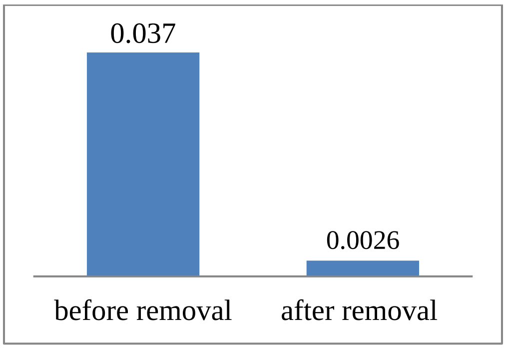

Figure 2. Methyl-sulfhydryl average concentration in waste gas(mg/m^3)

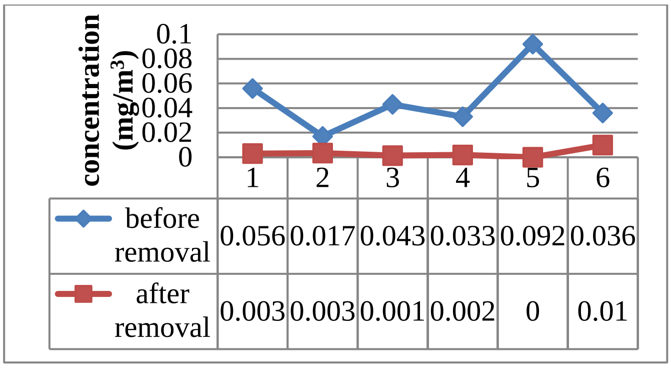

Figure 3. Dimethyl sulfide concentration in waste gas

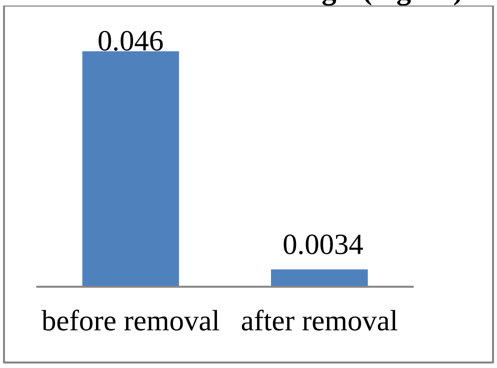

Figure 4. Dimethyl sulfide average concentration in waste gas(mg/m^3)

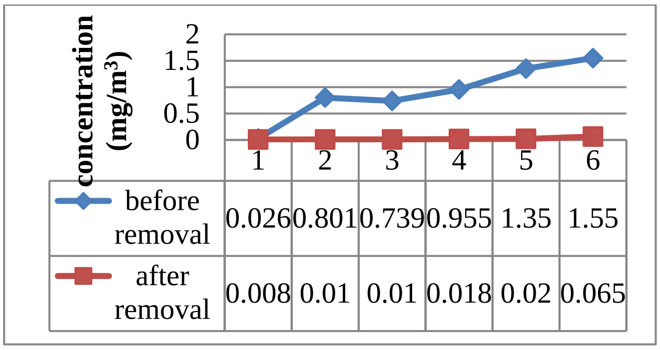

Figure 5. Methyl disulfide concentration in waste gas

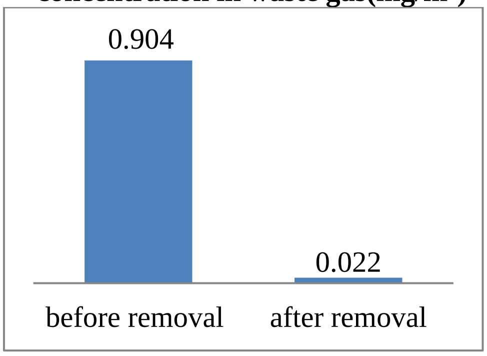

Figure 6. Methyl disulfide average concentration in waste gas(mg/m^3)

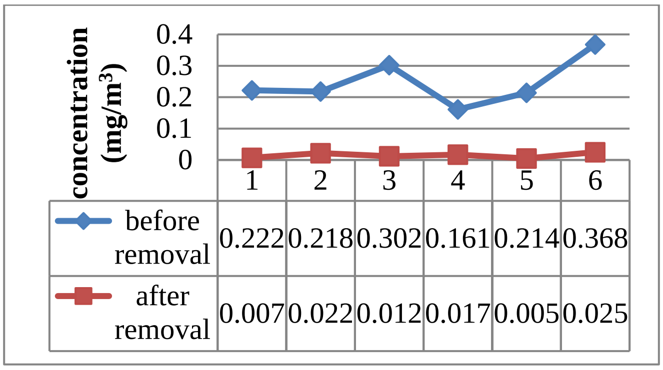

Figure 7. Hydrogen sulfide concentration in waste gas

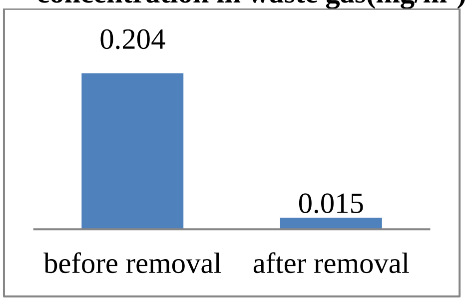

Figure 8. Hydrogen sulfide average concentration in waste gas(mg/m^3)

By analysis of above testing result, it could be found:

(1) In the process of medical steam treatment, the content of VOCs varied with treatment stages. For example, as for as hydrogen sulfide, its most content in waste gas was the sixth sampling time, and the lowest content on the fourth time. Other components also had this obvious characteristics. Comparing the sampling time with the state of the process, it was found that the highest concentration of organic always existed in the drying stage, and the lowest concentration time were pre-vacuum and crushing stage.

(2) Among the four VOCs, the most odor components in medical waste gas was methyl disulfide, its average was 0.904mg/m^3.

(3) The deodorization efficiency for the four VOCs in this study were: methyl mercaptan 93%，dimethyl sulfide 92.6%, methyl disulfide 97.6% and hydrogen sulfide 92.6%.

(4) Mean concentration of methyl mercaptan after purification is 0.0026 mg/m^3, its discharge rate at sampling times was 9.3×10-8~1.1×10-5kg/h. Dimethyl sulfide mean concentration was 0.0034 mg/m^3, and discharge rate was 7.7×10-7~1.0×10-5kg/h. Formethyl disulfide mean concentration was 0.022 mg/m^3 and discharge rate was 7.6×10-6~6.6×10-5kg/h. As for as hydrogen sulfide, its mean concentration was 0.015 mg/m3 and discharge rate was 4.8×10-6~2.6×10-5kg/h. According the standard GB14554-1993, if the chimney height is 15 meters , the limiting values for emission are as follows: methyl mercaptan0.04 kg/h, dimethyl sulfide 0.33 kg/h, methyl disulfide0.43kg/h and hydrogen sulfide0.33 kg/h. So to speak, deodorization effect of this four VOCs could meet requirements of national standards.

4. Conclusion

(1)Odor concentration was different in different stages in medical waste steam treatment process, the maximum amount of odor produced during the drying stage.

(2) Biological deodorization technology could effectively reduce VOCs in medical waste treatment.

References

[1] Wei Zhao, Ester van der Voet, Gjalt Huppes 2009 Comparative life cycle assessments of incineration and non-incineration treatments for medical waste *Int J Life Cycle Assess* **14**(2)pp 114-121.

[2] Diaz L F, Savage G M, Eggerth L L2005 Alternatives for the treatment and disposal of healthcare wastes in developing countries *Waste Management* **25**pp626-637.

[3] Majid Sartaj.Raheleh Arabgol 2015 Assessment of healthcare waste management practices and associated problems in Isfahan Province (Iran) *J Mater Cycles Waste Manag.* **17**pp99-106.

[4] Jin Dengchao, Li Yang, Bao Zhenbo 2015 kinetic equation of biological indicator for moist heat sterilization in medical waste treatment *Chinese journal of environmental engineering* **9(9)** pp4531-4533.

[5] Guillaume Darracq, Annabelle Couvert, Catherine Couriol 2012 Removal of Hydrophobic Volatile Organic Compounds in an Integrated Process Coupling Absorption and Biodegradation—Selection of an Organic Liquid Phase *Water Air Soil Pollut* **223**pp4969-4997.

[6] China EPA 2003 *Method for analysis of air and waste gas(Fourth Edition)*(Beijing: China Environmental Press)p512-513.