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Research Article

Assessing the level of air pollution at some small-scale household waste incinerators in Hai Hau district, Nam Dinh province

Nguyen Tien Dung[1]*, Vu Duc Toan[2]*, Ngo Tra Mai[3], Nguyen Ngoc Anh[3]

[1] Institute of Environmental Science and Technology, Vietnam Cooperative Alliance; nguyentiendunghb78@gmail.com

[2] ROOM strong research, Environmental and life science research laboratory, Thuyloi University; vuductoan@tlu.edu.vn; huongntl@tlu.edu.vn

[3] Institute of Physics, Vietnam Academy of Science and Technology; ntmai@iop.vast.vn; ann@iop.vast.vn

*Corresponding author: nguyentiendunghb78@gmail.com; vuductoan@tlu.edu.vn; Tel.: +84–914953335

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Abstract: In this study, sixteen air samples from two small-scale household waste incinerators in Hai Hau district, Nam Dinh province, Vietnam, were collected and investigated for some pollutants such as SO_2, NO_2, CO, H_2S, and BTEX. The results showed that the concentration of SO_2, NO_2, CO, and H_2S were correspondingly in the range of 351.1 -450.0, 30300-36600, 200.7-212.0, and 78.9-100.1 µg/m^3. In addition, the BETX concentration ranged from 5.16 to 20.7 µg/m^3 for Benzen, from 21.63 to 120.66 µg/m^3 for Toluen, from 3.13 to 12.57 µg/m^3 for (m, p)-Xylene, and from 1.58 to 7.73 µg/m^3 for o-xylene. All the values of SO_2, NO_2, CO, and H_2S concentration were higher than standard concentrations in QCVN 05: 2013/BTNMT, however, the BETX concentration was lower than the standards in QCVN 06:2009/BTNMT.

Keyword: BTEX; Concentration of pollution; Small scare incinerators.

1. Introduction

Waste generation has been increasing as long as society has developed. In 2016, the total amount of waste included into factor all commercial activity and households was 2538 million tons in the European Union (EU) based on the figure [1]. To reduce the amount of waste, the EU has been guiding the European environment policy from 2014 to 2020 and vision in 2050 in which waste treatment by incineration was limited [2]. Nevertheless, regardless of these policies, a significant amount of incinerators have continued to operate [3].

The main reason why the EU has recommendations to minimize waste treatment by incinerators is due to the negative effects on human health. A number of toxins that are created during the incineration process or are found in the trash have an adverse effect on both humans and the environment [4]. The cancer incidence of residents near municipal solid waste incinerators was studied by [5], and the findings indicated a statistically significant increase in the risk of lung, colorectal, and stomach cancer. According to epidemiological data, there is evidence linking air pollution, particularly particulate matter (PM), to an increase in respiratory and cardiovascular-related issues. According to observations, between 40% and 70% of airborne fine particulate matter originates from combustion. This type of particulate matter has been linked to a decline in lung function and an increase in the prevalence of chronic obstructive pulmonary disease [6].

In the air environment, many harmful pollutants, particularly particulate matter (PM), volatile organic compounds (VOCs), heavy metals, and polychlorinated dibenzofurans and p-dioxins (PCDD/Fs), can be released by waste treatment incinerators [7]. The study [8] showed that PCDD/F concentrations were found in indoor air (0.29-0.85 pg/m^3) and indoor dust (14.93-649.70 ng/kg) samples taken from residences nearby to an East China municipal solid waste incineration (MSWI) plant. Study [9] reported that when sixty-four samples from four MSWI power plants were tested, 102 target volatile organic compounds (VOCs) were found, including o-xylene, toluene, ethylbenzene, etc. According to [10], 25 VOC species were found in the chimney plume and 29 VOC species were found in the discharge workshop. A high temperature of 1000^{o}C was used throughout the incineration process to decompose most of the organic materials in the rubbish, releasing CO, CO_2, VOCs, and other gases from the stack. Toluene was a typical byproduct of waste combustion, but benzene can be generated by the recombination of C_3H_3 and the interaction of C_3H_3 and other species during the burning process.

In Vietnam, according to the National Environmental Status Report 2019 on solid waste, there are currently 1,322 solid waste treatment facilities, including 381 incinerators [11]. Some small-sized incinerators for MSW treatment, many of these incinerators do not meet the requirements of QCVN 61-MT:2016/BTNMT [12]. Some incinerators are damaged and degraded after a period of operation. Some incinerators meet the requirements of QCVN 61-MT:2016/BTNMT, but when applied in localities, they encounter some problems such as MSW having low calorific value, high humidity, and the operating level of the companies. Factories are still weak, do not comply with technical requirements, or do not operate the exhaust gas treatment system, leading to uncontrollable waste generation. [13] designed a waste treatment system using incineration with high-temperature combustion systems (900-1100^{o}C) to ensure solid waste burns completely and does not produce gases. poison. The laboratory-scale incinerator with a capacity of 5kg/h is tested and the exhaust quality is evaluated. The results show that the exhaust gas after combustion was surveyed with absorption solutions, with a NaOH concentration of 0.5N, and the concentration of NO_2, CO, and SO_2 emissions met the requirements according to QCVN61-MT:2016/BTNMT. However, to our knowledge, studies specifically evaluating air pollution in small-scale waste incinerators have not been evaluated in Vietnam or abroad.

Hai Hau district, Nam Dinh province is a district with many attractive tourist attractions, so it has attracted many people from all over the province as well as other provinces, so the amount of waste generated daily in the area is quite large. To solve the waste problem, the District People's Committee has focused on investing in small-scale waste incinerators. According to statistics from the People's Committee of Nam Dinh province, currently throughout Hai Hau district, there are 29 domestic solid waste incinerators, including 20 Losiho technology incinerators, with a capacity of 400 kg/hour using fuel natural gas [14].

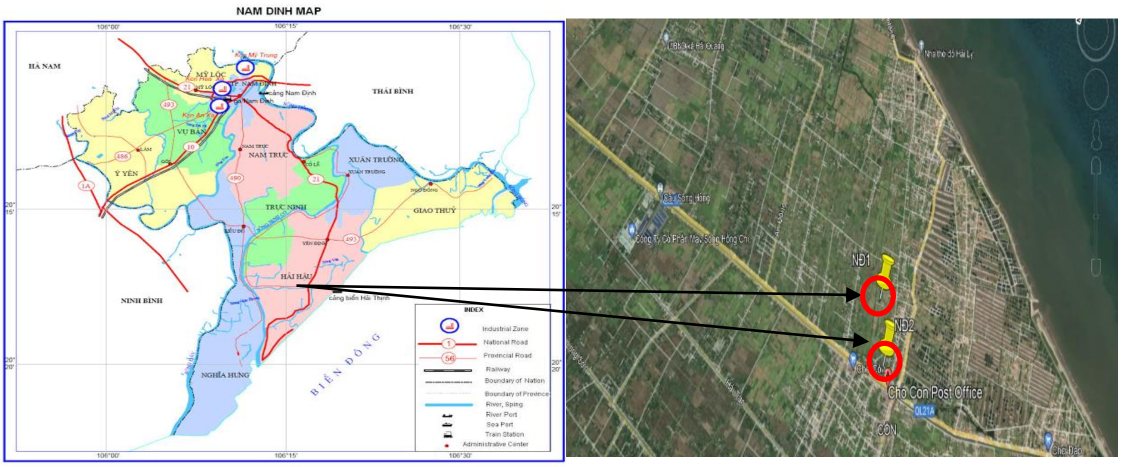

Figure 1. Location of the study area.

In this study, we focus on assessing air pollution at two small-scale waste incinerators in Hai Hau, Nam Dinh province.

2. Materials and methodology

2.1. Study area and sampling

2.1.1. Study area

The study area in Nam Dinh was selected in Con Town (NĐ1) and Hai Ly commune (NĐ2), Hai Hau district (Figure 1).

2.2. Methodology

2.2.1. Investigation and survey

Conducted investigation and survey of 29 waste incinerators in Hai Hau district, Nam Dinh province. Based on the survey results, the plementation team selected 02 incinerators with technology and waste composition representative of the research area to conduct sampling and analysis.

2.2.2. Sampling

A total of 16 samples were collected from two incinerators in Hai Hau district. Repeating sampling time is September, and November 2022 at each location of the waste incinerator. Samples were taken according to the instructions in Circular No. 10/2021/TT–BTNMT on technical regulations for environmental monitoring and management of information and data for environmental quality monitoring [15]. Basic parameters such as: SO_2, NO_2, CO, H_2S and TSP samples are taken with a Gas Sampling Pump: 1-5 LPM Model: 224- PCXR8KD SKC - USA, measuring range from 5-5000 lm/min.

BTEX group parameters: taken with Japanese Shibata HV 500R 5Y0164 gas sampling device, measuring range 100-800 L/min.

2.2.3. Study methods

SO_2: Analysis According to TCVN 5971:1995 - Ambient air - Determination of the mass concentration of sulfur dioxide - Tetrachloromercurate (TCM) pararosaniline method [16].

NO_2: Analysis According to TCVN 6137:2009 - Ambient air - Determination of mass concentration of nitrogen dioxide - Modified Griess- Saltzman method [17].

CO: Analysis According to Industry standard 52TCN 352:1989 on Carbon Oxides [18].

H_2S: Analysis According to Standard MASA-701 - Method for sampling H_2S gas [19].

TSP: Analysis According to TCVN 5067-1995: Air quality - Weighing method for determination of dust content [20].

BTEX group parameters: In compliance with NIOSH Manual of Analytical Method 1501, BTEX air sampling was performed. Charcoal sorbent tubes were used for BTEX adsorption (SKC, USA) [21]. After being collected, every sample was kept at -10°C and examined within 72 hours. Analytical reagents are all substances. After obtaining the BTEX standard, CS2, and n-hexane from Merck KgaA, Darmstadt, Germany, it was utilized without any purification procedures. The BTEX chemicals were extracted from gently shaking activated carbon with 2 mL of carbon disulfide (CS2) for 60 minutes using a vial containing 2 mL of CS2. After that, the solvent was put into a GC vial, and BTEX chemicals were measured using gas chromatography (GC/MS) with a mass spectrometer detector (Thermo Scientific Model IQS 7000). There was one capillary column utilized, the DB-WAX (30 m × 0.25 mm i.d × 0.25 μm thickness). The BTEX technique detection limits varied between 4.1 and 12.3 ng/m^3. Nearly every sample exceeded the limits of detection. For 10% of the samples that were collected, double analyses were carried out, and the results showed that the relative standard deviation values for each BTEX compound ranged from 5% to 9%. The back section of the tubes was separately analyzed in order to control the breakthrough of the sorbent tubes regarding BTEX compounds; the results showed that none of the target compounds were significantly detected in the back section for all of the samples analyzed (15 samples chosen at random from real samples).

3. Results and discussion

3.1. Assess the current status of pollution some basic parameters around the incinerator area of SSI

To assess the current status of air pollution in the area surrounding household waste burning, the research team conducted two rounds of sampling and sample analysis on September 8, 2022 and November 9, 2022, the analysis results are presented in Tables 1.

Table 1. Results of analysis of some basic indicators in the air environment around the incinerator area.

Compound	Unit	September	November	QCVN 05:2013/BTNMT [22]
A. Nam Dinh 1				
TSP	µg/m^3	314.7 - 335.2 (322.4 ± 8.1)	312.8 – 332.4 (320.1 ± 7.7)	300
SO_2	µg/m^3	445.1 – 450.0 (447.0 ± 1.9)	441.2 – 447.1 (443.4 ± 2.3)	350
CO	µg/m^3	31000 – 36600 (33100 ± 2113.6)	30450 - 37000 (32906.2 ± 2589.1)	30000
NO_2	µg/m^3	201.5 – 212.0 (205.4 ± 4.1)	200.7 – 210.7 (204.4 ± 2.9)	200
H2S	µg/m^3	89.2 – 100.1 (93.3 ± 4.1)	78.9 – 97.4 (85.8 ± 7.3)	42
B. Nam Dinh 2				
TSP	µg/m^3	317.3 – 322.7 (319.3 ± 3.1)	315.7 – 321.5 (317.9 ± 3.3)	300
SO_2	µg/m^3	351.3 – 357.1 (353.5 ± 2.3)	351.1 – 354.7 (352.4 ± 1.4)	350
CO	µg/m^3	30380 – 30400 (30387.5 ± 7.9)	30300 – 30800 (30487.5 ± 197.6)	30000
NO_2	µg/m^3	207.1 – 210.5 (208.4 ± 1.3)	205.4 – 208.4 (206.5 ± 1.2)	200
H_2S	µg/m^3	91.4 – 98.5 (94.1 ± 2.8)	89.5 – 97.4 (92.3 ± 3.0)	42

The treatment system includes a dust collection silo, a cooling silo, an absorption silo and 04 water tanks and 01 clear lime water tank. For this treatment technology, the concentration of common gases such as CO_2, SO_2, NO_2,... after going through the treatment system is significantly reduced. Currently, Losiho incinerator is using wet gas treatment technology. The treatment system includes a dust collection silo, a cooling silo, an absorption silo and 04 water tanks and 01 clear lime water tank. For this treatment technology, the concentration of common gases such as CO_2, SO_2, NO_2,... after going through the treatment system is significantly reduced. However, currently, the operation and maintenance of the incinerator exhaust gas treatment system has not been carried out regularly, leading to low treatment efficiency, leading to quite high concentrations of pollutants after treatment.

CO was the most abundant species, followed by SO_2, TSP, NO_2 and H_2S in all samples.

In Nam Dinh 1, the concentration of CO, SO_2, TSP, NO_2 and H_2S was in the range of 30450-37000, 441.2-450.0, 351.1-357.1, 315.7-322.7 and 78.9-100.1 µg/m^3; while in Nam Dinh 2 were 30300-30800, 351.1-357.1, 315.7-322.7, 205.4-210.5 and 89.5-98.5µg/m^3, respectively.

The results show that all analytical indicators exceed the allowed standard compared to QCVN 05:2013/BTNMT, of which the largest exceeding criterion is H_2S, this indicator exceeds the allowable standard from 2.13 to 2.38 times [22].

Air samples around the incinerator area in Nam Dinh 1 are more polluted than in Nam Dinh 2. The reason may be that the composition of domestic solid waste in Nam Dinh 1 is more complex than that in Nam Dinh 2 (it contains many agricultural waste products, organic ingredients, inorganic waste, etc.).

3.2 Contamination of BTEX around the incinerator area

To assess the current status of BTEX pollution in the area surrounding household waste burning, the research team conducted two rounds of sampling and sample analysis on September 8, 2022, and November.

Table 2. Results of BTEX analysis in the air environment around the incinerator area.

Compound	Unit	September	November	QCVN 06:2009/BTNMT [23]
Nam Dinh 1				
Benzen	µg/m^3	7.62 - 12.71 (9.3 ± 2.1)	6.13 – 20.70 (11.5 ± 5.7)	22
Toluen	µg/m^3	33.92 - 53.94 (40.6 ± 6.4)	27.82 – 120.66 (62.6 ± 36.7)	500
(m,p)-Xylene	µg/m^3	6.3 – 7.66 (6.8 ± 0.5)	6.55 – 12.57 (10.7 ± 6.3)	1000
o-Xylene	µg/m^3	3.07 – 3.48 (3.1 ± 0.16)	2.00 – 4.13 (2.8 ± 0.18)	
Etyl Benzen	µg/m^3	2.95 - 4.56 (3.4 ± 0.6)	2.78 – 7.73 (4.6 ± 1.9)	-
B. Nam Dinh 2				
Benzen	µg/m^3	7.28 – 11.35 (8.8 ± 1.6)	5.16 – 16.82 (9.5 ± 4.6)	22
Toluen	µg/m^3	32.58 – 48.14 (38.4 ± 6.1)	21.63 – 95.90 (49.5 ± 29.3)	500
(m,p)-Xylene	µg/m^3	5.21 – 5.49 (7.0 ± 1.7)	3.13 – 12.54 (6.3 ± 3.6)	1000
o-Xylene	µg/m^3	2.6 – 2.74 (3.2 ± 0.5)	1.58 – 6.48 (3.3 ± 1.9)	
Etyl Benzen	µg/m^3	2.78 - 7.73 (4.6 ± 1.9)	2.45 – 6.41 (3.9 ± 1.6)	-

Analytical results of 02 sampling periods showed that Toluene concentration was the highest, followed by benzene, m,p-xylenes (p,m-X), ethylbenzene (E) and o-xylene (o-X). The concentrations of substances are summarized in Table 2.

In Nam Dinh 1, the concentration of benzene, toluene, m,p-xylene, o-xylene end Etyl Benzen was in the range of 6.13-20.7, 27.82-120.66, 6.55-12.57, 2.0-4.13 and 2.78-7.73 µg/m^3; while in Nam Dinh 2 were 5.16-16.82, 21.63-95.9, 3.13-12.54, 1.58-6.48 and 2.45-7.73µg/m^3, respectively.

Overall, the BTEX concentration in Nam Dinh 1 was considerably higher than in Nam Dinh 2. The BTEX concentration during the sampling period was highest in September (Table 2).

In Vietnam, there is currently no research on BTEX concentration pollution around household waste incinerator areas. However, we can see that the concentration of BTEX substances will depend on the furnace technology as well as the composition and properties of the fuel. [24] showed that different combustion compositions produce different BTEX products. Survey results show that the waste that needs to be burned in the area is mainly organic (food scraps, leaves, tree branches); waste paper, glass, plastic bags, plastic bottles; concrete dishes, etc. Currently, Losiho incinerator's exhaust smoke treatment technology is only effective for common pollutants. For the BTEX group of organic compounds, it is not very effective, so most of the emissions generated by the BTEX group will be released into the local environment.

The concentration of organic substances in the BTEX group in September tends to be higher than in November. However, the concentration of the BTEX group measured in the study area is still lower than the allowed standard compared to QCVN 06:2009/BTNMT.

3.3 Ozone formation potential and isomeric ratio of BTEX

The percentage and ozone formation potential of BTEX are summarized in Table 3.

Table 3. Percentage (%), ozone formation potential (µg O_3/m^3) and isomeric ratio of BTEX.

Compound	Nam Dinh 1	Nam Dinh 2
A. Percentage of BTEX (%)		
Benzene	13.46–13.96	13.61–14.82
Toluene	62.47–69.14	64.15–66.61
Ethylbenzene	5.10–5.83	6.36–7.44
m,p-Xylene	8.4–13.13	8.16–9.76
o-Xylene	3.36–5.08	4.16–4.90
B. Ozone formation potential (µg O_3/m^3)		
Benzene	2.74–7.50 (4.5 ± 1.9) (a)	3.44–9.67 (5.8 ± 2.5)
Toluene	70.62–235.4 (132.4 ± 65.1)	97.1–344.3 (189.8 ± 97.8)
Ethylbenzene	6.35–19.0 (0.25 ± 0.11)	8.1–27.8 (15.5 ± 7.8)
m,p-Xylene	37.9–70.8 (50.2 ± 13.0)	49.2–101.6 (55 ± 21)
o-Xylene	15.10–28.6 (20.1 ± 5.3)	19.5–35.3 (25.4 ± 6.3)
Total BTEX	132.7–361.4 (218.5 ± 90.4)	177.4–518.7 (305.4 ± 134.9)
C. Isomeric ratio of BTEX		
T/B	4.64–5.04	4.33–4.97
(m,p-X)/E	1.65–2.25	1.33–1.57
(m,p-X)/B	0.6–0.9797	0.61–0.66
E/B	0.31–0.48	0.21–0.54
o-X/B	0.24–0.38	0.43–0.53

(a): min – max (mean±standard deviation)

The summary results in table 3 show that Toluene accounts for the highest proportion, ranging from 62.47-69.14%, followed by Benzene with a ratio of 13.46-14.82%, m,p-Xylene with a ratio of 37.9-101.6%, Ethylbenzene accounts for 5.10-7.44% and o-Xylene accounts for 3.36–5.08%.

Among BTEX species, Toluene was the largest contributor to ozone formation, followed by m,p-Xylene, o-Xylene, Ethylbenzene and the lowest was benzene (Table 3). In Vietnam, there is no announcement on the analysis rate of BTEX in the air around the incinerator area, however, if compared with the rate of BTEX in traffic locations, this rate is equivalent.

The average T/B ratio ranged from 4.33 to 5.04 in this study, which is higher than 0.7-1.3 in Hanoi [25], 0.63-4.71 in Texas, USA [26], 1.3-3.0 in Windsor, Canada [27] and 1.29-2.45 in Cairo [25]. The above-mentioned values were lower than values commonly found in developed countries such as 6.4-8.5 in Tokyo and 9.2-11.5 in Hong Kong. This study's (m,p-

X)/E values ranged from 1.33 to 2.25, in the same range in Hanoi [25]. They were remarkably lower than the E/B values of this study (from 0.35 to 0.41).

The isomeric ratio of BTEX help us identify waste sources, the toluene to benzene ratio (T/B) was higher than 2, indicating that the fixed incinerators were the main sources.

4. Conclusion

An investigation was conducted on the air pollution at a few small-scale residential waste incinerators in the Hai Hau district. Dust samples from the Losiho incinerator turned up sixteen samples. The analysis's findings indicate that burning household garbage has had an impact on the air near the incinerator, with concentrations of CO_2 (200.7-212 μg/m^3), SO_2 (351.1-450.0), NO_x (30300-36600), H_2S (78.9-100.1) and TSS (312-317). In addition, the BETX concentration ranged from 5.16 μg/m^3 to 20.7 μg/m^3 for Benzen; from 21.63 μg/m^3 to 120.66 μg/m^3 for Toluen; from 3.13 μg/m^3 to 12.57 μg/m^3 for (m, p)-Xylene; and from 1.58 μg/m^3 to 7.73 μg/m^3 for o-Xylene. All concentration of CO_2, SO_2, NO_x, H_2S exceed the allowed standard compared to QCVN 06:2013/BTNMT, in which the H_2S indicator exceeds the allowed standard from 2.13 to 2.38 times. Currently, there is almost no assessment of air pollution as well as assessment of health effects of people in areas surrounding incinerators in Vietnam. Therefore, there is a need for more specific research and evaluation on small-scale incinerators so that there can be measures to improve and reduce pollution.

To minimize negative impacts on the environment and health of incinerator operators, the article suggests applying a number of management measures such as equipping labor protection equipment for incinerator operators regularly and periodically maintaining the incinerator system, at the same time improving and installing additional exhaust gas treatment systems for the incinerator, etc. to ensure that emissions generated during the combustion process are treated before being released into the environment.

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References

1. Eurostat, S.E. Waste statistics. 2018.
2. EC. Living Well, Within the Limits of Our Planet. Prcoceeding of the 7th EAP–The New General Union Environment Action Programme to 2020, 2013.
3. Jose L. Domingo, Montse Marquès, Montse Mari, Marta Schuhmacher. Adverse health effects for populations living near waste incinerators with special attention to hazardous waste incinerators. A review of the scientific literature. *Environ. Res.* **2020**, *187*, 109631.
4. Cangialosi, F.; Intini, G.; Liberti, L.; Notarnicola, M.; Stellacci, P. Health risk assessment of air emissions from a municipal solid waste incineration plant–a case study. *Waste Manag.* **2008**, *28(5)*, 885–895.
5. Elliott, P.; Shaddick, G.; Kleinschmidt, I.; Jolley, D.; Walls, P.; Beresford, J.; Grund, Y.C. Cancer incidence near municipal solid waste incinerators in Great Britain. *Br. J. Cancer*. **1996**, *73(5)*, 702–710.
6. Dugas, T.R.; Lomnicki, S.; Cormier, S.A.; Dellinger, B.; Reams, M. Addressing emerging risks: scientific and regulatory challenges associated with environmentally persistent free radicals. *Int. J. Environ. Res. Public Health.* **2016**, *13*, 573.

7. Bai, Y.; Guo, W.; Wang, X.; Pan, H.; Zhao, Q.; Wang, D. Utilization of municipal solid waste incineration fly ash with red mud-carbide slag for eco-friendly geopolymer preparation. *J. Clean. Prod.* **2022**, *340*, 130820.
8. Yu, J.; Li, H.; Liu, Y.; Wang, C. PCDD/Fs in indoor environments of residential communities around a municipal solid waste incineration plant in East China: Occurrence, sources, and cancer risks. *Environ. Int.* **2023**, *174*, 107902.
9. Chengyi, S.; Zhiping, W., Yong, Y.; Minya, W.; Xianglong, J.; Guoao, L.; Jing, Y.; Liyun, Z.; Lei, N.; Yiqi, W.; Yuxi, Z.; Yang, L. Characteristic, secondary transformation and odor activity evaluation of VOCs emitted from municipal solid waste incineration power plant. *J. Environ. Manage.* **2023**, *326*, 116703.
10. Liu, S.L.; Wang, B.G.; He, J.; Tang, X.D.; Luo, W.; Wang, C. Source fingerprints of volatile organic compounds emitted from A municipal solid waste incineration power plant in Guangzhou, China. *Procedia Environ. Sci.* **2012**, *12*, 106–115.
11. Ministry of Natural Resources and Environment, National environmental status report on domestic solid waste incinerator.
12. Ministry of Natural Resources and Environment. QCVN 61: 2016/BTNMT: National technical regulation on domestic solid waste incinerator.
13. Huong, P.T.M., Tung, N.Q.; Ngan, N.H.; Van, D.T.C; Huy, H.V.; Yen, P.T.T. Study on the treatment process of air pollution and ash from the solid waste incinerator. *J. Sci. Technol.* **2020**, *56*, 120–124.
14. People's Committee of Nam Dinh province. Project on management and treatment of household waste in Nam Dinh province for the period of 2020 - 2025.
15. Circular No. 10/2021/TT–BTNMT on technical regulations for environmental monitoring and management of information and data for environmental quality monitoring.
16. TCVN 5971:1995 - Ambient air - Determination of the mass concentration of sulfur dioxide - Tetrachloromercurate (TCM) pararosaniline method.
17. TCVN 6137:2009 - Ambient air - Determination of mass concentration of nitrogen dioxide - Modified Griess- Saltzman method.
18. Industry standard 52TCN 352:1989 on Carbon Oxides.
19. Standard MASA-701 - Method for sampling H_2S gas.
20. TCVN 5067-1995: Air quality - Weighing method for determination of dust content.
21. NIOSH Manual of Analytical Methods (NMAM), Fourth Edition "Hydrocarbons, Aromatic: Method 1501, Issue 3, dated 15 March 2003".
22. Ministry of Natural Resources and Environment. QCVN 05: 2013/BTNMT: National technical regulation on ambient air quality.
23. Ministry of Natural Resources and Environment. QCVN 06:2009/BTNMT- National technical regulation on some toxic substances in ambient air - QCVN 06:2009/BTNMT, 2009.
24. Puttaswamy, N.; Natarajan, S.; Saidam, S.R.; Mukhopadhyay, K.; Sadasivam, S.; Sambandam, S.; Balakrishnan, K. Evaluation of health risks associated with exposure to volatile organic compounds from household fuel combustion in southern India. *Environ. Adv.* **2021**, *4*, 100043.
25. Truc, V.T.Q.; Oanh, N.T.K. Roadside BTEX and other gaseous air pollutants in relation to emission sources. *Atmos. Environ.* **2007**, *41*, 7685–7697.
26. Raysoni, A.U.; Stock, T.H.; Sarnat, J.A.; Chavez, M.C.; Sarnat, S.E.; Montoya, T.; Holguin, F.; Li, W. Evaluation of VOC concentrations in indoor and outdoor microenvironments at near-road schools. *Environ. Pollut.* **2017**, *231*, 681–693.
27. Miller, L.; Xu, X.; Wheeler, A.; Zhang, T.; Hamadani, M.; Ejaz, U. Evaluation of missing value methods for predicting ambient BTEX concentrations in two neighbouring cities in Southwestern Ontario Canada. *Atmos. Environ.* **2018**, *181*, 126–134.