Proceedings of the 11th World Congress on New Technologies (NewTech'25)
Paris, France - August, 2025
Paper No. ICEPR 124
DOI: 10.11159/icepr25.124

Study on VOCs Pollution Characteristics in Industrial Complex Area Using Advanced Environmental Mornitoring Equipment

MinJi Kim[1], KyoungGu Kang , YooKyung Lee, BuJu Kong, DaeIl Kang
National Institute of Environmental Research
42, Hwangyeong-ro, Seo-gu, Incheon, Republic of Koea
hello1217@korea.kr; kkg0223@korea.kr; leeyk412@korea.kr; bjkong@korea.kr; nierkang@korea.kr

Extended Abstract

The Ministry of Environment(ME) of Korea has been managing industrial sites by introducing advanced monitoring equipment capable of measuring volatile organic compounds(VOCs) such as benzene and toluene since 2019, to manage air pollutants. VOCs are the subject of ongoing research due to their direct health hazards[1,2,3] and their role as precursors to photochemical smog, even though some may not pose significant direct harm to human health [4,5].

This study utilized Advanced Environmental Monitoring Equipment(PTR-TOF-MS, SIFT-MS) to assess the concentration distribution of VOCs(63 species) in industrial complex areas and evaluate their contributions to ozone formation. PTR-TOF-MS(Proton Transfer Reaction Time of Flight Mass Spectrometry) is an equipment that uses protons (H+) for measurements without sample destruction by complementing electron ionization (EI) and chemical ionization (CI) methods. SIFT-MS (Selected-Ion Flow Tube Mass Spectrometry) measures using chemical ionization with four quadrupole mass filters.

Measurements were conducted during the summer season (June 1 to August 31, 2024) across three industrial complexes (Yeongam Daebul, Gimpo Yangchon General Industrial Complex, and Siheung National Industrial Complex). The number of operating facilities in each complex was 359, 960, and 20,891, respectively, with primary industries including primary metal manufacturing and fabricated metal product manufacturing.

According to a survey of national emission data for air pollutants (SEMS) and chemical substances (PRTR), the SEMS emissions revealed that ethylbenzene (938 kg/year) was the most emitted substance in Yeongam-gun, while dichloromethane (34,580 kg/year) topped the emissions in Siheung and Ansan cities. As for the chemical emission (PRTR), it was confirmed that the representative chemicals common to each industrial group were 2-propanol, xylene, and ethylbenzene, and the distribution of other upper components was different.

To examine the concentration distribution characteristics by industrial complex, 63 types of VOCs were categorized into alkanes (16 types), alkenes (12 types), aromatics (11 types), carbonyl compounds (16 types), halohydrocarbons (4 types), and hydroxyl groups (3 types). As a result, three groups (Alkane, carbonyl compounds, hydroxyl group) accounted for more than 80% of the total concentration in the industrial complex areas. The individual concentration distribution of VOCs showed that methanol had the highest concentration in all three industrial complexes, followed by butane and propane.

To analyze the VOCs concentration variations, measurement data from Daebul Industrial Complex were organized and compared by time of day. The results indicated that methanol and toluene were detected at high concentrations during business operation hours, peaking between 12 PM and 2 PM, while the lowest concentrations were observed during the early morning and nighttime when emission intensity decreased. Most pollutant concentration variations were found to be heavily influenced by changes in emission intensity from various VOC sources, atmospheric chemical reactions, and meteorological conditions.

The ozone formation contribution was evaluated by setting the total of all 63 items to 100, using the concentration of pollutants and their ozone formation potential (POCP) coefficients to calculate their contribution to ozone formation. As a result, among the VOCs, methanol, despite having a low POCP coefficient of 13 [6,7,8], was detected at a higher concentration than other substances, leading to the highest contribution to ozone formation.

References

[1] WHO(2000) Guidelines for air quality for Europe, WHO Pub., European Ser. No. 91, p. 273.

[2] Kampa, M. and Castanas, E.(2008) Human health effects of air pollution, Environmental Pollution, 151(2), pp. 362-367.
[3] Baek, S.O.(1996) Sampling and analytical methods for the determination of volatile organic compounds in ambient air, Journal of Korea Air Pollution Research Association, 12(1), pp. 1-13.
[4] Okada, Y., Nakagoshi, A., Tsurukawa, M., Matsumura, C., Eiho, J. and Nakano, T.(2012) Environmental risk assessment and concentration trend of atmospheric volatile organic compounds in Hyogo prefecture, Japan, Environmental Science and Pollution Research, 19, pp. 201-213.
[5] Ziemann, P.J. and Atkinson, R.(2012) Kinetics, products, and mechanisms of secondary organic aerosol formation, Journal of Chemical Society Reviews, 41(19), pp. 6582-6605.
[6] Derwent R.G., Jenkin M.E., Saunders S.M., Pilling M.J.(1998) Photochemical ozone creation potentials for ofganic compounds in northwest europe calculated with a master chemical mechanism, Atmospheric Environment Vol. 32, No. 14/15, pp. 2429-2441
[7] Derwent R.G., Jenkin M.E., Passant N.R., Pilling M.J.(2007) Reactivity-based strategies for photochemical ozone control in Europe, Environmental Science & Policy 10, pp. 445–453
[8] Cheng H.R., Guo H., Saunders S.M., Lam S.H.M., Jiang F., Wang X.M., Simpson I.J., Blake D.R., Louie P.K.K., Wang T.J.(2010) Assessing photochemical ozone formation in the Pearl River Delta with a photochemical trajectory model, Atmospheric Environment 44, pp. 4199-4208