Analysis on the treatment of VOC pollution hazards

Chunhui Liu
School of mechanical engineering, Shandong Huayu Institute of Technology, Dezhou, Shandong, China
email: 18953465089@126.com,
*Corresponding author’s e-mail: kyc@sdhyxy.com

Abstract. This paper introduces the harm of VOCs, makes a more detailed demonstration and understanding on the governance of VOCs, and introduces the emission characteristics and governance technology of key industries in detail, so as to learn from the governance methods of volatile organic compounds (VOCs), briefly discusses the governance and comprehensive utilization, and truly governs VOCs from the source.

1. Introduction
VOCs (volatile organic compounds) is a kind of chemical substance. It has high steam at room temperature and pressure. In China's current national standards, VOCs refer to all volatile substances or all volatile organic compounds under specific applicable conditions with vapor pressure ≥ 0.01kpa at 20 ℃. VOCs are composed of alkanes, aromatics, alkenes, halohydrocarbons, esters, aldehydes, ketones and other compounds. In 1989, the World Health Organization (who) defined volatile organic compounds (VOCs) as volatile organic compounds with saturated vapor pressure greater than 70pa at room temperature and boiling point less than 50 ~ 260 ℃ at normal pressure.

2. Harm of VOCs
Typical VOCs treatment technologies include recovery technology, destruction technology and combination technology. Recovery technology includes physical methods, including absorption method, condensation method, adsorption method and membrane separation method; Destruction technologies include thermal incineration, catalytic combustion, biodegradation, photocatalytic degradation and plasma technology; The combined technologies include adsorption concentration catalytic combustion technology, zeolite runner adsorption concentration catalytic combustion technology, cartridge dust removal + regenerative catalytic combustion and adsorption + advanced oxidation. Thermal incineration, catalytic combustion and biodegradation are traditional technologies; Photocatalytic degradation and plasma technology are new technologies.

3. Toxic effect of VOCs on human body
The toxicity of VOCs to respiratory system. Smell, respiratory tract, lung, almost all VOCs; It is mainly odor, organic sulfide, chlorinated organic compounds, nitrogenous organic compounds, etc. Toxicity to skin and eyes. Mainly in the aspect of irritation, among which aldehydes are the most prominent; They are mainly organic sulfides, chlorinated organic compounds and nitrogenous organic compounds.
Toxic to blood, nervous system, liver and kidney. Can cause leukemia, liver and kidney failure, mainly pesticides, herbicides, aldehydes, olefins, alkanes, benzene series, chlorinated organic compounds, organic halides and so on.

"Three causes" function. They are carcinogenic, teratogenic and mutagenic, among which benzene series are the most prominent, including alkenes, chlorinated organic compounds and nitrogenous organic compounds.

4. VOCs governance

4.1. The importance of VOCs governance

Although there are many types of VOCs emission sources, they can be roughly divided into natural sources and man-made sources. The natural sources mainly include wild animals and plants, pollutant emissions, wetland anaerobic process emissions and forest fire emissions; Anthropogenic source emissions are mainly industrial production emissions, domestic emissions and so on, and the latter is one of the main factors causing VOCs emissions.

Anthropogenic sources of VOCs emissions are mainly divided into mobile sources: including motor vehicles, ships, aircraft, etc., and fixed sources, that is, living sources and industrial production sources. In industrial production, surface spraying, chemical storage, petrochemical, solvent use and so on, will cause different types of VOCs emissions. According to the statistical data obtained in 2018, the VOCs emission related to spraying operation is about 591t, and the VOCs emission caused by solvent use is about 65732t. Most of these VOCs will be discharged into the atmosphere, so it is very important and necessary to carry out centralized management of these hazards in the treatment of industrial production.

4.2. Implementation of VOCs source control

It can be seen from the above analysis that the source control of VOCs can improve the management effect of air quality, especially in the control of fixed sources. The source control method can significantly improve the control effect and reduce the cost of control, which has good feasibility. For example, in the construction and public works, cosmetics home life production, the application of different control methods with industrial emission source control, such as reducing spraying and printing at the source, using adhesives and other related production, can carry out organized zero emission, this control method is more operational.

In addition, the use of new environmental protection coatings and other technologies to promote zero emission at the source, such as polymer solid materials, water-based coatings, powder coatings and so on, to replace the traditional high pollution spraying materials, can reduce the air pollution caused by VOCs as far as possible. At the same time, industrial enterprises can also control VOCs emissions by optimizing the selection of materials, but this kind of management cost is relatively high, which will further compress the profits of enterprises, and the new pollution chain caused by the use of new materials is not clear at present, so it needs to be vigorously implemented by the state and relevant policy support.

4.3. Terminal management of VOCs

The removal of VOCs from industrial production by end treatment method can also significantly improve the effect of air environmental protection. Generally speaking, taking spraying enterprises as an example, most enterprises use activated carbon adsorption. For the removal of VOCs in industrial waste gas, the efficiency is 50% - 80% (different activated carbon adsorption methods and adsorption efficiency are quite different), which can be used for air purification more effectively.

In addition, industrial enterprises also use water spray + activated carbon adsorption and other combined technologies, activated carbon adsorption concentration + catalytic combustion treatment technology, low temperature maintenance method for removal, etc. the removal range of these treatment technologies can be between 90% and 98%. In comparison, the water spray + solution
absorption method has higher removal efficiency and better overall cost. Therefore, in the future development process, technology enterprises should carry out source development to continuously improve and control the effect. Through comprehensive methods such as low-temperature plasma, solution absorption and activated carbon adsorption, they should fully consider their own organizational information and emission concentration, combine with the future development strategy of enterprises and the integration of technical talents, Carry out relevant technology construction and platform management to further improve the effect of VOCs purification. The situation of VOCs Pollution terminal treatment technology is shown in Figure 1.

4.4. Prospect of VOCs governance

In the process of future development, the management and control of VOCs should not only control the source, but also carry out comprehensive end treatment, and integrate upstream and downstream industrial departments for coordinated control

(1) Through the development of new environmental protection materials, environmental protection spray coating and the development of more scientific standards of management countermeasures, further improve the understanding of various industrial enterprises and organizations for VOCs hazards.

(2) Organize technical personnel to conduct comprehensive analysis and learning, and learn from the experience and methods of governance in developed countries.

(3) Continue to carry out technological innovation and research and development, and take VOCs governance as an important control link of industrial production.

(4) We will eliminate backward production capacity, especially backward equipment, backward production technology and enterprises producing backward products, and further charge VOCs Pollution fees.

In the process of smart city construction, only comprehensive control and emission of VOCs can improve China's air quality and promote the sustainable development of the industry.

5. Emission characteristics and treatment technology of key industries

5.1. Four links of industrial VOCs emission

① Typical industries in the production process: petrochemical industry, organic chemical raw material production enterprises (including solvents), chemical API industry.

② Typical industries in the process of storage and transportation: warehousing and logistics, mainly the process of product storage, transfer and distribution.

![Figure 1 VOCs Pollution terminal treatment technology](image)
③ Typical industries in the use process: paint and architectural coatings industry, polymer synthesis industry, food industry, daily necessities industry (soap, detergent), agricultural chemicals industry, tire manufacturing industry.

④ Typical industries in the emission process: paint and architectural coatings industry, wire and cable industry, electronic industry, printing industry, textile industry, paper industry, steel smelting industry, semiconductor industry.

5.2. Feasibility control technology of VOCs
① Source control: the unorganized emission of waste gas organized, closed feeding and closed production.

② Recycling: freezing or condensing the high concentration organic waste gas for recycling.

③ Non end treatment: for low concentration organic waste gas, adsorption catalytic combustion or regenerative catalytic combustion is used.

6. Management and comprehensive utilization
1) Relevant manufacturers are encouraged to recycle VOCs, and priority is given to VOCs recycling in production systems of units at all levels.

2) The process route should be selected based on the comprehensive analysis of VOCs emission, harmful components and physical properties of pollutants, evaporation temperature, saturation pressure and other factors.

3) For high concentration VOCs waste gas, the more suitable method is to use high-pressure condensation recovery, pressure swing adsorption complete evaporation recovery technology to recycle VOCs in waste gas.

4) For low concentration VOCs waste gas components, when there is great value of program recovery, the more suitable method is to use pressurized adsorption technology to recover organic solvents and discharge them up to the standard.

5) The suitable method for odor gas is to use biodegradation reduction technology, plasma adsorption technology, high concentration adsorption technology and so on, and then discharge into the atmosphere after reaching the standard.

7. Summary
To sum up, the characteristics of VOCs gas treatment are different. At the same time, different performance indicators, investment and construction costs, operation costs and emission standards should be taken into consideration when selecting the recovery technology. At present, all kinds of related enterprises at home and abroad have some common rules and relevant national and local standards to follow in the selection of VOCs treatment technology and treatment methods. However, due to the fact that the actual industrial production is in different industries, the composition and characteristics of VOCs emitted by enterprises are quite different, Therefore, it is difficult to use one standard to cover all cases in the current technology level of similar enterprises.

In reality, it is difficult to meet the emission requirements by a single way of VOCs treatment process. Different types of emissions often have different characteristics, so it is difficult to adopt common treatment. It is necessary to add pretreatment control unit or carry out the combination of different treatment processes before the corresponding main process, so as to comprehensively and effectively deal with pollutants. For the gas containing volatile organic compounds (VOCs) and particulate matter, the pretreatment unit such as water washing or deep filtration should be added before the VOCs removal unit. For the gas with low concentration and not suitable for direct catalytic combustion of VOCs, the process combination of deep adsorption concentration and deep catalytic combustion can be used for treatment.

Adsorption concentration, catalytic conversion combustion, bioengineering treatment, thermal catalytic combustion and plasma treatment are widely used in the field of industrial VOCs gas treatment at home and abroad.
Catalytic conversion combustion, thermal deep combustion, strong adsorption and other treatment processes show strong efficiency and completeness for VOCs, while biological treatment technology, condensation and membrane separation technology show certain preference and selectivity. VOCs gas characteristics, economic performance of VOCs treatment technology, emission standards and other factors should be comprehensively considered for technology selection. The continuous development of VOCs treatment technology is the development trend of all kinds of treatment enterprises. Only in this way can the atmospheric environment be better used, the common home of mankind be protected, and the blue sky and white clouds of future generations be contributed.

8. Conclusion
The governance of VOCs is a common problem in front of people engaged in related industries. How to carry out comprehensive governance in this aspect is a long-term topic. For the treatment of VOCs, we should adopt comprehensive treatment, separate control, layer upon layer implementation, and critical verification. Only in this way can we achieve an effective control of VOCs emission. Thanks to Professor Gao Jucheng, the leader of the research group of ultra low concentration VOCs adsorption technology, and the hard work of all members, as well as the enterprise personnel of Dezhou Aoshen energy saving and Environmental Protection Technology Co., Ltd.

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References
[1] Gao, S.H.. (2019) Development and application prospect of optical remote sensing technology for volatile organic compounds. J. Sci. Monograph and summary., 12: 1–5.
[2] WU, N.YANG, Z.K. (2020) Research Progress on treatment technology of volatile organic compounds. J. Sci. Modern chemical industry., 40: 17–22.
[3] QIU, N.YANG, K.T. (2019) Analysis of VOCs harm and treatment technology. J. Sci. Environmental research and monitoring., 32: 13–15.
[4] ZHU, P.F. (2019) Application of catalytic combustion in treatment of volatile organic pollutants. In: Science and Technology Annual Meeting of Chinese society of Environmental Sciences in 2019. Beijing. pp. 3555-3562.
[5] Wang.Z, (2020) Analysis on pollution characteristics of volatile organic compounds in Changzhou in summer of 2019. J. Environmental monitoring and early warning.,13: 55–65.
[6] Ozone pollution in China: A review of concentrations, meteorological influences, chemical precursors, and effects. J. Tao Wang, Likun Xue, Peter Brimblecombe, Yun Fat Lam, Li Li, Li Zhang. Science of the Total Environment. 2017.