Analysis on the hazard control technology of volatile organic compounds

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Abstract. This paper introduces the Constitution and mechanism of VOCs, and then analyzes the hazard path, demonstrates the importance of VOCs treatment, analyzes the status quo of VOCs treatment, and introduces in detail various methods of controlling VOCs Pollution, such as combustion, absorption (washing), condensation, charging and biological methods. It is easy to use for reference on the treatment methods of VOCs, and to reduce the harm.

1. Introduction
The World Health Organization defines VOCs as a kind of organic substances with boiling point between 50 °C and 250 °C, saturated vapor pressure over 133.3 Pa at room temperature and existing in the air in the form of vapor at room temperature. Common pollutants, sulfur dioxide, nitrogen dioxide and so on, belong to primary pollutants, while VOCs and other ozone volatile organic compounds belong to secondary pollution, which will cause very serious harm to the air.

2. Harm of VOCs

2.1. Composition and harm of VOCs
According to the results of chemical analysis, VOCs can be divided into alkanes, lipids, aldehydes, aromatics and other categories. At present, more than 300 kinds of VOCs are harmful to the air. These substances can react with other substances in the atmosphere physically and chemically, and can spread the harm in a wide range, produce ozone and other pollutants, cause atmospheric warming and ozone hole, and even form photochemical fog.

2.2. Harm mechanism of VOCs
Researchers in the United States believe that the formation of photochemical smog is closely related to the release and decomposition of VOCs. If it is accompanied by problems such as the leakage of petroleum gas in the surrounding area and the emission of automobile exhaust, an obvious ozone hole controlled by VOCs will be formed over the city. This kind of air cavity is rich in aromatic compounds, olefins and so on, which has an important impact on the secondary formation of oxygen.

2.3. Harm path of VOCs
In addition to the above hazards, VOCs can also lead to the formation of organic aerosols, which can enter the human respiratory tract and digestive tract, leading to neonatal lung disease, elderly cancer
and related mutations. This kind of pathological change is accompanied by the chronic respiratory function of human beings, and it will enter into the nerve center of human body to produce anesthetic and inhibitory effects. People who have been in this kind of air environment for a long time will have symptoms such as drowsiness, drowsiness, weakness and trance, and human retina, skin tissue, mucous membrane tissue and respiratory tract tissue will be corroded to varying degrees. Canadian scholars believe that long-term intake of air containing excessive VOCs will lead to varying degrees of canceration of human nervous system, liver, kidney and other metabolic organs.

3. The importance of VOCs governance

There are many types of VOCs emission sources, which are roughly divided into natural sources and man-made sources. Natural sources mainly include wild animals and plants 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., as well as 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. Most of these VOCs will be discharged into the atmosphere, which is very important in the control of industrial production.

4. Research status of VOCs governance Technology

At present, the governance approaches of VOCs are mainly as follows:

① Source reduction (cleaner production), in the production process, optimize the production process, reduce the use of harmful raw materials, avoid or reduce VOCs emissions from the source. However, due to the limitations of the existing production process and economic reasons, the technology is quite difficult.

② Process control, the use of modern technology, such as the petrochemical industry leak detection and repair program (LDAR) and infrared masked flux Remote Sensing Monitoring Technology (SOF), timely monitoring of VOCs emissions in production. At present, LDAR has been applied in 51 refining and chemical enterprises of Sinopec, and the emission reduction efficiency can reach 60% ~ 80%.

③ End treatment: the existing treatment technologies are used to treat VOCs waste gas, mainly including recovery technology, destruction technology and joint treatment technology of two or more single technologies.

5. Research status of VOCs governance Technology

5.1. Control of VOCs Pollution by combustion method

The process of transforming harmful gases such as steam, smoke or liquid, Co, NOx and HC into harmless substances by combustion is called combustion purification. The characteristics of combustion control are as follows

1) It can only adapt to the harmful substances decomposed or burned at high temperature.
2) It can remove the foul smell.
3) You can't recycle useful materials.
4) It can recover heat.

Combustion process generally uses direct combustion, catalytic combustion and thermal combustion.

5.2. Control of VOCs Pollution by absorption (washing) method
Solvent absorption method is to use low volatile or non-volatile liquid as absorbent, make use of the difference of solubility or chemical reaction characteristics of various components in the exhaust gas
in the absorbent, so that the harmful components in the exhaust gas are absorbed by the absorbent, so as to achieve the purpose of purifying the exhaust gas.

The VOCs absorption process is shown in Figure 2. The gas containing VOCs enters the absorption tower from the bottom of the absorption tower. During the rising process, it contacts with the absorbent from the top of the absorption tower countercurrent and is absorbed and purified. The purified gas is discharged from the top of the absorption tower. After passing through the heat exchanger of the absorption tower, the absorbent absorbed VOCs enters the top of the stripper and can be desorbed when the temperature is higher than the absorption temperature or (and) the pressure is lower than the absorption pressure of the absorption tower. The absorbent is condensed by the solvent condenser and then enters the absorption tower for recycling. Absorption technology is one of the important means to control air pollution. It can not only eliminate gaseous pollutants, but also transform pollutants into useful products.

Solvent absorption is a method used in the early stage. This absorption process is relatively old and has low purification efficiency. At present, it has been less used and replaced by more advanced treatment methods.

5.3. Control of VOCs Pollution by condensation method
The condensation control of VOCs Pollution is based on the fact that volatile organic compounds have different saturated vapor pressures at different temperatures and pressures. The method of increasing system pressure, decreasing system temperature or both pressure and temperature can be used to condense the pollutants in vapor state and separate them from the exhaust gas. This method is especially suitable for the treatment of organic vapor with the volume fraction of waste gas above $10^{-2}$. In theory, condensation method can achieve a high degree of purification, but when the volume fraction is less than $10^{-6}$, the cooling measures must be taken to meet the standard. Condensation method is not suitable for the treatment of low concentration organic gas, but is often used as the pretreatment process for other purification of high concentration waste gas to reduce the load and recover organic matter.

Condensation treatment process also has many shortcomings. At present, it is only used in a few simple treatment processes. With the development of technology, there will be many more advanced methods.

5.4. Control of VOCs Pollution by adsorption
Adsorption is the most widely used method for VOCs recovery. It belongs to the dry process, which uses adsorbent with large specific surface area to adsorb VOCs contained in waste gas and discharge the purified gas into the atmosphere. Adsorption method is mainly used for the treatment of VOCs
with low concentration and high flux. As shown in Figure 3, when the gaseous mixture containing volatile organic compounds (VOCs) contacts with porous solid, the volatile organic compounds (VOCs) in the mixed gas are adsorbed on the solid surface by using the unbalanced molecular absorption force or chemical bond force existing on the solid surface, so as to achieve the purpose of separating volatile organic compounds (VOCs) from waste gas. Due to the complexity of the whole process, the cost is relatively high.

Adsorption operation has been widely used in petrochemical, organic chemical and other production departments, and has become an important operation unit. There are many backwardness in this treatment method. With the development of technology, there will be more advanced treatment methods.

![VOCs adsorption process with activated carbon](image)

Fig. 2 VOCs adsorption process with activated carbon

To sum up, the governance of VOCs is an important issue that cannot be ignored in the process of industrial production. In the next stage, only by comprehensively analyzing the VOCs emissions of various industries and finding out the details, can we formulate feasible policies. From the analysis of this paper, it can be seen that the study of VOCs Pollution and control is beneficial for us to view the deficiencies in the process of VOCs governance from the perspective of problems. Therefore, we should strengthen systematic analysis, explore effective policy methods and technical methods, so as to improve the comprehensiveness and scientificity of VOCs governance.

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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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