Research on the Progress of VOCs Adsorption by Biomass Nanocomposites

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Abstract. The avoidance and control of the air is forthcoming, and its deterioration sources have a wide range of origin. Among them, the emission of VOCs is worthy of our attention. Its source is very wide, which seriously define the improvement of green chemical industry in our country. There are many types of VOCs, and when the concentration is too high, it will cause serious harm to the human body. Therefore, the avoidance and control of VOCs gas has become one of the current research tosspots. In this paper, several methods for alter VOCs gas are related, and it is found that adsorption is more economical and safer, and the core is the preparation of adsorbents. At the same time, the preparation of high-performance VOCs adsorbents based on TiO₂ as the matrix and manganese-based as the raw material of biomass waste is also prospected.

1. Introduction
Nowadays, the development of China’s industrial economy has greatly improved our living standards, but it also brings many potential safety hazards to our life safety. Air pollutants mainly come from the exhaust emissions of key industries such as thermal power generation, iron and steel industry, refining tar and cement, petroleum industry, agricultural harvesting machinery, glass refining and motor vehicles, which directly lead to a significant decline in China’s air quality. Nowadays, China strictly controls the emission of air pollution gases and strictly formulates relevant standards to ensure the effective prevention and improvement of China’s environment [1]. VOCs not only seriously endanger our physical and mental health, but also our living environment [2-5], which is mainly reflected in the following aspects: once VOCs are discharged into the atmosphere without treatment, they will directly react with the light generated by sunlight to produce toxic organic compounds, thus forming highly oxidizing ozone, aldehydes and other harmful substances, which will lead to more serious pollution [6]. Since 2020, China has implemented new regulations on the prevention and control of VOCs Pollution to strictly control the emission of VOCs in China. Meanwhile, China strives to reduce VOCs emissions by more than 10% compared with the previous year in recent two years [7]. In the process of controlling VOCs emission, the task is still arduous. Therefore, it is urgent to develop efficient VOCs treatment technology. Therefore, VOCs adsorption technology is an environment-friendly and low-cost treatment and purification technology. It has a bright development prospect in our society and can promote the economic and social development of our country.
2. Overview of VOCs treatment technology

The governance of VOCs mainly includes source reduction, strict control in the process and tail treatment [8]. Tail processing is the most important of the three links. In the process of tail treatment, it is usually implemented by physical or chemical means [9]. Physical means mainly include membrane material [10], adsorption and absorption method [11] and condensation method, which are collectively referred to as physical method, ionization method [12], combustion method [13], photocatalytic method and biological method [14].

(1) Membrane separation

Membrane separation method is to separate gas according to the rate difference of organic matter passing through membrane material. Therefore, it can be applied in the treatment of VOCs gas, and it can also be applied to the separation of aromatic and aliphatic compounds, esters, alcohols, aldehydes, phenols, ketones, etc [15-17]. Therefore, this method can effectively solve the problem of recovery of organic pollutants, including the separation and recovery of volatile organic pollutants such as HCHO, C₆H₆, CH₃COCH₃, the recovery rate can reach more than 90%.

(2) Absorption method

Different gases have different solubility in the same solvent. At the same time, the gas will also produce chemical reaction with our selected absorbent. Using these characteristics, we can effectively use the solvent to absorb VOCs gas, so as to achieve the purpose of purifying the gas we need. At present, kerosene and water are mostly used as absorption solvents. Ozturk B found that fresh lubricating oil has excellent performance of removing VOCs gas, which is second only to the effect of water as absorbent [18].

(3) Adsorption method

The earliest method to deal with VOCs. Xi Jinling et al. Used this method to study a large number of VOCs gas treatment. In addition, adsorption method is widely used in high concentration VOCs gas treatment [19]. The main advantages of the adsorption method are high mature technical route, low cost and no secondary pollution. The disadvantage is that the treatment effect of the current adsorption method is limited by the adsorption capacity of the adsorbent itself. Therefore, it is of great significance to develop a composite and efficient green adsorbent.

(4) Biological method

After decades of development, many countries have begun to use biological methods for VOCs treatment on a large scale [20]. Microorganisms eliminate harmful gases generated in industrial production through respiration, which also provides a new idea and possibility for their elimination of VOCs gas. Its main device composition can be divided into biofilter, biofilter, biological washing tank [21-22], etc. This method has the excellent characteristics of low price, easy maintenance and strong treatment effect [23].
5. Combustion method

Combustion method is also used on a large scale. This method is simple and effective. However, if VOCs gas is directly oxidized, it may cause other pollution, so attention should be paid during combustion. Thermal combustion requires fossil fuel as a carrier, which is expensive and easy to cause secondary pollution. Regenerative combustion needs to be carried out at high temperature, which is not very safe. Catalytic combustion reaction is a very classic gas-solid catalytic reaction, and its main essence is the oxidation reaction solution with the participation of active oxygen and deep oxygen [24-25]. The safety performance of this method is relatively good. Compared with other combustion technologies, the reaction temperature is low and there is no secondary pollution [26].

6. Condensation method

Condensation method is widely used in the treatment of VOCs gas. It is implemented through the difference of saturated vapor pressure of volatile organic compounds at different temperatures and environmental conditions. By changing the temperature or pressure of the system, we can condense the volatile gaseous organic pollutants and turn them into gaseous pollutants, so as to separate the waste gas. This provides ideas and methods for the treatment of VOCs at room temperature, high temperature and high concentration. The removal degree is affected by two factors: cooling temperature and saturated steam pressure of the treatment object [27].

7. Plasma technology method

At present, the research on the removal of VOCs by plasma technology is mostly in BDB reactor, using relevant catalysts. Usually, during high-frequency discharge, a large number of high-energy particles will be generated while plasma is generated. These high-energy particles can destroy the molecular structure, so as to promote the purification of VOCs gas and achieve the treatment of polluted gas [28].

To sum up, various research technologies for VOCs treatment, adsorption method is widely used in many VOCs treatment methods because of its low cost, high efficiency and no secondary pollution.

3. Preparation of biomass Nanocomposites

Researchers prepare composites by compounding a series of biomass nano materials with TiO₂, which has become a mainstream research. At the same time, the catalyst activity of TiO₂ as support reached the highest. TiO₂ is relatively cheap. It does not need other auxiliary reagents. It shows effective damage to toxic pollutants. It reacts at a certain ambient temperature and pressure and chlorinated organic compounds. The reaction products are usually carbon dioxide and water. For example, Lan [29] and others first demonstrated a simple hydrothermal induced solvent limited single micelle assembly method, which can synthesize monolayer two-dimensional ordered mesoporous TiO₂ nanosheets. The material has uniform size, thickness and high specific surface area. In addition to nano-TiO₂, Dinh et al. [30] prepared a series of TiO₂ nanocrystals by thermal reaction using oleic acid and oleamine as active agents.

Noble metal based catalysts (such as Pt, Pd and Zr) show high oxidation and selectivity to VOCs gas, improve their catalytic efficiency and enhance the progress of oxidation reaction, which has been widely recognized by experts from various countries [31]. Transition metal oxides show very good catalytic properties in oxidation reactions. In addition, they have lower cost, higher resistance to poisons, higher metal content and higher active surface area. Therefore, transition metals are widely used in the treatment of VOCs to cope with increasingly strict management regulations [32-33]. Manganese based catalyst is one of the low-cost active catalysts. It is active in catalytic reaction and has no toxic components. It shows good catalytic activity in a variety of volatile organic compounds, including n-hexane [34], acetone [35], benzene [36], ethanol [37], propane [38], etc. Wu et al. prepared a series of manganese series and titanium dioxide catalysts, studied the effect of the ratio of manganese group to titanium group on the catalytic activity, and found that when the ratio of manganese group to titanium group was 0.3, it had the highest catalytic activity. Biochar is widely used in water treatment and supercapacitors, and its unique structure deserves special attention in the research of VOCs gas treatment [39-40].
At the same time, the high adsorption properties of biomass activated carbon nanocomposites can also be widely used in daily tail gas and formaldehyde treatment. Banana peel is a potential huge raw material resource. At the same time, it also has the effects of clearing intestines and detoxifying. However, banana peel, as a waste of banana products, has not been fully developed and treated. Fresh banana peel accounts for 40% of the total banana mass; In addition, with the development of banana processing industry, its waste banana peel is directly discarded and cannot be fully treated and applied [41-43]. If this part of waste is fully utilized to prepare activated carbon, it can not only solve the problem that banana peel can not be treated due to large accumulation, but also achieve the purpose of making full use of waste[44-45].

4. Conclusion
The treatment of VOCs has always been a major research hotspot, and adsorption technology is a widely used method at present. In recent years, there have been relevant research reports on the preparation of activated carbon from banana peel, which is mainly used in supercapacitor, sewage treatment and other fields. However, there is no research on the preparation of biological activated carbon nanocomposites from banana peel to treat VOCs. Therefore, it is planned to explore biomass nanocomposites with better performance by designing synthesis routes and changing industrial conditions, and there are few reports on the research of composite manganese based and titanium dioxide materials. Our research group plans to design and synthesize a series of biomass nanocomposites, hoping to be used as air purification materials in daily life.

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