

# Indoor air pollution and control technology

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**Abstract.** The improvement of indoor air quality, control and prevention of indoor air pollution should be given adequate attention. Analysed the main indoor pollutants are formaldehyde, benzene, TVOC, ammonia and so on. This put forward the corresponding such as adsorption technology, catalytic conversion technology, TiO<sub>2</sub>, etc. to effectively prevent indoor air pollution, improve indoor air quality, ensure that people have good Life and work environment.

## 1. Introduction

On average, modern people live and work indoors for 90% of the time. Therefore, the indoor environment is closely related to human health. With the rapid development of science, technology and economy, the modern people's living environment has received more and more attention. However, according to the survey, the degree of indoor air pollution in modern cities is often higher than that of outdoor air pollution. At present, the annual number of excess deaths caused by indoor air pollution in China has reached 111,000, and the number of excess emergency visits reaches 4.3 million, which directly and indirectly caused economic losses amounted to US\$ 10.7 billion. According to the China Indoor Decoration Association Environmental Testing Center, the average number of deaths caused by indoor air pollution in the country is about 304 people per day, and one person died in less than 5 minutes due to poor indoor air quality. It can be seen that modern indoor air pollution seriously threatens the health of modern people. Therefore, it is of importance and necessity to conduct research on the substances that cause indoor pollution and to control the indoor pollution in combination with existing technologies.

## 2. Analysis of main pollutants in indoor gas

### 2.1. Formaldehyde pollution factor

Formaldehyde (CH<sub>2</sub>O) is an irritating gas that is colorless and soluble, and its aqueous solution, "formalin," can be absorbed through the digestive tract, which is extremely harmful to human health. When the indoor air content is 0.1mg/m<sup>3</sup> or more, there is odor and discomfort; 0.3mg/m<sup>3</sup> or more can stimulate the eye to cause tearing; 0.6mg/m<sup>3</sup> or more can cause throat discomfort or pain, the concentration can be higher when cause nausea, vomiting, cough, pleura, asthma; when the concentration is higher than 6.5mg/m<sup>3</sup>, it can even cause pneumonia, emphysema and other injuries, carcinogenic and teratogenic. However, formaldehyde is a strong binder and hardness agent, so it is widely used in sponge fillers, coatings, paints and adhesives, and such products are essential in home improvement.



### 2.2. Benzene contamination factor

Benzene (C<sub>6</sub>H<sub>6</sub>) is a colorless to light yellow transparent liquid with a strong aromatic odor. It is a type of indoor volatile organic compound. Benzene was identified by the World Health Organization (WHO) as a carcinogen in 1993. The health effects of benzene are manifested in three aspects: hematologic toxicity, genotoxicity and carcinogenicity. Epidemiological surveys have shown that when the benzene content in the air is 1 µg/m<sup>3</sup>, the unit-adult risk estimate for humans suffering from leukemia is 6×10<sup>-6</sup>. Correspondingly, the unit extra value for human lifetime leukemia is 100× 10<sup>-6</sup>. The benzene contents in the air corresponding to 6, 10 x 10<sup>-6</sup> and 1 x 10<sup>-6</sup> were 17 µg/m<sup>3</sup>, 1.7 µg/m<sup>3</sup>, and 0.17 µg/m<sup>3</sup> (WHO), respectively. Benzene is present in large quantities in organic solvents in various building materials, such as various paint additives and thinners, and in some water-repellent materials.

### 2.3. TVOC pollution factor analysis

The main impact of TVOC on human health is the perception and hypersensitivity effects. When the indoor TVOC content is between 200 and 3 000 µg/m<sup>3</sup>, if there are other types of exposure interactions, the human body may feel irritation and discomfort; when indoors TVOC When the content is between 3 000 and 25 000 µg/m<sup>3</sup>, the human body feels uncomfortable; when the content of indoor TVOC is greater than 25 000 µg/m<sup>3</sup>, it has a toxic effect on the human body. Incomplete combustion and human excreta of building materials, interior decoration materials, and office supplies, as well as domestic fuels and tobacco; outdoor industrial exhaust, automobile exhaust, and photochemical smog are the major sources.

### 2.4. Ammonia contamination factor analysis

Ammonia (NH<sub>3</sub>) is a colorless gas with a strong irritating odor. It decomposes into hydrogen and nitrogen at high temperatures and has a reducing effect. Exposure to ammonia in a residential environment can cause irritation of the skin and respiratory tract, eyes, pleural, throat, sore throat, taste, and hyposmia, headache, dizziness, anorexia, fatigue and other feelings. Repeated low-dose exposure can cause bronchitis and can cause dermatitis. The current survey found that indoor ammonia pollution is mainly concentrated in the construction of ammonia-containing antifreeze used in the construction of structures. The highest test value can reach 0.5mg/m<sup>3</sup> or more.

## 3. Control Technology

### 3.1. Adsorption technology

At present, the main types of adsorption treatment materials include activated carbon, activated carbon fibers, and zeolites. Activated carbon is a porous carbonaceous material with a well-developed microporous structure and a large specific surface area. It includes many kinds of carbon-based substances that have an adsorption ability, and can adsorb many chemical substances on the surface, and has been widely used. In-car, furniture, and indoor air purifiers. According to the principle of adsorption, the treatment effect of activated carbon is closely related to the size of its internal surface area. Activated carbon has a good purifying effect on VOCs with a concentration of about 100 mg/m<sup>3</sup>. Its use cycle is more than 1000h, and the purification effect will decrease with the extension of the use time. When it is used as an adsorption material, it has the following advantages: 1 good adsorption performance, with a large specific surface area of 1000~3000m<sup>2</sup>/g and abundant Micropores have a pore volume of more than 90% of the total pore volume. Compared with general activated carbon, they have a larger surface area and pore volume. The outer surface is more than 100 times larger than that of common activated carbon, and the adsorption capacity is about 1 to 10 times larger. All on the outer surface, so adsorption / desorption speed; 3 redox performance. Active carbon fiber can reduce noble metal ions to low-valent ions and can also reduce inorganic gases such as carbon monoxide and nitrogen oxides; 4 has good load capacity for microorganisms.

### 3.2. Catalytic conversion technology

Photocatalytic degradation is a photochemical reaction using nano-semiconductor materials as a catalyst. The photocatalytic degradation catalyst is often referred to as a photocatalyst. Photocatalysts absorb specific wavelengths of ultraviolet light to excite electrons, generate electron-hole pairs, and rapidly move to photocatalysts. The surface activates oxygen and moisture adsorbed on the surface of the photocatalyst to produce active hydroxyl radical OH and superoxide anion radical  $O_2^-$  with extremely strong oxidizing power, which can oxidize and decompose organic compounds into harmless  $H_2O$  and  $CO_2$ . The currently widely used photocatalyst material is activated anatase nano-titanium dioxide (such as aluminum-based nano-titanium dioxide photocatalyst), which has high chemical stability, UV resistance, and a deep valence band energy level. Some endothermic chemical reactions are realized and accelerated on the surface of the  $TiO_2$  irradiated by light. Such catalytic conversion treatment materials can effectively decompose organic harmful gases such as formaldehyde, benzene, and ammonia to achieve the purpose of purifying indoor air.

### 3.3. $TiO_2$

Visible-light catalytic purification technology Photocatalysis of nano-materials is currently the most promising indoor air purification technology, but it can not purify the suspended solids and fine particles in the air; at the same time, the catalyst pores are easily blocked by dust and particulate matter to make them inactive. The problem of semiconductor photocatalysis is that the quantum efficiency is low (about 4%) and the recombination of photogenerated carriers affects the catalytic efficiency, which makes it difficult for the photocatalysis to compete with conventional environmental protection technologies economically. Through the photosensitization, transition metal ion doping, semiconductor coupling, noble metal precipitation, electron capture, and microwave field-strengthening measures such as external field, it is expected to improve  $TiO_2$  in visible light catalytic purification activity.

## 4. Conclusion

On average, modern people live and work indoors for 90% of the time. It takes a long time to get in contact with indoor pollutants. If the concentration of indoor pollutants exceeds the standards, it will have an impact on people's health and affect people's lives and normal work. Therefore, people should strengthen their understanding of indoor air pollution, strengthen their awareness of prevention, simplify their decoration, and adopt more green building materials. At the same time, we must make good use of the development achievements of modern science and technology and use such technologies as adsorption, catalytic conversion, and  $TiO_2$  to effectively prevent indoor air pollution, improve indoor air quality, and ensure that people have a good living and working environment.

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