Harm and countermeasure of indoor air pollution

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Abstract. Due to the rapid development of the economy, the consumption of coal, oil and other fossil fuels increases year by year, resulting in the problem of air pollution also increasing. Economic development has also brought about people's pursuit of quality of life, air pollution on the comfort of life and even human health, will affect. Therefore, not only outdoor air pollution, but also indoor air pollution has gradually received attention [1]. According to the investigation results of the U.S. Environmental Protection Administration, the concentration of indoor air pollutants is at least 2-5 times that of outdoor pollutants, and sometimes can even reach 100 times that of outdoor pollutants [2]. These particles are usually smaller than 10μm in size and can enter the respiratory tract during breathing. Smaller particles can even enter the alveoli and then enter the bloodstream. In addition, these tiny particles are likely to be carriers of bacteria and fungi, and may enrich heavy metals, organic pollutants and acid oxides, which will cause great harm to the human body [3]. All in all, it is of great significance to study indoor air pollution.

1. Introduction
Indoor environmental air pollution refers to the pollution of residences, schools, offices, shopping malls, various restaurants, public buildings, and various public gathering places caused by human activities. Indoor air pollution refers to the behavior of indoor environmental pollution caused by various reasons that the harmful substances contained in the indoor air exceed the standard, thereby affecting human health. As pollution levels continue to intensify, the human body will produce sub-health reactions and even threaten life safety. Indoor air pollution is one of the human hazards that have received increasing attention.

2. Sources of indoor air pollutants
The results show that the main sources of indoor pollutants are outdoor particulate matter and indoor source. Indoor sources include daily activities such as smoking, cleaning and cooking. People often improve their indoor environment by opening Windows for ventilation. In the process of air circulation, outdoor dust, TVOC and other harmful gases and particles will also enter the room together. After closing doors and Windows, these outdoor pollutants will stay indoors and cannot be discharged, which may aggravate the degree of indoor pollution. In the building and decoration of the time, often need to use a lot of building materials and decoration materials. Due to the use of coatings and adhesives, these boards usually release formaldehyde, TVOC and other harmful chemicals to human health. In addition, carpets, appliances, and curtains also contain certain amounts of TVOC.
Statistics show that human beings spend 80%~90% of their time indoors every day, so the level of indoor air quality has a very significant impact on human health.

3. Main indoor air pollutants and hazards

3.1. Formaldehyde
Formaldehyde is a colorless gas with a strong pungent odor, and 35% to 40% of its aqueous solution is collectively called formalin.

The main harm of formaldehyde to human body is the stimulation of skin and mucous membrane, which harms human safety by combining with protein. Formaldehyde inhaled in high concentrations can cause severe respiratory irritation and edema, as well as headaches. Direct contact with formaldehyde can cause dermatitis, spots and skin necrosis. Often inhaled formaldehyde, even a small amount will cause chronic poisoning, resulting in mucosal congestion, headache, insomnia and other problems. Formaldehyde is absorbed by the human body through the respiratory system, which can seriously cause abnormal lung, liver function and immune function. Formaldehyde has been identified as one of the three carcinogens by the World Health Organization [4].

3.2. TVOC
TVOC is a pungent odor gas, and some of its compounds are genotoxic. TVOC is an acronym for "Total Organic Compounds" and includes benzene series, organic chlorides, Freon, etc., which are recognized as important air pollutants by the World Health Organization.

TVOC can cause dysregulation of the body's immune level, affect the function of the central nervous system, and induce self-conscious symptoms such as dizziness, headache and drowsiness. It may also affect the digestive system and damage the liver and hematopoietic system in severe cases. It is generally believed that TVOC concentrations up to 325mg/m3 will cause irritation and discomfort, and when concentrations greater than 25mg/m3, other neurotoxic effects besides headache may occur. A survey from Beijing Children's Hospital showed that 90% of the children with leukemia treated by the hospital had their families decorated within six months. Experts speculated that TVOC may be an important cause of leukemia in children.

3.3. Ammonia
Ammonia is a colorless, pungent smell of gas, easily soluble in water. Ammonia gas mainly comes from concrete antifreeze and interior decoration materials.

Ammonia can irritate and corrode the upper respiratory tract, weaken the body's resistance, and cause cardiac arrest and respiratory arrest through the reflex of the trigeminal nerve endings. Ammonia easily enters the blood through the alveoli when it is inhaled into the lungs, where it binds to hemoglobin and impairs oxygen transport.

3.4. Radon gas
Radon is a colorless, odorless and tasteless gas. Radon gas in indoor environment mainly comes from building materials and interior decoration materials. Especially some building materials made of slag and other raw materials and interior decoration materials with high uranium content, such as granite, marble, ceramic tile and so on. Radon is also produced in the foundation soil.

Radon gas is charged in the process of decay and is easily inhaled into the human body, causing the human body to produce plastic anemia. Radon gas accumulation in the human body is easy to induce lung cancer, is the second major cause of lung cancer in addition to smoking. According to the U.S. National Environmental Agency, 5,000 to 20,000 people die from radon pollution every year in the United States.
4. Data collection and analysis

4.1. Sample collection
This sampling mainly detects the contents of formaldehyde, ammonia and TVOC in the air. Sampling time was 910 months in 2020. A total of 108 rooms of 36 residential houses in Tianjin were monitored within one year of the completion of new decoration. Samples were collected according to GB/T18883-2002 Indoor Air Quality Standard. Before sampling, close the doors and Windows, open the drawer and cabinet doors, and conduct sampling after sealed for 24h; one sampling point is arranged in the room; A tripod is used for sampling. Considering People's Daily behavior in the room, the relative height of sampling is 0.5-1.5m, which is highly consistent with people's breathing. Vents should be avoided as far as possible during sampling, and the sampling point should be more than 0.5m away from the wall.

4.2. Evaluation criteria
In this study, the standard value stipulated in GB/TL8883-2002 Indoor Air Quality Standard was used as the evaluation standard, and the concentration standard limit of each monitoring item was 0.10mg/m³ for formaldehyde, 0.20mg/m³ for ammonia, and 0.60mg/m³ for TVOCs.

5. Data analysis

5.1. Analysis of indoor air pollutant content detection results
Test results of indoor air pollutant content are shown in Table 1. It is easy to see from the table that the content of formaldehyde and TVOC exceeds the standard seriously. The exceeding rate of formaldehyde is 35.7%, and the highest concentration exceeds the standard by 2.50 times. TVOC exceeded the standard rate of 30.7%, and the highest concentration exceeded the standard by 2.63 times. Ammonia pollution is relatively light, exceeding the standard rate of 12.5%, the highest concentration exceeded the standard 1.10 times. It can be concluded that the main indoor air pollutants in Tianjin are formaldehyde and TVOC.

From the point of view of the number of detection points, the number of detection points for formaldehyde is the most, the number of ammonia monitoring points is in the middle, and the number of TVOCs is the least. This phenomenon reflects that people pay more attention to the hazards of formaldehyde and do not have enough awareness of the air pollution hazards of TVOC. It is necessary to strengthen the publicity of TVOC hazards and raise the public's awareness of environmental protection in this regard.

Table 1. Indoor air pollutant content detection results.

| The test items | Number of test points | Exceeding standard rate (%) | The average (mg/m³) | The highest value (mg/m³) | Maximum exceedance multiple (times) | Standard values (mg/m³) |
|----------------|-----------------------|----------------------------|--------------------|--------------------------|----------------------------------|------------------------|
| formaldehyde   | 98                    | 35.7                       | 0.09               | 0.35                     | 2.5                              | 0.1                    |
| ammonia        | 48                    | 12.5                       | 0.09               | 0.42                     | 1.1                              | 0.2                    |
| TVOC           | 26                    | 30.7                       | 0.51               | 2.18                     | 2.63                             | 0.6                    |

5.2. Analysis of formaldehyde concentration detection results in different functional rooms
According to the function of the room, the detection points are divided into four categories: bedroom, study, living room and kitchen. The statistical results of formaldehyde detection in indoor air are shown in Table 2. It can be seen from Table 2 that the mean formaldehyde concentration and the over-standard rate are high in the bedroom and the study. This is mainly because the bedroom and the study, compared with other functional rooms, have good sealing performance, poor ventilation, and complex decoration. Wood floors, wooden furniture and wallpaper are mostly used, resulting in serious pollution. And the living room area is larger, ventilated better. Living room and kitchen decoration is relatively simple, resulting in relatively light pollution.
Table 2. Detection results of formaldehyde concentration in different functional rooms

| Room       | Number of test points | Exceeding standard rate (%) | The average (mg/m³) |
|------------|-----------------------|-----------------------------|---------------------|
| Bedroom    | 60                    | 40.0                        | 0.10                |
| Study      | 9                     | 44.4                        | 0.08                |
| Livingroom | 18                    | 27.8                        | 0.07                |
| Kitchen    | 9                     | 22.2                        | 0.06                |

6. Indoor air pollutants control measures

6.1. Improve indoor environmental awareness
Learn more about the basic knowledge of indoor environmental protection, use more environmental protection materials and furniture produced by regular manufacturers, clear construction methods during construction, eliminate the use of harmful additives, choose furniture also want to choose log furniture produced by regular enterprises, cut off these indoor air pollutants from the source. In addition, do not rush to move in the newly renovated rooms. It is best to store the vacant rooms for more than six months to avoid contact during the strong release of pollutants in the decoration materials. At the same time, air circulation must be maintained to shorten the residence time of pollutants in the house.

6.2. Planting green plants to improve indoor air
Many plants have the function of purifying the air, and some plants can break down poisonous substances. In addition to improving the air, indoor greening can beautify the living room. Research shows that in the closed room containing formaldehyde placed 1~2 basins of Chlorophytum or ivy, half a day can reduce the formaldehyde content by half, a day can absorb more than 90% of the indoor formaldehyde. Chrysanthemum can eliminate TVOC.

6.3. Fresh air system
The fresh air system refers to the circulation operation mode that the indoor air is discharged and the filtered outdoor air is sent into the room. This is an effective way to remove harmful substances from indoor air and filter out dust from outdoor air. Under the condition of not opening the window, it can still maintain the circulation of air to be smooth, and the effect of ventilation is better than that of traditional ventilation [5].

7. Conclusion
The types and sources of indoor air pollution are various and do great harm to human body. Prevention and control of indoor air pollution is a systematic project. Not only need people from the source of environmental awareness, but also with the help of scientific and technological means comprehensive treatment. Only from two aspects at the same time can effectively improve the indoor air environment.

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