Analysis on the Present Situation of Indoor Air Quality

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Abstract

The concentration level of air pollutants has always been one of the important criteria for evaluating indoor air quality. The importance of air quality in residential buildings is well known, but indoor air pollution in public places has just attracted people's attention in recent years. Although some scholars have carried out investigation and research on indoor air pollution in public places, most of them are aimed at the investigation and study of formaldehyde and benzene pollution in entertainment places. Lack of comprehensive and systematic research on various indoor air pollutants in public places with various functional types.

Keywords

Air Quality; Research Status; Indoor Gas Detection.

1. Research Background and Significance

The research on indoor air pollution at home and abroad mainly focuses on formaldehyde, VOCs, particles, CO2, CO, NO2, SO2 and air colonies. The investigation by Wang Hao et al shows that formaldehyde and particulate matter are the most important pollutants in public places, and the pollution of benzene series such as benzene, toluene and xylene can not be ignored in public places. WHO report "indoor air pollution and health" in 2019 mentions that indoor particulate pollution can lead to diseases such as chronic obstructive pulmonary disease and lung cancer, and is associated with low birth weight, tuberculosis, nasopharyngeal carcinoma and laryngeal cancer. The importance of air quality in residential buildings is well known, but indoor air pollution in public places has just attracted attention in recent years. At present, the total area of public buildings in China has exceeded 10 billion m2, but the public pays less attention to the influence of indoor air pollution on human body and mind. Public places are the general name of all public buildings, places and facilities used to provide the public with various social life needs, such as work, study, social, entertainment, medical treatment and so on. Among them, shopping malls, home markets and electronic cities are mainly used for shopping and entertainment in the city. People stay indoors for a long time, and there are many kinds of goods in the place and complex decoration. Therefore, the above kinds of places have great significance to the influence of air quality on human health. Before testing this paper, the research group has carried out the test and analysis of formaldehyde and particulate matter in furniture market, comprehensive shopping mall, clothing wholesale market and comprehensive wholesale market, but the types of pollutants are not comprehensive. Therefore, this paper looks for new public places to test many kinds of indoor air pollutants. Therefore, it is of great significance to study the pollution level, influencing factors and exposure evaluation of indoor air pollutants to human health of formaldehyde, PM2.5, benzene series, TVOC and CO2 in different types of public places, and to improve indoor air quality in public places and strengthen people's attention to indoor air quality in public places.

2. Research Status

In recent years, Indoor air quality in public places such as shopping centers, playgrounds, cinemas, stations, hospitals, temples, bookstores and galleries has become the object of study one after another.

Ms. Alyan et al conducted on-site testing of indoor air in three types of public places, including accommodation, shopping malls, supermarkets, culture and entertainment, in Chaoyang District, Beijing-2015, Total pass rate 83.8%, The qualified rate of formaldehyde is 63%, CO2 pass rate is 91.8%, PM10 qualified rate is 82.2. Cai Jingchun and others investigated the status of indoor air quality in public places in Ziyang City, Formaldehyde, benzene and PM10 were detected and analyzed in 49 public places in 7 categories, The results showed that the qualified rate of hairdressing salon was the lowest, Hotel qualified rate is the highest; Formaldehyde (80.4%) & lt; from low to high pass rate of pollutants Benzene (82.8%)& lt; PM10(83.6%). Zhu Zhongping and others tested formaldehyde, CO2 and TVOC in public places in Guangming District, Shenzhen, And the results show that the formaldehyde in the test site exceeds 6.5 times and the TVOC exceeds 6.3 times, At the same time, the results showed that the qualified rate of formaldehyde and TVOC in shopping malls was the lowest. Research shows that, Concentrations of indoor air pollutants in public places are usually three ~ six times higher than those outside, If it's more than 100 times, Indoor environmental pollution gas is usually formaldehyde, benzene series and other volatile organic compounds, They are all included in US EAP published toxic air pollutant emission inventories (TRI). Weng et al the investigation of indoor air pollution in public places in Hangzhou area shows that formaldehyde is the most serious pollutant. Qi Congliang and others tested and analyzed formaldehyde and TVOC in public places in Guilin. The results showed that hotels, shopping malls and furniture cities all exceeded the standard, and the furniture plates and leather products in the test places were the main pollution sources.

3. Main sources of indoor air pollutants in public places

The main sources of formaldehyde pollution in indoor air are decoration and fuel combustion. With the rapid development of building types and decoration materials, there are more and more sources of indoor air pollution in buildings, And in order to reduce the energy consumption of buildings, As a result, pollutants can not be discharged from the room in a timely and effective manner, As a result of the accumulation of indoor air pollutants, affect human health . Formaldehyde is usually used in the production of artificial plates, adhesives, decorative materials and cosmetics, Formaldehyde is often used in plastics and rubber processing, Smoking indoors also releases formaldehyde. According to Fabio et al, Formaldehyde is widely used in formalin aqueous solutions used to preserve organic tissue in hospitals. Benzene, toluene and xylene are colorless, volatile, toxic liquids, A strong irritating aroma. In daily life, The main sources of indoor benzene are decorative materials, wood-based panel furniture, adhesives, air disinfectants and pesticides , Toluene and xylene are usually used as raw materials for chemical production, such as the production of industrial supplies such as dyes, paint coatings and adhesives. A wide variety of VOCs in indoor air, It is relatively difficult to measure qualitatively and quantitatively one by one, As a result, total volatile organic compounds (Total Volatile Organic Compounds,) are commonly used TVOC) this quantitative index to characterize the total mass concentration of volatile organic compounds in indoor air. Indoor volatile organic compounds mainly come from two categories of building materials and daily necessities. Farrow et al. found that higher levels of TVOC were associated with air fresheners and aerosols. Furthermore, human activities such as the use of office equipment, such as printers and scanners, cooking and smoking can produce a variety of VOCs.. Table 2 Particles with an aerodynamic equivalent diameter of less than or equal to 2.5 mm in the atmosphere are called PM2.5, Also known as pulmonary particles or fine particles, due to the relatively small particle size, For a longer time in the air, PM2.5 will follow the air through the nasal cavity or mouth into the body, Thus causing negative effects on human health. The concentration and composition of indoor particulate matter are mainly determined by outdoor infiltration and indoor source emission. studies in australia by He et al. showed that smoking, frying and barbecue caused PM2.5 to be 3 times ,30 times and 90 times higher than the background value, respectively. A monitoring study by Brauer et al shows that, Environmental tobacco smoke and cooking are the main sources of indoor particulate matter in residential and non-industrial environments. Hiroshi and others investigated indoor air pollution in

downtown Tokyo and found that smoking increased the concentration of fine particles in the indoor environment by about 50~85. Cheng Hong and others found that indoor cooking, heating and cleaning activities will significantly increase the concentration of indoor particulate matter in a short period of time. CO2 is also one of the main pollutants in indoor air, For public places, Indoor CO2 mainly comes from the respiratory products of the crowd. Public places usually have a large flow of people and a high density of people, As a result, larger CO2, are generated If the air flow is poor due to the old air conditioning system or poor operating conditions, Can lead to a large accumulation of indoor CO2.

4. Levels of indoor air pollutants in public places

Wu et al. investigated and published concentrations and emission rates of indoor aldehydes and VOCs in 30 small and medium-sized commercial buildings of different sizes and uses in California, The results show that the formaldehyde concentration in retail stores and offices is high, More than 80 per cent of commercial buildings have indoor formaldehyde concentrations exceeding 9 g/m3. OEHHA the requirements Liu Benxian and others investigated the status of indoor air quality in 9 furniture markets in Weifang, Turns out, The total qualified rate of formaldehyde and benzene series (benzene, toluene, xylene) during heating period is 39.71%,63.28%,94.53% and 96.88%, while the pass rate of non-heating period was 44.35%,75.78%,100% and 100%, respectively. Liu and others investigated the indoor formaldehyde concentration in a comprehensive mall, The results showed that formaldehyde exceeded the standard by 60%, The highest standard is nearly 6 times.

Chen Jing and others investigated the pollution of formaldehyde and benzene in a large supermarket and a teaching building, Test results show that the supermarket cooked food area formaldehyde exceeding 57%, Washing area formaldehyde exceeded the standard 66. Tang and others tested the VOCs of department stores, fast food restaurants, video game rooms and bookstores in a large comprehensive shopping mall in Guangzhou, The results showed that the maximum concentration of TVOC in mg/m3, mall was 596.8 Among them, fast food restaurants and leather stores VOCs the highest concentration. Tao Haitao and others tested the TVOC concentration levels in nine underground shopping malls in Xi'an, Among them, the TVOC mass concentration of 7 underground shopping malls exceeded the standard, The exceeding standard rate is 77.8. The results showed that the average concentration of TVOC was 0.052,0.070,0.049,0.137 and 0.048 mg/m3, the qualified rate was 98.7%,98.9%,100%,95.0% and 100%, and the TVOC concentration range was 0.001~0.805 mg/m3. respectively

by Xiang Linlin and others through on-site testing of the PM2.5 concentrations of five types of public buildings, such as office buildings, hospitals, schools, hotels and shopping malls in Shanghai, Comparative analysis of the PM2.5 concentration levels and sources of various public buildings, The average PM2.5 concentrations in public places were mg/m3.0.142,0.140,0.052,0.031 and 0.050 Shi Tongxing and others to collect and test three kinds of public places, such as shopping, accommodation and catering in the central urban area of Guangzhou, The average concentration of PM2.5 in each site was 49.47±13.88, 53.5±14.38, 62.42±17.18 mg/m3., respectively A total of 38 public places, such as Chongqing restaurants, collective canteens, hospital waiting rooms, entertainment places and office halls, were studied by Xu Chunyu and others, Testing their indoor PM2.5 pollution levels, Their total indoor mean concentrations were (211±93 mg/m3,). Table 2 The concentration range is 85~402 mg/m3.

Yang Lianhui and others analyzed the indoor PM2.5 concentration levels of four kinds of public places, such as hairdressing, shopping malls, theatres, hotels, bars KTV game halls, The results showed that the concentration levels of indoor PM2.5 were (0.065±0.025), (0.050±0.013), (0.075±0.016), (0.120±0.018) mg/m3. respectively Li and others selected nine shopping malls in Hong Kong as research subjects, The survey found that 40 percent of shopping malls, whether on weekdays or weekends, The average indoor CO2 concentration exceeds the standard 1000 ppm, The reason for exceeding the standard lies in the congestion and lack of ventilation in the indoor space. Wang Qingjun and others investigated the indoor CO2 of four kinds of public places, such as

shopping malls, hotels, hairdressers and beauty shops, and cultural and entertainment places, The results showed that the CO2 in hotels, hairdressing shops and cultural and entertainment places were more than 1000 ppm. Zhuang Xiaohong and others tested the indoor CO2 of 18 public places, including shopping malls, supermarkets, train station waiting rooms, home cities, cinemas and libraries, The range of CO2 concentration in the mall is about 244~1100 ppm,. The The concentration range of CO2 in supermarkets is about 433~1800 ppm.

5. Main hazards of indoor air pollutants in public places

Carcinogenic risk of formaldehyde is high in VOCs, Even low-dose formaldehyde long-term exposure can cause chronic respiratory disease. Golden believe that formaldehyde exposure has a significant causal relationship with cancer of human respiratory organs such as nasopharyngeal carcinoma and leukemia. Lu Zhaohong and Liang Hairong found that formaldehyde and benzene had obvious damage to cell DNA, Formaldehyde and benzene act on the cells at the same time to the damage of DNA show mutual reinforcement phenomenon. Yang Di and others observed the plasma and lung tissue of mice after inhalation of formaldehyde, It was found that formaldehyde could cause oxidative damage to lung tissue in mice, At the same time produce organizational changes. Marsh and others investigate formaldehyde exposure of workers in plastic processing plants, The results showed that the death risk of pharynx cancer and nasopharyngeal carcinoma increased by 2.23 times and 5 times than that of other workers, respectively.

Benzene has carcinogenic, neurotoxic and genotoxic hazards, serious can lead to leukemia, so it is WHO identified as a strong carcinogen. Benzene has a toxic effect on hematopoietic stem cells, so it can easily cause acute myeloid leukemia, myelodysplastic syndrome and lymphoma. WHO studies have shown that for every 1 mg/m3, the concentration of benzene in the air increases the of leukemia in 6 cases per 1 million people. Toluene and xylene usually enter the human body from the skin mucosa or respiratory tract, and stimulate the skin mucosa slightly, causing dermatitis or eczema; when serious, they can harm the nervous system and cause symptoms such as dizziness, chest tightness, nausea, insomnia, fatigue and neurasthenia syndrome. The toxic effect of TVOC on human body involves many respiratory organs, such as pharynx, nose and throat, and many systems such as nerve, respiration and immunity, so it is WHO listed as a strong carcinogen. Farrow et al. found a significant association between diarrhea, ear pain, vomiting, and headache symptoms in the mother for 8 months postpartum.

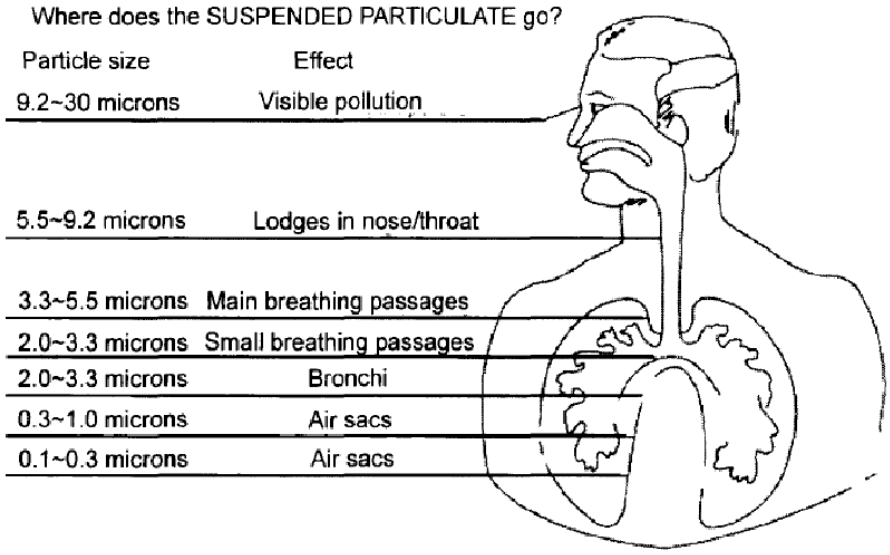

Fig. 1 Deposition of particles of different sizes in human respiratory tract CO2

PM2.5 particles not only increase the risk of lung disease, It also causes inflammation, contraction, or movement of fat plates, Causes high blood pressure or blood clots and causes stroke or heart disease.

In recent years, by observing, speculate that PM2.5 in the blood may cause the brain to accelerate aging because of inflammation; In addition, PM2.5 can also damage the white matter in the brain and cause Alzheimer's. Air quality-life index (AQLI) converts pollution concentrations of particulate matter from long-term exposure to the effects on the average life expectancy of the population, When exposed to PM2.5 concentrations of 10μg/m3, Average life expectancy will lose 0.98 years. Studies Pope et al. show that PM2.5 concentrations increase by 10μg/m³, The lung cancer mortality rate increased by 8 per cent, A 6% increase in mortality from heart and lung diseases, The annual total mortality rate increased by 4 per cent. Particulate matter is different in size, When they enter the body, they deposit in different parts of the respiratory tract, And that leads to multiple respiratory diseases, Details of deposition are shown in figure 1.

Although not inherently toxic, But CO2 the concentration is too high to make people feel tired, (b) The resulting decrease in work and learning efficiency; Exposure to high concentrations of CO2 for a long time, That would destroy the electrolyte balance, Cause blood acidosis. Meanwhile, CO2 plays a role in regulating breathing, Breathing centers are sensitive to changes in CO2 concentrations, If the CO2 concentration is too high, Easy to produce toxic effects on the central nervous system.

6. Health Risk Assessment of Indoor Air Pollutant Exposure

Tong Ruipeng and others Carcinogenic and Non-Carcinogenic Health Risk Assessment for Workers on VOCs in the Production Process of a Furniture Factory in Zhuhai, Guangdong Province, The results showed that the carcinogenic risk values of workers exposed to benzene exceeded 10-6, Risk of cancer; Among them spray paint worker benzene carcinogenic risk is 3.07×10-6; Only spray paint workers in each station have non-cancer risk. Wang Xun et al .evaluated the health risk of employees by formaldehyde in the air of 185 public places in 7 categories of Longgang District, Shenzhen, The results showed that only hospital waiting room formaldehyde did not have a chronic non-cancer risk to staff, Formaldehyde in the remaining six public places has adverse effects on the health of staff; Formaldehyde in the indoor air of 7 public places has a carcinogenic risk to employees, And the highest risk of carcinogenic formaldehyde in cinemas, reach 1.02×10-4. Liu Jianlei points out that the average value of benzene carcinogenic risk for male and female employees in the office is

The average risk of benzene carcinogenesis in kindergarten teachers was 8.85×10-6 and 9.88×10-6, There is a risk of cancer. Li Guoqiang and others tested formaldehyde and benzene in recreational public places in Xi'an and evaluated the health risk of workers in the places, The evaluation showed that, Men's exposure to benzene and formaldehyde was 6.21×10-5 and 10.59×10-5, Women employees are 5.46×10-5 and 9.32×10-5, All over 1×10-6, There is a greater risk of cancer. Liang Xiaojun and others the detection and analysis of formaldehyde in indoor air of 1249 different types of public places in Jinggangshan City, The results showed that the risk range of formaldehyde cancer in staff was 4.70×10-5~1.57,10-4, Among them, the place with the highest risk of cancer is beauty, Men are at greater risk of cancer than women under the same conditions.

7. Conclusion

Although some scholars have carried out research on indoor air pollution in public places, most of them are aimed at the investigation and study of formaldehyde and benzene pollution in entertainment places. Lack of comprehensive and systematic research on various indoor air pollutants in various public places. Therefore, this paper deeply studies the concentration level, pollution status and influencing factors of formaldehyde, benzene series, TVOC, PM2.5 and CO2 in different types of public places. On this basis, it is of great significance to evaluate the health exposure of workers by benzene and formaldehyde.

8. Future research

(1) To identify the main types of pollutants affecting the indoor air quality of public places through the investigation of relevant literature on indoor air pollutants and air quality in public places;

(2) According to the survey results, five representative public places, such as shopping malls, electronic cities, furniture cities, gymnasiums and offices, are selected, and the experimental scheme is formulated with reference to the previous research results of the research group (division and location arrangement of functional areas of public places), and the pollutants such as formaldehyde, benzene series, TVOC, PM2.5, CO2 and other pollutants in the indoor air, as well as environmental parameters such as temperature, relative humidity and air velocity are investigated and sampled and on the spot;

(3) Single factor evaluation of indoor air pollutants in public places, analysis of the concentration levels of different air pollutants in different types of public places, discussion of the factors affecting the concentration of air pollutants in the environment of each place, and analysis and description of other environmental parameters in public places;

(4) To calculate and describe the indoor air quality of different kinds of public places by using the comprehensive index evaluation method, to evaluate the air pollution degree of each pollutant by the ratio of the actual test value to the standard limit value, and to compare and analyze the indoor air quality grade of each place;

(5) Assessment of the health effects of indoor benzene and formaldehyde on respiratory exposure of workers in different public places using carcinogenic and non-carcinogenic health risk assessment models and Crystal Ball software based on basic exposure parameters such as sex, age, weight and exposure time, combined with the measured concentrations of benzene and formaldehyde in indoor air in various public places and basic exposure parameters;

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