

THE INVESTIGATION AND ANALYSIS OF INDOOR AIR POLLUTION IN CHINA

Z Tonghua^{1,3*}, T Guangbei¹, W Lai², C Hua^{1,3} and L Jing^{1,3}

¹Institute of Environmental Science and Technology, Tianjin University, Tianjin, China

²Institute of Science, Tianjin University, Tianjin, China

³Dept. of refrigeration and air conditioning, Tianjin University of Commerce, Tianjin, China

ABSTRACT

People spend more than 80% of their time in room. It is very imperative that the indoor air pollution problem be studied, because it does great harm to people's health with the increasing of the sources of indoor air pollution. The main reasons of indoor air pollution are found by investigation and analysis in some Chinese metropolises, and some measures to improve the indoor air quality are put forward.

INDEX TERMS

Indoor air quality, Sources of pollution, Standards, Measures

INTRODUCTION

In recent years, people have realized clearly that it is a vital task to study the harm of indoor pollutants on human's health. People usually spend approximately 80% of their time in indoor environment, especially to the children, the youngsters, the old people, and the patients. When modern science and technology brings us luxury indoor decoration, it also makes the building come down with some pathological changes.

In fact, early at the end of 1970s, some European scientists set about to study the influence of gases released from building decorative materials on the indoor air quality and the harm on human health. They pointed out that there were more than 20 kinds of carcinogen from the 500 kinds of organic matters tested out of indoor air. Indoor air pollution is threatening human health more and more seriously. These pollutants are mainly: sulfur dioxide, nitrogen oxide, total floating particles, formaldehyde, volatile organic compounds (VOCs), asbestos and artificial mineral fibrin, heavy metal, radon, and electromagnetic wave radiation.

THE INVESTIGATION AND ANALYSIS OF INDOOR AIR POLLUTION IN THREE CHINESE METROPOLISES

Beijing

Chinese Consumer Association and Science and Technology Parent Company of Beijing Industry University had tested the indoor environment status of some newly furnished houses in Beijing, and made a questionnaire investigation found in the adorning process by consumers. 30 families were chosen as samples, including 14 families furnished within 3 months, 4 families furnished from 3 months to 6 months, 4 families furnished from 6 months to 12 months, and 8 families furnished over 12 months. These samples were tested on the items including formaldehyde, benzene, radon, radioactivity of rock substances, and VOCs in indoor air. The results of investigation were as followings.

* Contact author email: zouth2002@yahoo.com.cn

1) It was ubiquitous phenomena that the concentration of formaldehyde of indoor air exceeded the allowed value of standard. According the Chinese standard GB/T16127-1995, the allowed concentration of formaldehyde in indoor air is less than 0.08 mg/m^3 . There were 22 samples in which the concentration of formaldehyde in indoor air exceeded 0.08 mg/m^3 , occupying 73.3% of the total samples. The highest concentration of formaldehyde in indoor air arrived at 0.89 mg/m^3 , exceeding the allowed value of Chinese standard more than 10 times.

2) Among the 30 samples, there were 10 samples in which the concentration of benzene in indoor air was not found, and 13 samples in which the concentration of benzene in indoor air exceeded 0.087 mg/m^3 , occupying 43.3% of the total samples. It showed that many families faced to the indoor air pollution of benzene.

3) The concentration of radon was within the security. Among 30 samples, no one was found in which the concentration of radon exceeded the allowed value of Chinese standard, and the concentration of benzene of a majority of samples was lower than 30 Bq / m^3 .

4) Among the 30 samples, all the rock substances used in indoor, including natural marble and artificial ceramic tile, belonged to A class products, and the radioactivity did not go beyond the allowed value of Chinese standard.

5) The total amount of VOCs was tested. Among the 30 samples, there were 6 samples in which the concentration of VOCs was relatively high. The concentration of VOCs in the children bedroom of sample 1 was 1.60ppm. The concentration of VOCs in the children bedroom of sample 5 was 0.89ppm. The concentration of VOCs in the main bedroom of sample 8 was 1.16ppm, in the main bedroom of sample 12 was 1.35ppm, in the main bedroom of sample 22 was 0.86ppm. The concentration of VOCs in the toilet of sample 28 was 1.78ppm. (She F, 2001)

Hangzhou City

The Consumer Association of Chekiang Province and The Disease Defending and Controlling Center of Hangzhou City made an investigation and test on the indoor environment quality of some newly furnished houses in Hangzhou City. 53 families were chosen as samples, including 33 families furnished within 3 months, 20 families furnished from 3 months to 6 months, these samples were tested on the items including formaldehyde, radon, and radioactivity of rock substances in indoor air. Among the 53 samples, there were 42 samples in which the concentration of formaldehyde exceeded the allowed value of Chinese standard, 3 samples in which the concentration of radon exceeded the allowed value of Chinese standard, and 10 samples in which the radioactivity went beyond the Chinese standard. (She F, 2001)

Tianjin

Tianjin Health and Disease Defending Center made an investigation on the indoor air quality at Tianjin. The results showed that the indoor air pollution threatening the health of inhabitants was conversing from biology pollution and soot pollution to chemical pollution. The indoor air quality was tested on over 180 places newly built and furnished including infants' schools, office buildings and families, only 34.7% of them getting up to grade. The ammonia pollution was the severest. Its rate of exceeding the allowed value of Chinese standard to the total samples was 27.8%. The highest concentration of ammonia exceeded the standard value 62.8 times and the average concentration of ammonia exceeded the standard value 36.5 times. In the next place, the ratio of formaldehyde exceeding allowed value of

Chinese standard was 27.8%, and the ratio of benzene substances such as toluene and dimethylbenzene exceeding allowed value of Chinese standard was 14.6%. (Cao Y, and Gu Q, 2001)

Analysis

People in Chinese cities have paid more and more attention to the problem of indoor air pollution. After moving into the newly built or furnished house, they felt at large that the indoor air quality was poor, and had the symptoms of eyes, noses and respiratory tract being stimulated, even had a headache and nausea, which caused the bad effects on the well-balanced life and work. Indoor air pollution has become a serious problem to which must be attached importance by all people and solved by great efforts.

1) Viewed on the spots and the tested results of the samples which went beyond the allowed value of Chinese standard, most of the samples in which the concentration of formaldehyde exceeded the allowed value of Chinese standard were newly furnished, generally less than 12 months. Most of the samples exceeding the formaldehyde allowed value of Chinese standard seriously utilized artificial plank to make furniture and to decorate wall. The furniture is arranged too much and closely. Bad binder in plank is the main source of formaldehyde. All the inhabitants felt their eyes, noses and throat stimulated.

2) Viewed from the situation of benzene exceeding the standard, benzene pollution was resulted from adorn material, furniture, carpet, binder, construction dope, cosmetic and commodity.

3) According to Chinese Industry Standard JC518-91, the radiation level of rock substance is partitioned into 3 classes. A class is safe and can be used everywhere, B and C classes can not be used in interior decoration. Consumers should choose A class of rock substance to adorn their rooms. While based on the investigation, Non-A class products lie on the market of rock substance which make consumers feel unsafe.

4) Radon is the middle product of uranium decay, and radon itself also can decay. In the process of its decay, the radiation rays are given off. Radon is the important reason resulting in lung cancer. Some radon comes into house through the floor and wall split. Other is resulted from the radioactive construction materials, such as the granite which contains much uranium. Moreover, when natural gas was burning, radon in the exhausted gas will stay in the house if the ventilation is poor.

5) The indoor air pollution of VOCs has been attached importance to all over the world. Many people working indoors have the sick symptoms with unidentified reasons, such as headache, tired, discomfort, and letdown of memory, which is suspected to be in relation with the high concentration of indoor VOCs. The main source of indoor VOCs is the construction adorning materials. The allowed concentration of VOCs acts as a key index in many countries. In this test, the concentration of VOCs is confirmed as excessively high if it exceeds 0.7ppm.

THE MEASURES TO IMPROVE THE INDOOR AIR QUALITY

Our ancestor paid much attention to the indoor air quality of building. When choosing a location to build a house, they must consider the geomantic omen of the building. They were sunshine, ventilation, terra, and influence of the hill and stream path around the building. With the appearance of modern construction materials in recent years, in order to seek for the luxury and excellent adornment, people ignore the harm of pollution, radiation, carcinogen,

and asphyxiation caused by some adorn materials, which leads some building to fall short of the basic requisition of health safety. In order to break away from the danger of sick building, some suggestions at the beginning of programming and designing are presented as followings:

1) The environment and the sector of an area good for health should be selected carefully at the layout and designing. Nowadays, some areas in industry districts and large city in china, such as downtown, roadway, parking place, are polluted seriously. On selecting a place to build the houses, be sure to keep away from these sectors. There are approximately 700 cities in china now, while only five of them, that is, Beijing, Shanghai, Shengyong, Guangzhou and Sian, take part in global atmosphere inspection net. The result of inspection is depressing. The daily average concentration of floating particles in the air in the five cities covers from 200 to 500 mg/m³, which exceeds the standard of WHO from 3 to 10 times. Beijing is one of the capital cities in the world with the worst environment quality (Jin L. 2000). But this condition is changing rapidly at recent years.

2) The construction materials with non- or low-contamination should be chosen as possibly on the constructing and decorating. Presently, some decorative materials used in the indoor adorn can give off harmful gases and substances in the process of construction, which pollute the indoor air, lure many kinds of diseases, affect the health of people, even cause person casualty. China has a vast territory, with a complex geology structure and an extensive distributing of rock materials. Some kinds of granite, marble, porcelain covering brick, coal ash brick contain the radioactive material such as radium, titanium, γ radial, and radon. When selecting these materials, one must make sure to get their certificates of products, and don't use the rock materials in which the radiation concentration exceeds the allowed value of Chinese standard.

Some organic construction materials, such as oil paint and dope, contain toxic matter such as benzene, hydroxybenzene, aldehyde and their ramifications. For example, toluene and dimethylbenzene occupy 20%~50% in solvent oil paint. The concentration of benzene indoors over 0.8mg/m³ is thought to exceed the allowed value of Chinese standard. When decorating a house, one must select the variety of oil paint and dope carefully, make sure that the concentration of toxic matter is under the scope controlled.

Artificial plank such as veneer, fiberboard, flakeboard and stickiness are in common use as the adorn materials, which usually contain formaldehyde and other VOCs. VOCs volatilize easily and pollute indoor air, stimulate people's skin and mucous membrane, especially of eyes and noses, cause eyes acerbity and ache, respiratory tract inflammation, cough, dizzy, and headache.

Asbestos fibrin cement products used in the decoration of indoor or outdoor wall contain minute asbestos fibrin which is less than 3 μ m length and 1 μ m diameter. One will have the asbestos pulmonary disease or even cancer difficult to be cured if inhaling the asbestos fibrin. The developed countries have prohibited from producing and using all the asbestos products, and succeeded in developing the substitute of asbestos cement. Some enterprises in china also succeed in developing the non-asbestos cement products. So non-asbestos cement products should be selected firstly in decorating a house.

3) Designer should warn inhabitants of taking full advantage of ventilation, direction to the sun, and controlling temperature and humidity. A large numbers of researches show that indoor ventilation has a definite effect on the indoor air quality. Some construction materials,

such as dope, wood scraps board, mine cotton fibrin, can give birth to mildew and give off VOCs and other pollutant in the condition of poor ventilation and watery air. Indoor direction to the sun, daylight and sunlight are also the important factors. Sunlight can kill the bacteria and microorganisms effectively. Bright and clean windows help to protect our eyes. Sanitation specialists suggest that the ratio of available area of the windows to floor area of the rooms should be more than 1 to 5.

Experiment certified that indoor net highness also has an effect on the indoor air quality. When the net highness is lower than 2.55m, inhabitants will feel oppressed, and the concentration of indoor carbon dioxide will rise. According to the regulation, the net highness of residence in the South China should be not less than 2.8m, while in the North China, it should be not less than 2.6m.

Physiologist testified through researches that indoor temperature and humidity have close relationship with inhabitants' health, work, study, and living. Too high temperature will affect the thermoregulation function, result in body temperature rise, blood vessel expansion, pulse rapidness, heart acceleration. While too low temperature will cause metabolize function declining, pulse and respiration slowness, blood vessel under the skin contracting, skin straining, and place a premium on disease of respiratory tract. Scientist limits the indoor temperature in the scope from 11°C to 32°C.

At the same time, indoor humidity also should be pay attention to. In summer, when the humidity is too high, body's dispelling heat will be oppressed, and inhabitants will feel very sultry and fretful. In winter, when the humidity is too high, heat conduction will accelerate, and people will feel gloomy and cold, depressing, throat aching, voice hoarseness, and nose bleeding, and easy to catch cold. Specialists believe that the upper limit of humidity should not exceed 80%, and the lower limit should not be lower than 30%. However, human senses are affected not only by the temperature and the humidity simply, but also by the integral action of temperature and humidity. Experiment shows that the suitable temperature and humidity are as following: temperature is 18°C to 23°C, humidity is 30% to 80% in winter, and temperature 22°C to 26°C, humidity 50% to 70% in summer in China.

4) Green plants growing in room can purify the harmful gases. It is a disputed question whether growing green plants in rooms is beneficial or harmful. Shanghai Arboretum and Shanghai First Medical University cooperated in researching the purifying function of green plants. Results show that living green plants grown in rooms, such as evergreen vine and bracket plant, can purify the indoor air, absorb the harmful gases such as carbon dioxide, carbon monoxide, formaldehyde and benzene, and be beneficial to health. Some green plants can also change toxic chemistry matters into plant food.

CONCLUSION

From the investigation of indoor air pollution in China, we can know that the problem of indoor air pollution exists universally in China. If the measures mentioned above are taken, the problems of indoor air pollution can be solved or avoided.

REFERENCES

- Cao Y, and Gu Q. 2001. The rate of indoor air quality up to standard only 30%, Tianjin: Tonight Paper, 2001-9-7
- Jin L. 2000. Architecture Science and Culture, Beijing: Popular Science Press.
- She F. 2001. The statue of indoor air, Beijing: China Message Paper, 2001-8-9.