Analysis of Indoor Air Pollution of Decoration and Control Measures

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Abstract. Nowadays, the human health is closely related to quality of indoor air. This article analyzes the main types of pollution to indoor air and their harms to human health, and on this basis, it sets forth the prevention measures comprehensively and proposes advices to normalize industry standards.

1. Introduction

People now spend most of their time indoors, either in home or in office. As the modernization of lifestyle, the time spent indoors is in majority, and even as high as 93%. According to WHO report, the death caused by outdoor air pollution is about 3.7 million each year; however the death caused by indoor pollution is 4.3 million. When comes to China, the average death caused by this is up to 11.1 million, which means about 304 per day, equal to the number of people who died due to traffic accidents every day. The indoor air pollution is also considered as third kind of air pollution in addition to pollution types of "fuliginous model" and "fuliginous model". Years ago, the United States Environmental Protection Agency has counted indoor air pollution as the 4th largest hazards to environmental health after air pollution, toxic chemicals from factory and water pollution; and it is also be considered by WHO, as one of top ten threats to health. In 1980s, the terms of SBS (Sick Building Syndrom), BRI (Building Related Illness) and MCS (Multiple Chemical Sensitivity) etc., have been arisen. In conclusion, the human health is closely related to indoor air.

2. Main sources of indoor air pollution

2.1. Chemical pollutants

This kind of pollutant comes from decoration materials of wood-based panel, carpet, paint, adhesive and furniture, etc.; these materials often contain toxic and hazardous substances with actual content that exceeding certain limits (tabulated as table 1).

2.2. Physical pollutants

This kind of pollutant comes from building ceramic, including tile, wash basin and water closet etc.; it also derived from the natural stones like granite, marble; and the electromagnetic radiation caused by electric appliances of radio broadcasting, television and so on.

2.3. Biological pollutants

The biological pollutant, which includes virus, bacteria, mildew, fungi, dust mites and organic substances etc., mainly comes from domestic waste, household appliances, modern office facilities, indoor plants, pets, indoor decoration and furniture. All of these contaminations could cause diseases like allergic asthma, anaphylaxis, influenza and pneumonia etc.
### Table 1. Limits of Indoor Environmental Pollutants in Civil Construction Engineering

| Contaminant               | Class I Civil Construction Engineering | Class II Civil Construction Engineering |
|---------------------------|----------------------------------------|-----------------------------------------|
| Radon/(Bq/m³)             | 200                                    | 400                                     |
| Free formaldehyde/(mg/m³) | 0.08                                   | 0.10                                    |
| Benzene/(mg/m³)           | 0.09                                   | 0.09                                    |
| Ammonia/(mg/m³)           | 0.2                                    | 0.2                                     |
| TVOC/(mg/m³)              | 0.5                                    | 0.6                                     |

2.4. Outdoor pollution
There are 3 main factors as following, ① the industry pollutions of sulfur oxides, nitrogen oxides and so on; ② the photochemical smog and dust etc.; ③ the automobile exhaust containing pollution of nitrogen oxides and hydrocarbon etc.

2.5. Biological pollutants
The biological pollutant, which includes virus, bacteria, mildew, fungi, dust mites and organic substances etc., mainly comes from domestic waste, household appliances, modern office facilities, indoor plants, pets, indoor decoration and furniture. All of these contaminations could cause diseases like allergic asthma, anaphylaxis, influenza and pneumonia etc.

3. Main contaminants and hazards

3.1. Formaldehyde
Formaldehyde is a colorless, irritant and volatile gas, it mainly released from wood-based panels, furniture and wall materials. The Formaldehyde posses a significant danger to human health especially for eyes, nose and mouth; for long-term exposure through respiratory and skin, it cause intoxication with indications of headaches, dizziness and sick, and it also leads to dysfunction in lung, liver and immune system. The formaldehyde is carcinogenic with a release duration as long as 3~15 years [1] on basis of finding from Yokohama National University. In newly constructed houses, the indoor formaldehyde is always more than ten times of relevant standards, sometimes even more than over forty times. Some scholars compared standard value of formaldehyde concentration in GB/T 18880-2002 [2] and GB50325-2010 [3] to the maximum actual concentration of formaldehyde 2.11[4], 1.22 [5], 1.45 [5] in house, office and public place, and found it was more than 2.1 times, 1.2 times and 1.4 times to reference limits. Some researches show that the content of newly renovated reading room are higher than newly renovated house, and the outdoor posses relative lowest concentration, however the furnish posses highest concentration of formaldehyde regardless of the types. The correlation between concentration and body response is tabulated as Table 2 [6].

3.2. Volatile organic compounds (VOC)
The primary sources of indoor VOC are interior decorations of paint, floor, wall paper and adhesive etc. According to reports from Environment Protection Agency, the indoor VOC in a stuffy room will leads to indoor pollution higher than 10 times of that of outdoor. When VOC reaches a certain concentration in room, it causes symptoms of headache, nausea, vomit and exhaustion etc.; and may even incurs serious consequences of tic, coma, inflicting damage to liver, kidney, brain and nervous system, causing hematological abnormality, memory decline, and leukemia etc. So the VOC has also been called as ‘invisible killer’. Many studies on pathogenic causes indicate pollution is serious in newly renovated house which leads to a higher incidence of leukemia in infants and toddlers [7]-[9].

### Table 2. Formaldehyde on acute irritating reaction for human health in short time

| Body response | Concentration of formaldehyde, mg/m³ |
|---------------|--------------------------------------|
|               |                                      |
3.3. Benzene compounds

The benzene compounds are mainly sourced from chemical construction materials of filler, paint and various organic solvents etc. This kind of contaminant often possesses characteristics of volatility, inflammability and explosivity of its vapors. It causes dizziness, headache, nausea and weakness under inhalation of high concentration of benzene, xylene within short time, and even leads to coma and death in severe cases. And for long-term exposure, it will result in chronic intoxication, insomnia, headache, mental sluggishness, failing memory, and may even leads to leukemia. Actually, WHO has recognized benzene compounds as carcinogenic material.

3.4. Radon

The Radon is colorless, tasteless and natural radioactive inert gas that mainly released by underground water, burning of fuel gas and construction materials of slag brick, cinder brick, granite, tile and cleaning facilities. The Rn can be closely conjugate fat to widely distribute in blood, nervous system and reticuloendothelial system, and then rise damage to cells and eventually leads to cancer. WHO recognize Radon as carcinogen, which could increase the probability of cancer, and may simultaneously cause damage to heath of next generation and even third generation.

3.5. Ammonia

Ammonia is a colorless gas and has a strong irritating odor. It generally sourced from materials of concrete anti-freezing, additives and whitener of furniture finishing, wood plate; ammonia is alkaline that will corrode and irritate the substance directly contacted, and after massive inhalation to human body, it will incurs symptoms of lacrimation, dizziness, cough, nausea, chest tightness and breathing difficulties etc., and even rise pulmonary edema in serious case.

4. Control measures to indoor air pollution

4.1. Prevention and sources controlling

The best way of controlling is to control the pollution headstream.

4.1.1. Green environmental protection design. Hold consciousness of environment-protecting by well considering of ventilation, lighting etc. indoor during construction, the materials should be employed rationally to save the quantity.

4.1.2. Green building and decoration materials. The green and natural materials are recommended to be employed for decoration; at same time the reliability of green materials should be ensured.

4.2. Initiative management to reduce dangers

4.2.1. Ventilation. It’s better to keep windows open for ventilation and put off the moving into newly constructed house [8] so as to dilute the concentration of hazardous gas, generally to say, it is the most common, effective and economical way to prevention of indoor pollution. Actually there are three types of ventilation as natural one, mechanical and natural ventilation with auxiliary facilities; thereinto, the mechanical ventilation consuming energy, thus the installation of this kind equipment should be well considered at the designing of building so as to save energy.
4.2.2. **Physical adsorption.** The adsorption property of adsorbent could be employed to reduce the smell and concentration of hazardous gas effectively. The normal adsorbents include activated carbon, bamboo charcoal, silica gel, plaster and diatom and so on; thereof the activated carbon posses characteristics of good hydrophobicity, highly developed capillary structure, cheap and good adsorption properties, it is used frequently, what is more, it can be recycled after soaking in salty water and direct-sun exposure; although so many advantages, the weak absorption to inorganic gas still needs to be strengthened. Some researches show that the fibred activated carbon behaves high ability to absorb inorganic gas as well as organic gas, with absorption of more than 1~10 times\(^9\) to normal activated carbon. And some researchers are now studying on some of new types of activated carbon, which possess absorption of 4 times to the Bamboo Activated Carbon and 1.5 times to Coconut Base Activated Charcoal \([10]\).

4.2.3. **Biological absorption.** The green plants are widely applied for low price, easy operation and great varieties, the function of green plants are not only limited to absorbing pollutants, but also beautifies the environment. Some researches \([11], [12]\) indicate the plants posses unique advantage in purifying air. For instances, the ivy could eliminate about 90% of benzene; the bracts of rhizoma arisaematis could eliminate 80% of benzene and 50% of trichloro ethylene; the Chlorphytum comosum could decontaminate about 96% of carbon monoxide, 86% of formaldehyde and nitrogen peroxide \([13]\); the zamioculcas zamiifolia rehd could absorb 88% of dimethyl benzene just within 72hours \([14], [15]\), and it is also effect in absorption of benzene, toluene and ethylbenzene indoors \([16]\); the plants of Sansevieria trifasciata and Kalanchoe blossfeldiana could decontaminate 77% of toluene within 72hours; all Chlorphytum comosum as well as Sansevieria hyacinthoides and Aglaonema commutatum could eliminate 70% of ethylbenzene \([16]\); in addition to these, the monstera, cactus and aloe also possess function of air purifiction.

4.2.4. **Initiative management.** Air depuration devices could also be used to absorb the indoor pollution gases. The devices could absorb, decompose and transform various hazardous gases, is workable for air purification. Furthermore, many scholars and scientists put forward some new methods such as photocatalysis with nano materials, plasma catalytic \([9]\), photocatalyst, air catalytic technology, discharge-catalytic technology with nano plasma of Hydrogen peroxide, etc \([17]\).

4.3. **Strengthen supervision to ensure health**

It is better to request an analysis report from the decoration company after decoration, and also employed professional organization to monitor the quality of indoor air before moving in.

5. **Summary**

Along with the continuous improvement of living standard, people are paying more and more attention to the quality of indoor air. From the source, we hope the national authority could establish suitable regulations to normalize the specification for construction and decoration materials, and prevent fake and low-quality product and the firms manufacture or marketing such products from approaching market. Meanwhile all of us should encourage manufacturers to support more and more green products, also the people shall improve awareness of health, green decoration, and adopt more effective approaches to decrease the danger of indoor air pollution.

6. **Acknowledgments**

Because of such short notice, there are certain shortcomings and mistakes that have not yet been found. Of course, my personal opinions still need further analysis and meticulous argumentation, and I hope experts and scholars can help me improve it and even correct them. I shall be very grateful.

7. **References**

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