

Indoor air pollution and preventions in college libraries

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Abstract. The college library is a place where it gets the comparatively high density of students often staying long time with it. Therefore, the indoor air quality will affect directly reading effect and physical health of teachers and students in colleges and universities. The paper analyzes the influenced factors in indoor air pollution of the library from the selection of green-environmental decorating materials and furniture, good ventilation maintaining, electromagnetic radiation reducing, regular disinfection, indoor green building and awareness of health and environmental protection strengthening etc. six aspects to put forward the ideas for preventions of indoor air pollution and construction of the green low-carbon library.

1. Introduction

According to China Standardization Association, 68% diseases are caused by indoor air pollution which has become an “invisible killer” to people's health. America has considered the indoor air pollution as five major environmental factors in damaging public health. Cities residents in China are staying in various indoor environments with around 70% to 90% of time [1].

With the continuous development of the college libraries, the integration services mode of books of collection, borrowing, reading and consulting have been extensively practiced. There is an increasing large scale of libraries with a growing number of in-library readers and rising intensiveness of staff. The opening time has reached to 10 to 13 hours and some have opened round the clock. College students' residence time in the library is 2 to 4 times longer than that in the classroom, averaging to 3 to 6 hours (according to those staying in the library). Indoor air pollution of libraries does a severe harm on physical health of massive readers and staff working in libraries. The main reader groups of college libraries are young students in puberty. Researching and improving the indoor air quality of college libraries is a responsible practice for students and society, which should be given enough attention within it.

2. The testing of indoor air and environmental quality and data analysis of the Shandong Women's University library

Referring to *The Sanitary Standards of the Library, Museum, Gallery, Exhibition Hall* (GB 9669-1996), Shandong Women's University library carries out the testing on the indoor temperature, relative humidity, carbon dioxide, formaldehyde and respirable particulate matter etc, and analyses them. The results of testing and analyzing are as shown in table 2.



Table 1. The Sanitary Standards of the Library, Museum, Gallery, Exhibition Hall (GB 9669-1996)

Subjects	Library
Temperature/ °C (airconditioner turned off)	18 ~ 28
Relative humidity/ %	40 ~ 65
Carbon dioxide/ %	<0.10
Formaldehyde/(mg/m ³)	<0.12
Respirable particulate matter(mg/m ³)	<0.15

Table 2. The analysis results of temperature, relative humidity, carbon dioxide, formaldehyde and respirable particulate matter based on experimental data

Site	Temperature (°C)	Relative humidity (%)	Carbon dioxide (%)	Formaldehyde(mg/m ³)	Respirable particulate matter (mg/m ³)	Remarks
The First Reading & Borrowing Room	22	40	0.05	0.02	0.11	Daily Average
The Second Reading & Borrowing Room	23	41	0.04	0.02	0.05	Daily Average
The Third Reading & Borrowing Room	23	36	0.0	0.01	0.11	Daily Average
The Fourth Reading & Borrowing Room	23	38	0.04	0.01	0.07	Daily Average
The Fifth Reading & Borrowing Room	23	37	0.05	0.02	0.04	Daily Average
The Sixth Reading & Borrowing Room	23	38	0.04	0.02	0.04	Daily Average
The Periodicals Reading Room	24	37	0.11	0.03	0.12	Daily Average
The Self-Studying Room	24	38	0.11	0.02	0.12	Daily Average
The Electronic Reading Room	25	36	0.12	0.03	0.06	Daily Average
The self-studying Zone in the hall	23	41	0.08	0.10	0.10	Daily Average
Ring Gallery surrounding the Hall	23	41	0.08	0.11	0.10	Daily Average
Overdated Periodical Reading Room	23	37	0.05	0.01	0.17	Daily Average
Fundamental Stack Room	23	37	0.05	0.01	0.16	Daily Average
Intensive Stack Room	23	36	0.05	0.01	0.16	Daily Average

According to the table2, the indoor temperature of Shandong Women's University completely accords with the indoor temperature standard without air conditioner working. As for the relative humidity simply the First, Second Reading and Borrowing Room, and the self-studying zone conform to its standard while others do not. It could be attributed to the relatively dry weather of the northern area and consequently understandable the comparatively low relative humidity of the indoor air.

According to the table2, the carbon dioxide in the indoor air reaches the standard except for Periodicals Reading Room, Self-studying Room and Electronic Reading Room of Shandong Women's

University. Carbon dioxide in the air of Periodicals Reading Room and Self-Studying Room reached to 0.11%. The relatively higher concentration belongs to air pollution, as here come a number of students to study around 1000 person-time, and the poor ventilation that cases the disadvantage of carbon dioxide emission. The situation in the Electronic Reading Room is 0.12% containing around 110 persons with 130 computers and 7 windows. But less 3 windows will be opening usually which results in the poor condition to the air flow, belonging to air pollution likewise.

According to the table 2, it tells that the indoor formaldehyde is not beyond the standard in Shandong Women's University Library, except for testing tiny formaldehyde in the zone of hall for self-studying and the ring gallery, others' seldom. The leathered sofas are disposed on the halls from the first to fourth floor. A side wall of ring galleries is being decorated the wood based panels. And the walls of hall and stairs were repainted. Therefore, the formaldehyde is thought as the release from leathered sofas, decorating panels and paintings.

According to the table 2, it is obvious shown only over-dated periodicals reading room, Fundamental Stack Room and Intensive Stack Room failed to accord with the standard on respirable particulate matter while the rest reach it. The Over-dated Periodicals Reading Room, Fundamental Stack Room and Intensive Stack Room are places where are being collecting the "antique-rank" books with quite infrequent reading and flowing. As it is continuing reserved, the volatiles will be increasing with it as well as the floating dust on the books' surfaces which are impossible to clean it totally. In the flowing of the air (such as draught, taking books and walking with wind) will float the dust indoors, causing to indoor air pollution.

3. The influence factors in indoor air pollution of college libraries

3.1. Large intensiveness of students and staff

The library in the college is one of the fondest places for college students. It is opened for a long daily time with around 1000 person-time of readers to a normal reading room per day. Because of the high density of students and staff working in the college library, physical bodies of people themselves are the major source of the indoor air pollution. People indoors will emit heat and moisture and expel a large number polluted substance through respiratory tract, skin and sweat gland such as carbon dioxide, virus and bacteria etc... According to research, an adult will generate around 25 liters carbon dioxide per hour, thereof including over 16 poisonous substances; shed skin to every person by metabolism will reach to total 600 thousand per hour with a great deal of bacteria. In walking into the library, the dust outdoors will be brought into the library together [2]. Undoubtedly, the more people in the library, the severer pollution will be.

3.2. Building decoration materials and interior furniture

Libraries are decorated with decorative materials such as flooring, plywood, carpets, coatings, paints, gypsum, and adhesives etc. to release harmful substances such as formaldehyde, benzene, chloride and so on. Furniture used in the production of a variety of plates, adhesives and paints, it will produce toxic and hazardous substances. According to statistics, 73.6% of indoor pollution is caused by interior decoration and 24.3% by the purchase of furniture. If the library ventilation is not good, variety of materials will release the harmful gas superposition, resulting in excessive harmful gas concentration among the indoor air and the damage to physical health.

3.3. Volatiles and dust of books in stack rooms

Because of the current paper books mainly through the ink, lead printing, ink rich in lead, benzene toxic ingredients, many books are too heavy for oil or improper use of ink, and a lot of ink is filled in the air. As Low flow of books with the continuing preservation, the book gradually increased volatiles. The more infrequent those books are flipped, the more volatile will form while taking books, which results in indoor air pollution. As the books' adsorption to the indoor dust, dust is always on the books,

which is hard to clean it out. In air flow the dust will float indoors, leading to the air pollution and effect on physical health [3].

3.4. Bacteria breeding of books in stack rooms

As cellulose, lignin and semi-cellulose basically make up the paper of books, these will offer enough nutrients to bacteria. Mould might have been bred with the warm condition and high humidity. Dust is the transmitter of the mould spores, which will provide the advantage for mould spreading with the high dustiness in the air by the poor sanitary working of the library. There have set up the compact stack rooms in many college libraries where those ancient books lack of circulation are easily parasitic with mites for breeding in a large number. Much of mould will generate poisonous substances with pungent smell by metabolism, causing people's liver, kidney and brain nervous system, but some even will lead to the cancer, damaging on physical health.

3.5. Electromagnetic radiation pollution

With the development of the computer and the network technology, books purchase has been in a relatively small quantity while electronic readings relatively increased. The computer, displayer, typewriter, copier, books monitoring and projector etc are universally applied to library, which of these appliances will produce different wave length and frequencies electromagnetic waves in normal working. According to research by experts, the excessive electromagnetic radiation for a long period time will result in the direct damage on the body's genial system, nervous system and immune system, being the leading precipitating factor of cardiovascular disease, diabetes and cancer mutation. Electromagnetic pollution has been listed in the fourth of the great sources of environmental pollution after water resources, atmosphere and noises by the World health Organization, and become the "invisible killer" of people's physical health. As a result, electromagnetic pollution has become the new threat of indoor environmental pollution of college libraries [4].

4. The prevention methods of indoor air pollution of college libraries

4.1. Selections of environmental protection building materials, decorative materials and furniture

Utilizing the environmental building materials and decorative materials is the crux of retaining the indoor air pollution of libraries. In libraries construction and decoration, it should be in a strict accordance with *Code for Indoor Environmental Pollution Control of Civil Construction Projects* and *Ambient Air Quality Standards* to execute from the sources of materials by selection of unpolluted and harmless decorative materials with environmental protection. In decorative materials and furniture purchasing, it should comply with principles of security, health, comfort and aesthetic appearance. Meantime it is necessary to ensure whether the seller has the ISO9001 international quality certificate and ISO14001 international environmental certificate, and assure the "ten rings" mark on the production. In termination of the library decoration, it had better not be urgent to move in but make ventilation for a couple of times to release fully the hazardous gas in materials. After moving into the new library, it should be keeping in ventilation with more windows opened.

4.2. Maintaining of good ventilation

Ventilation is the optimal mean of preventing and controlling indoor air pollution of libraries. Ventilation has been divided into two ways of natural ventilation and mechanical ventilation. Frequent ventilation indoors in libraries can keep in fresh and clean air. According to research, the air qualities of college libraries that have effectively designed the space for draught are better than that of haven't. Under the circumstance of low wind speed in the morning, indoor air can be reached the sanitary standard 2-8 minutes later if there passes the draught; if there is no this convection, it will take as least 40 minutes.

Many college libraries have adopted the pulling window in order to assure an enough real opening area outside the walls. Sliding windows nearly open flat and the real opening area will be reduced by

40%-50%, so more windows have to be installed on the library's walls. Transoms and skylights are also added available. In addition, shelves should be perpendicular with windows to decrease the wind drag and expedite the air motion.

In the place of people intensiveness, mechanical ventilation system should be used while the natural ventilation cannot meet the requirement. In the author's view, installing intake fans and exhausts fans (or pipes) in an appropriate way will basically meet the requirement for the indoor ventilation.

4.3. The reduction of electromagnetic pollution

Electromagnetic pollution is called the "invisible killer". From current technology levels, it remains difficult to completely eliminate the pollution to the environment from computers. Main approaches to reducing the electromagnetic radiation are as followed: not to use computers for a long time; to keep a certain distance from computers because of the farther from it, the weaker radiation; to purchase the qualified computer and the copier etc productions with the special attention to the graph scope like its security certified marks; not to place the copier in the hall and reading rooms but to the special copying room; to pull the curtains for avoiding the direct exposure of the computer under sunlight; to add a protection screen for the computer etc. The simplest way is to open the door and window or install the exhausts fan to keep ventilation, reducing or eliminating pollution.

4.4. Arrangement for regular disinfection by special staff

Books with bacteria is the main medium that causes the cross infection among readers. To cut the virus and bacteria transmission channel, first of all is to carry out the disinfection to returned books. Currently, disinfection methods by libraries are as followed:

(1) To regularly disinfect with the ultraviolet fluorescent lamps to eliminate bacteria propagules, fungi, mycobacterium tuberculosis etc., and this simple and convenient disinfection method is also economical and practical.

(2) Disinfectant is used for disinfection, such as potassium permanganate solution and 84 disinfectant to be sprayed on where should be disinfected. Wiping the desktop and ground with 500mg / L chlorine disinfectant can help eliminate dust mites, but it should be noticed not to sprinkle directly on the book as chlorine disinfectants cause paper damage.

(3) The air clear bacteria tablets, especially for pneumococcus, influenza virus can eliminate them to the ratio of 100%.

(4) It is available of variety of advanced disinfection equipment, such as electronic disinfection and disinfection cabinet, microwave ovens, paper, microwave insecticide sterilization vehicles.

4.5. The effort to a good job of indoor green building and improvement of indoor environment

Properly placing green plants in the library of not only can properly improve the indoor air quality, but also allows readers to feast for the eyes, feeling the breath of spring. Chlorophyll in green plants absorbs piton of carbon dioxide through photosynthesis and releases oxygen, being carbon dioxide natural consumers. Plants can also absorb the harmful substances in the gas as a nutrient for their own growth within a certain concentration range. As sulfur that is a component of the amino acid of the plant will transform into sulfurous acid and sulfite while being absorbed by the plant, and then into sulphate at a certain rate to form sulfate. Green plants can also purify other harmful gases in the air, such as nitrogen dioxide, carbon monoxide, ozone, lead steam and other heavy metal gases and aldehydes, ketones, ethers, phenol and other carcinogenic substances [5]. Therefore, the growing green plants in the library can reduce benzene in the air, especially from poor print books such as lead, benzene and other harmful substances concentration.

It also need to note too fragrant plant with exaggerating colors, drifting pollen and pests breeding that too strong and hilly, flies flying, insects breeding, smell or smell too thick plants should not be placed in the room. Usually around the reading room door there can be placed upright flowers without

blocking sights and ivy and chlorophytum can be placed on top of the shelves, a few pots of aloe vera, bamboo on the windowsill which can get library ambience changed greatly.

4.6. *Enhancement of sanitary and environmental awareness of readers and staff*

The hygiene and environmental awareness of the staff and the readers and personal sanitary morality can be enhanced through the form of newspaper, column and dissemination of promotional materials by libraries, such as non-smoking, hand washing and changing clothes, etc., which not only enhance the personal physical health, but also improve the indoor air quality of the library. Multimedia reading room staff can stick a health care on the computer table tips to remind the reader to wash their hands, open the window to ventilation, and maintain the line of sight with the computer screen distance.

Besides, staffs working in the library have to often clean dust, keeping hygienic anywhere. In addition to daily hygiene work, it also includes regular general cleaning for fouling; regular cleaning and replacement of the carpet, curtains, regular maintenance, cleaning and disinfection on air conditioning system components and related pipelines, and tuiyere. At the same time, developing the relevant environmental health management system improves the indoor health of the library. The cleanliness of the library is conducive to keeping the indoor air fresh.

5. Conclusion

College libraries as a special public places, it is not only a cultural heritage center, the ideological exchange center and knowledge service center, but also one of the three pillars of the college, the second classroom and spiritual civilization construction window for students. The library is a place where college students are more intensive and long residence time. The indoor air quality in the library will directly affect the reading effect and physical health of teachers and students in colleges and universities, and indirectly affect the quality and level of library services. Library indoor air pollution with prevention and control is a comprehensive project, the college library should actively study and take relevant measures to strengthen management, regular disinfection, prevention and control of indoor air pollution, and regularly monitor the air quality, to find out the problem in time and resolve it, constructing the green and low-carbon library.

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