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To cite this article: Xiaoxiang Li *et al* 2019 *IOP Conf. Ser.: Earth Environ. Sci.* **300** 032017

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Common Air Pollutants and Their Prevention in Digital Archives

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Abstract. The long-term preservation and utilization of archives make them vulnerable to harmful substances, reducing the storage and service life of archives. Meanwhile, these harmful substances are released into the air, which poses a threat to the health and safety of archivists. This paper analyzes the common air pollutants in the digital archives and proposes some solutions.

1. Introduction

Archives are historical records formed directly. Therefore, during the long-term preservation and utilization of archives, one important reason for the decay of archives is that they are harmed by harmful gases and organisms. For instance, sulfur dioxide can corrode paper through destroying its mechanical strength, and can also discolor writing materials with poor acid stability in varying degrees; harmful microorganisms such as molds can produce acidic substances which will make paper covered by bacterial plaque and become yellow and brittle. When archival materials are moldy, they will give off an unpleasant smell.

2. Main Types of Air Pollutants in Archives

According to relevant data, the concentration of indoor air pollutants is 5-10 times higher than that of outdoor air pollutants, and there are more than 500 indoor air pollutants. Due to the internal requirements, such as air tightness, light protection, and moisture resistance, the air mobility in the archive is very poor, so harmful substances are easily generated and accumulated. There are various types of pollutants in the air in the archive [1]. These pollutants are derived from various sources, including decoration materials of the archive and the aging of the archive carriers, which not only affects the security of archival information, but also threatens the health of archivists.

2.1. Formaldehyde

Formaldehyde is a volatile organic compound that is colorless at room temperature, has a spicy pungent odor, and is easily soluble in water [2]. Due to the construction of digital archives in recent years, many archives have been expanded or redecorated. Many building and decorative materials as well as office furniture will release a large amount of formaldehyde. The volatilization rate of formaldehydes is related to room temperature. The higher the temperature is, the more easily formaldehyde will volatilize, which



means the concentration of formaldehyde in the room will decrease more quickly. In contrast, formaldehyde is not easy to volatilize at a low temperature.

On October 27, 2017, the list of carcinogens released by the WHO's International Agency for Research on Cancer classified formaldehyde into A-class of carcinogens. When the indoor concentration of formaldehyde reaches a certain degree, people feel uncomfortable. In a short time, formaldehyde with a concentration greater than 0.08 mg/m^3 can cause pinkeye, eye itching, throat sore or pain, hoarseness, sneezing, chest distress, wheezing, dermatitis, etc. In addition, the release cycle of formaldehyde is up to 15 years [3]. Formaldehyde can be inhaled through the respiratory tract. Formaldehyde has long-term and latent harm to the human body. Long-term inhalation of formaldehyde can cause serious diseases.

2.2. Ozone

Ozone is extremely irritating. As a volatile substance, ozone is one of the main pollutants in indoor and outdoor air, and one of the strongest known oxidants. In the construction of digital archives, new equipment such as copiers, scanners and disinfection cabinets will produce ozone during use.

With strong oxidizability, ozone can react with all organic materials, which can be harmful to archives and cause a significant drop in paper folding endurance. When archival materials are exposed to harmful gases such as ozone for a long time, the discoloration of paper can be visible to the naked eyes[4]. Ozone is the most common hazardous gas, and is also harmful to the human body. It can not only stimulate and damage the respiratory tract, but also damage the central nervous system. Besides, it can irritate the eyes, reducing visual sensitivity and vision.

2.3. Radioactive Radon Gas

Radon gas is a radioactive inert gas. Its fundamental source is the huge amounts of radium contained in the soil of some areas. If a house is constructed with the bricks made of the clays or ores containing radium, radon gas can enter the room from the pores such as ground and wall cracks. The radon gas in the room can continuously decay into a series of solid radiators which are adsorbed on the aerosol particles. After the human body breathes the air containing radon or drinks the water containing radon, the internal exposure to radiation can cause diseases.

2.4. Fungi

Among various fungi, molds are the main factor harms archival materials. Molds are extensively distributed and exist in various environments and organisms. Microorganisms in indoor air are mainly produced by air exchange and human activities. For example, filters and pipes of air-conditioning systems are breeding grounds for molds and other microorganisms; archival materials, archives containers and repair tools will also produce molds when relative humidity is high. Due to morphological structure and other characteristics, mold spores are easy to fly in the air.

Molds can decompose the cellulose in paper archival materials, and meanwhile contaminate paper. Large amounts of molds will cause paper adhesion[5]. The moldy odor emitted by molds during the growth process has adverse effects on both indoor air quality and human health, leading to allergic diseases such as skin infections and rhinitis.

2.5. PM_{2.5} and PM₁₀

PM_{2.5} is also known as fine particulate matter. Fine particulate matter refers to particulate matter with a diameter of 2.5 microns or less in ambient air, and can suspend in the air for a long time. PM₁₀, also known as inhalable particulate matter, usually refers to particulate matter with a diameter below 10 microns. These dust particles are mainly derived from the dust generated during the production process, the traffic dust, the wind-blown dust, etc. When the outdoor particulate matter and the particulate matter in the return air enter the archives with air flow and human activities, the concentration of particulate matter will increase, polluting the air in the archives.

Dust particles are featured with irregular shapes, which will increase the mechanical wear of archival materials and affect the reading of archival information. In addition, due to their acidity or alkalinity,

dust particles will increase the acidity of archival paper and accelerate the aging of archival materials. A variety of pathogenic microorganisms and toxic chemical components attached to dust particles can go through the respiratory tract and deposit in the alveoli, harming the human body. Chronic respiratory tract inflammation and other diseases are significantly related to the pollution degree of dust particles in the air.

3. Prevention and Solutions

According to several common air pollutants, preventive work can be done from the following aspects:

3.1. Reasonable Selection of Site and Building Materials of Archives

First of all, reasonable consideration should be given to the site of the archive. Under the premise of ensuring the application and safety of the archive, the site of the archive should meet the principle of staying away from industrial polluted areas, rivers and ponds, and areas where natural disasters frequently occur[6]. The archive buildings should focus on ventilation, avoid east-west direction and prevent long-time exposure to the sun. The building structure should be moisture-proof and heat-proof, and the building materials and archives containers should be green, non-toxic and harmless. After the completion of the archive, attention should be paid to the greening of the surrounding environment, and the green coverage rate around the archive should be increased as much as possible. Green plants not only can absorb harmful gases such as sulfur dioxide and chlorine, but also can filter dust particles.

3.2. Strengthening Air Filtration and Ventilation

The archive is constructed in an enclosed space. Therefore, the archive should be ventilated regularly and timely to keep the indoor air fresh. If the conditions allow, the mechanical ventilation system and the appropriate air cleaner can be installed in the archive to ensure ventilation, purify the indoor air, remove dust particles and reduce the accumulation of harmful gases.

3.3. Controlling the Temperature and Humidity in the Archive

The temperature and humidity in the archive have a great impact on the preservation of materials. The archives can be well protected under the temperature of 14°C~20°C and the relative humidity of 50%~60% [7,8]. The large fluctuation range of temperature and humidity in the archive will cause mold growth, paper damage, and fading of characters. Therefore, the temperature and humidity in the archive must be maintained within a relatively stable range. Under normal circumstances, reasonable ventilation is conducive to maintaining normal temperature and humidity. In addition, an automatic temperature and humidity control system can be installed in the archive if the conditions allow.

4. Conclusion

The air pollutants of the archive are derived from various sources. Failure to carry out reasonable treatment and prevention will not only harm archival materials, but also adversely affect the relevant staff of the archive. The current detection and treatment technologies for air pollution are relatively comprehensive. As long as reasonable prevention is carried out, the air pollution in the archive can be minimized or even avoided.

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