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Research Progress of Indoor Formaldehyde Removal

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Abstract

With the development of economy and the improvement of living standard, indoor pollution has attracted more and more attention. Formaldehyde, known as the number one "killer" of indoor pollution, is one of the most serious and common pollutants in indoor air pollution, so it should be paid special attention to and studied. Present in this paper, the indoor formaldehyde pollution were summarized, for indoor formaldehyde in physical method, chemical method and biological method, various methods of coupling and in recent years at home and abroad about the research progress of formaldehyde removal techniques of horizontal comparison and induction, the existing research progress is summarized, and for our country after the related research is discussed.

Keywords

Indoor, formaldehyde, removal.

1. Introduction

Since modern times, people have paid great attention to the outdoor pollution problem, especially the discussion of haze once reached the peak, but according to statistics, people spend only 8% of their time outdoors on average every day, and generally no more than two hours. And most of the time in the indoor, indoor pollution is more terrible than outdoor, and indoor pollutants in the most deadly killer is formaldehyde. Formaldehyde is the most common and serious pollutant. The synthetic board that interior decorates the board that USES, be like plywood, joiner board, high school density board, particleboard, the formaldehyde in these board has the effect of glue agent, antiseptic, basically use at the hardness that strengthens board, prevent insect, anticorrosion. The formaldehyde that remains in the plate and does not participate in the reaction is released to the surrounding environment gradually, it is the main body that forms formaldehyde in indoor air [1].

2. The Harm of Formaldehyde

Formaldehyde has been identified by the world health organization as a class of carcinogens, short time effect is mainly stimulation, sensitization, long-term exposure to carcinogenic effect. The stimulating effect of formaldehyde is mainly manifested in the stimulation of skin and mucous membrane. Formaldehyde can be combined with proteins. When inhaled in high concentration, there may be respiratory tract irritation, edema and headache. Long-term exposure to low doses of formaldehyde can cause chronic respiratory diseases, nasopharyngeal cancer, colon cancer, brain tumors, menstrual disorders. Especially young people must pay special attention to, because young people's resistance is poor, it is easy to cause chromosome abnormalities, leukemia, etc.; Formaldehyde has mutational effect, high concentration of formaldehyde is a kind of gene poison, high concentration of formaldehyde inhalation can cause nasopharyngeal tumor. We especially want to remind children and pregnant women, they are more sensitive to formaldehyde than normal people, the harm is also greater, pregnant women

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long-term inhalation may lead to birth defects, and even death. Men long-term inhalation can lead to sperm abnormalities, death, sexual function decline, and serious can also lead to leukemia, pneumothorax, reproductive capacity loss [1].

3. Physical Removal Method

3.1. Natural Ventilation

In the daily removal of indoor formaldehyde method, ventilation is the most simple method. This method is simple and convenient to operate, but can not solve the problem from the source, the efficiency is very low, only suitable for formaldehyde concentration is not high indoor, the cycle is still very long [1].

3.2. Air Displacer

Air ventilation device is in the case that does not need to open a window, 24 hours to maintain the content of formaldehyde in the air within the range that does not affect human health, so that formaldehyde gas can not constitute pollution to indoor air. The principle is to continuously exhaust the indoor air to the outdoor, and then use the same principle to send the fresh outdoor air through the filter to the indoor. In the United States and other developed countries this device is used more commonly, is the domestic interior in recent years to promote the intelligent home system is an important component. However, the main reason why most people in China have not accepted the device is that it needs to be kept on at all times when it is used, which is relatively high in cost and high in long-term use.

4. Physical Adsorption Method

Physical adsorption method can avoid the disadvantages of ventilation and ventilation method, and achieve continuous indoor formaldehyde removal.

4.1. Filtration and Purification Method

Different types of filtration materials can be used to remove particles with different particle sizes from the air. Synthetic fiber filter material is not resistant to oil mist and moisture, and its performance is unstable. Cellulose filter material is easy to burn and its use is limited. HEPA filter material made of fiberglass is a new filter material developed in the 1980s, which can effectively trap inhalable particles, smoke, dust and bacteria above 0.3 meters. The filter efficiency, airflow resistance, strength and other performance indicators have been greatly improved, and high temperature resistance, corrosion resistance, waterproof, mildew [1].

4.2. Chemisorption Method

The method is to pass the polluted air through the adsorbent layer, so that the pollutants can be absorbed to achieve the purpose of purifying the air. The commonly used adsorbents are porous carbon material, activated carbon fiber, new activated carbon, zeolite, silica gel, molecular sieve, porous clay ore and activated alumina, etc. These adsorbents not only have a large specific surface area, but also have a suitable pore size distribution. Although the adsorption method is simple and easy to popularize, it can only temporarily absorb a small number of pollutant particles. When the temperature, humidity and wind speed rise to a certain extent, the adsorptive pollutant particles may free out and re-enter the air, causing secondary pollution. Moreover, the adsorbent has a state of adsorption saturation and needs to be replaced regularly, so it is not very convenient to use it in practice.

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5. Chemical Removal of Formaldehyde

The chemical method can not only remove formaldehyde efficiently, but also quickly transform the indoor excessive formaldehyde into non-toxic substances or substances with very low toxicity through chemical reaction, which truly realizes the efficient removal of indoor formaldehyde.

5.1. Inorganic Ammonium Salt and Sulfuric Acid (Hydrogen) Salt

Because ammonium salt solution contains NH3, it can form hexamethylenetetramine with formaldehyde, while sulfite ions in sulfite solution can easily form precipitation with formaldehyde. Even if the concentration of sulfite is very low, it can react with formaldehyde well, so as to achieve the purpose of removal [2]. Nebeking et al. used a solution with a pH value of 4 ~ 5, containing $(NH_4)_2 SO_4$ 2%~20% to absorb formaldehyde from industrial waste gas to form hexamethylenetetramine, and at the same time added NH_4OH to supplement NH_4^+ and control the pH value of the solution [3]. Lundquist found that aqueous solutions containing sodium metasulfite had a removal rate of over 95% for formaldehyde at low concentration, which is an economical and effective method for formaldehyde removal [4]. Ishida et al. believe that alcohols can be added to ammonium salt or sulfite solution or mixed with ammonium salt and sulfite to improve the absorption of gaseous formaldehyde by NH_4OH, sulfite or bisulfite solutions [5].

5.2. Organic Nitrogenous Compounds Or Polymers

Timely This kind of reagent is the most commonly used, is also the study more aldehydes material absorption agent, mainly has: urea and its derivative, hydrazine, melamine, dicyandiamide, saturated ring secondary amine, the combination of carbonyl primary amine or secondary amine, aniline and its derivative, contains the amino acid polymer and so on. The research group of Mitsui Toatsu Chemical inc. used urea or its derivatives to remove formaldehyde from the air at 20 ℃ under acidic conditions, which was considered to be very effective [6]. Yoshino used granular activated white clay, Al_2O_3, diatomite, porous ion-exchange resin or activated carbon to soak hydrazine sulfate or hydrazine hydrochloride as adsorbents to remove formaldehyde from the air [7]. Gesser et al., using a mixture of polyethylene imine and glycerol solution daub on the glass fiber to remove the formaldehyde in air, can make a day after the formaldehyde in indoor air volume fraction from (0. 06-0.10) x 10^{-6} to 0.001 x 10^{-6}, glycerol in the mixed solution can prevent the polyethylene imine hardening, so that polyethyleneimine long-term effective trap low concentration of formaldehyde in indoor air [8].

5.3. Other Compounds

Gaylord adsorbs at least one water-soluble polyhydroxy polymer on a solid substrate to remove formaldehyde from the gas phase at ambient humidity. Horiki et al. used sulfomethylated or subsulfomethylated polyhydroxyphenol monomer solution as an absorbent of formaldehyde, which was highly stable. Inoue et al. used porous sepiolite impregnated vitamins as adsorbents, which can effectively remove aldehydes released from building materials and coatings, especially formaldehyde and acetaldehyde. Takagaki et al. found that the catechins extracted from green tea had an excellent effect as formaldehyde absorbent in the air [9,10].

5.4. Photocatalytic Oxidation to Remove Formaldehyde

Under the irradiation of ultraviolet light, the photocatalyst will produce hydroxyl radical on the surface. This free radical has super oxidation, which can directly oxidize the formaldehyde in the indoor air into tasteless and non-toxic substances, and will not cause secondary pollution. Wang shan et al. studied two methods of indoor photocatalytic removal of formaldehyde by ACF supported TiO_2 photocatalysis. They found that the removal rate could reach 65.5% when

ultraviolet light was added to formaldehyde by ozone control method, and 61.2% when ultraviolet light was added to water vapor control method [11].

6. Physical Adsorption Is Combined with Chemical Reaction

In order to achieve more efficient long-term anti-formaldehyde effect, the coating formula is often used in combination with physical adsorption and chemical reaction. For example, bamboo charcoal and anti-formaldehyde emulsion can be used together to enrich formaldehyde in the air into the coating through physical adsorption and promote its irreversible chemical reaction with the active hydrogen and other chemical structures in the coating, so as to achieve a more effective effect of reducing formaldehyde concentration.

7. Air Negative Ion Technology

The method USES a certain concentration of air negative ions to purify the air and disinfect it. Air anion is called the "vitamin" in the air, through its charge action, can effectively inhibit and sterilize, so that the pollutants in the air are effectively removed. A rare mineral stone with obvious thermoelectric and piezoelectric effects is used as the raw material, which is added to the wall material. After decoration and painting, the material will ionize the air and water in the air in contact with the air and generate negative ions. The material can polarize and discharge outward to purify the indoor air [12]. Jiang yao-ting et al [13]. reported that the concentration of suspended particles, total bacteria and formaldehyde in indoor air was significantly reduced when artificial negative ions were used for 2 h.

8. Biological Removal of Formaldehyde

Comparing physical formaldehyde removal method and chemical formaldehyde removal method, it can be found that biological formaldehyde removal method not only does not produce secondary pollution, but also has high removal efficiency. In today's era of strict control of environmental protection, more environmental protection and economic formaldehyde removal method. And biological purify formaldehyde method is pure natural, basically use the plant of nature and the action such as microbial absorption, degradation to achieve purify indoor formaldehyde purpose. The biological formaldehyde removal method mainly includes pot plant absorption method and microbial degradation method [14].

8.1. Pot Plant Absorption

Use potted plants for the removal of indoor formaldehyde, this tradition has a long history, scientific research has confirmed that the potted plants for the removal of indoor formaldehyde does exist a certain effect, in this respect at home and abroad in recent years research more some, research suggests that within 24 hours of lighting conditions, aloe can destroy 90% of formaldehyde in 1 cubic meter of air, tequila can devour 70% 50% of benzene and formaldehyde, vertical can absorb 96% of carbon monoxide and 86% of formaldehyde; Chlorophora, aloe, spider orchid and huwei orchid can remove formaldehyde. The bedroom of 15 square metre, plant two huwei orchid or spider orchid can maintain air pure and fresh, do not suffer the harm of formaldehyde, and the study still discovers potting soil also has the action that absorbs formaldehyde, soil absorbs formaldehyde, the microorganism that can decompose formaldehyde is had in the rhizosphere of the plant [15, 16].

8.2. Microbial Degradation Method

The method of microbial degradation is also applied to the removal of indoor formaldehyde, because formaldehyde can be partially metabolized and degraded by some microorganisms. The principle of the removal of indoor formaldehyde by microorganisms is to use the

metabolism of microorganisms to degrade indoor formaldehyde into harmless and non-toxic water and carbon dioxide, so as to achieve the purpose of removing indoor formaldehyde. But only some specific microbes have the ability to remove formaldehyde. After studying, zhang wei et al. found that a natural biological filter can be obtained to remove indoor formaldehyde by taking this microorganism as the basis, and it has a good effect on high, medium and low concentrations of formaldehyde. There are also microorganisms in the formaldehyde oxidase for the removal of formaldehyde also has a good effect. However, due to the imperfect mechanism of formaldehyde removal by microbial degradation, it still needs the unremitting efforts of all researchers. General microbial degradation method is not used alone, but in conjunction with pot plant absorption method, while ensuring the removal of formaldehyde and environmental protection [17, 18].

9. Conclusion and Prospect

Understand the advantages and disadvantages, efficiency and economy of each method. In the face of various air purification methods, air purification agents and air purification devices on the market, reasonable and economical purification strategies should be selected according to the actual conditions of the space that need purification, such as temperature, humidity, formaldehyde emission and industrial process requirements. The efficiency of the integrated purification method combining physics and chemistry is ideal. Formaldehyde emission is a long-term process, first of all try to formaldehyde emission from the root to solve the problem, strict control of all sorts of plank, leather, in the adornment material such as formaldehyde content, at the same time in the ventilation and air conditioning system design should fully consider optimization method, in view of the long-term formaldehyde release and adopt comprehensive and stable governance approach, test content in the exhaust air and the secondary return air to the secondary filter measures to remove may produce secondary pollution, and a variety of purification process of adsorption of contaminants in the dust.

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