STUDY ON STATIC ADSORPTION CHARACTERISTICS OF A NEW REDUCED GRAPHENE OXIDE AIR FILTER MATERIAL FOR VOLATILE FORMALDEHYDE FROM GLUE

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Abstract.Formaldehyde is one of the main indoor pollutants, and living in an environment with formaldehyde for a long time can cause serious damage to the human body. In this paper, non-woven fabrics and new reduced graphene oxide air filter materials were used to perform static adsorption tests on formaldehyde volatilized from glue. The results show that the new reduced graphene oxide air filter material has good formaldehyde adsorption performance, and the adsorption saturation of this material is as long as 4 hours, which is twice that of F6 non-woven fabric. Within 4 hours, the formaldehyde removal efficiency of the new reduced graphene oxide air filter material and F6 non-woven fabric were 15.4% and 2.9%, respectively, and the formaldehyde adsorption was $0.81 \cdot 10^{-3}$mg and $4.32 \cdot 10^{-3}$mg, respectively, and the removal efficiency was improved5.9 times. This paper provides reference and reference value for the adsorption performance of new composite air filter materials on harmful gas pollutants.

Keywords. Formaldehyde,Glue,Static adsorption,Adsorption performance

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1.Introduction

With the development of society and economy, people gradually pay more attention to a series of indoor environmental pollution problems caused by air pollution. Formaldehyde is one of the main indoor pollutants, living in that environment polluted by formaldehyde for a long time could directly lead to respiratory diseases[1], even damage human DNA and induce nasopharyngeal carcinoma and leukemia[2-4]. Therefore, it is significant to reduce indoor formaldehyde concentration for improving indoor air quality, and create a healthy indoor environment.

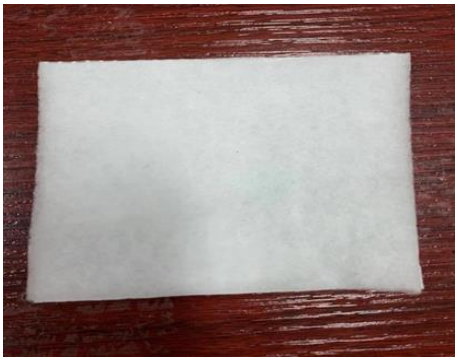
As a derivative of graphene, graphene oxide has large specific surface area and good chemical stability [5-7]. There are large number of functional groups on the surface and edge of graphene oxide [8], which had good adsorption performance for formaldehyde. However, the graphene oxide material is not easy to adhere to the surface of the non-woven fabric. The reduction treatment of graphene oxide by a reducing agent can improve the stability of the modified material. There are relatively few reports on using of reduced graphite oxide to modify air filter material for removing formaldehyde. Therefore, the development of a new type of air filter material is worth investigating.

The adsorption performance of the new reduced graphene oxide air filter material and F6 non-woven fabric on low concentration of formaldehyde was tested and analyzed in this paper. It provided data support and reference for new multifunctional air filter materials.

2.Materials and experiments

2.1 Experimental materials

The experimental materials are shown in the Figure1：



(a) non-woven fabric

(b) new reduced graphene oxide air filter material

Figure1. Physical map of experimental materials

2.2 Formaldehyde adsorption experiment

The effect of material modification before and after on formaldehyde adsorption: formaldehyde static adsorption test bench as shown in Figure 3,using glue, pour 20g white emulsion into the flat dish and turn on the fan under the condition that the indoor temperature is 20 ℃.1 hour later, the concentration of formaldehyde in the box reached equilibrium and stability, close the fan, open the Take-off port, remove the flat dish from the box, and hang the material to be tested in the box, and the Take-off port was closed, and this moment was taken as the starting point of timing, and the concentration of formaldehyde in the box was measured every hour.The UK PPM formaldehyde detector was used to measure the concentration of formaldehyde. The range was

0~10ppm, and the resolution was 0.01ppm; JK-002 thermostatic heating plate, and the range was 30~270℃. Acrylic box, and the volume was 0.027m^3. The side length of test sample was 7 * 7cm. The pollution source was glue using environmentally friendly white latex.

In order to eliminate the influences of the instrument, the original group experiment was added to this experiment. The experimental system was shown in Figure 2.

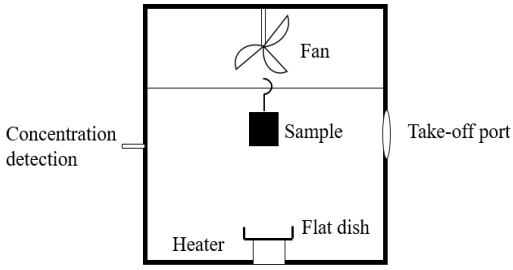


Fig. 2 Experiment system

2.3 Performance parameter representation

The experiment takes formaldehyde as the main treatment object and introduces the formaldehyde removal rate with reference to GB / T 26900-2011 to represent the removal effect of pollutants in the environment. The main feature of this index is to avoid the impact of different initial concentrations of pollutants on the removal effect.

The calculation formulas of formaldehyde removal rate and formaldehyde adsorption capacity were obtained as follows[9]:

$$D=[C_0-C_t)-(C'_0-C'_t)]/C_0 \quad (1)$$

$$M=[C_0-C_t)-(C'_0-C'_t)]\cdot V \quad (2)$$

Where, C_0 is the initial formaldehyde concentration of non-woven fabric group or new reduced graphene oxide air filter material group. C_t is the formaldehyde concentration of non-woven fabric group or new reduced graphene oxide air filter material group at a certain time. C'_0 is the initial concentration of formaldehyde in the original group. C'_t is the formaldehyde concentration of the original group at a certain time. V is box volume .

3.Results and Discussion

3.1 Adsorption Performance

The adsorption performances of new reduced graphene oxide air filter material and non-woven fabric on formaldehyde were shown in Figure 3，

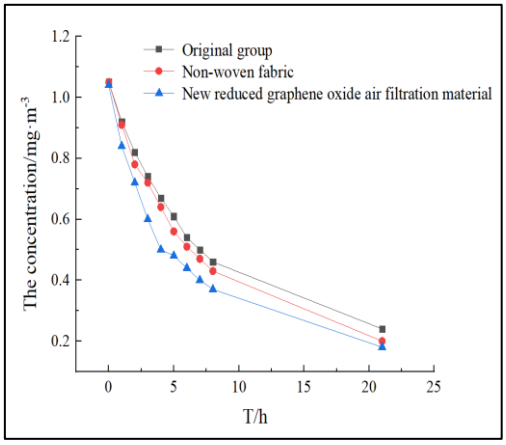


Fig. 3 Effect of adsorption time on formaldehyde adsorption effect

Compared with the untreated non-woven fabric, the new reduced graphene oxide air filter material had excellent adsorption performance from the Figure 3. In the first 2 hours, the drop rate of formaldehyde concentration in the non-woven group was higher than the original group, indicating that the untreated non-woven fabric also had a certain adsorption capacity for formaldehyde.But after two hours, the decreased rates of the non-woven group and the original group basically converged, probably because the non-woven fabric had reached saturation of formaldehyde adsorption. The new composite air filter material group in the first four hours of the formaldehyde concentration decreased rates were significantly higher than the non-woven group and the original group. Four hours later the new composite air filter material group formaldehyde concentration decreased rate and the original group tends to be

the same, it shows that the adsorption of this material to formaldehyde is close to saturation.

In the first 4 hours, when using non-woven fabric, the concentration in the box decreased from 1.05 mg/m^3 to 0.64 g/m^3, when using the new reduced graphene oxide air filter material, the concentration of formaldehyde in the box decreased from 1.04 mg/m^3 to 0.5 mg /m^3, according to formulas (1) and (2), the formaldehyde removal rates of the non-woven fabric group and the new reduced graphene oxide air filter material group at the 4th hour were 2.9% and 15.4%, respectively, and the formaldehyde adsorption capacity was $0.81\cdot10^{-3}$mg and$4.32\cdot10^{-3}$mg, the formaldehyde adsorption of the new reduced graphene oxide air filter material group increased by 5.9 times.

Conclusion

1. The adsorption capacity of the new reduced graphene oxide air filter material for formaldehyde was tested by static adsorption experiments, which showed a significant improvement compared with the untreated non-woven fabric.

2. Under the conditions of volatilization temperature of 20℃, and the adsorption time of 4 hours, the adsorption capacity of non-woven fabric and new reduced graphene oxide air filter material for formaldehyde was $0.81\cdot10^{-3}$mg and $4.32\cdot10^{-3}$mg, respectively. The adsorption capacity of formaldehyde in new reduced graphene oxide air filter material group was increased by 5.9 times.

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