

A Comparison of Absorption Efficiency of Absorbents to find more suitable Material for Analysis of Tritium in the Air

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1. Introduction

As a low-energy beta emitter, most of tritium exists in the form of water vapor in the air. So, to analyze the concentration of tritium in the air, tritium must be extracted from moisture of the air. In order to capture moisture contained in the air, an absorbent must be used.

When a certain amount of air passes through the absorbent, the adsorbent captures moisture. This absorbent is used as the analysis sample. In order to get pure water that contains HTO, the sampled adsorbent is distilled.

Widely used adsorbents for the H-3 analysis are silica gel, zeolite, etc. However, silica gel has the disadvantage that its strength decreases when it absorbs a large amount of moisture. And it is also not easy to process the pre-handling and after use. Zeolite is excellent as a porous material, so it has strong absorption properties. But this has the disadvantage of slow molecular movement. [1]

Therefore, a more efficient absorbent that could be replaced the existing absorbent was searched, and an experiment was studied to determine whether the natural pulp (paper) adsorbent was effective as a material absorbing moisture from the air.

Paper absorbent is a natural ingredient and is harmless to the human body. It also has the advantage of being easy to process of pre-handling and not changing its properties or shape even when it absorbs moisture. In this paper, it was determined based on the characteristics of paper adsorbents whether paper adsorbents are suitable as a material that absorbs moisture from the air.

For this purpose, the moisture absorption efficiency of silica gel and natural paper adsorbents was compared.



Figure 1. Silica gel and paper absorbent

2. Methods and Results

2.1 Method and Experiment

The experimental sequence to check the moisture absorption efficiency of between silica gel and paper absorbent is as follows.

Step1. Before the experiment, measure the weight of silica gel and paper absorbent and also measure the weight of the water filled in the humidifier.

Step2. Fill each drying tube with silica gel and paper absorbent. At this time, the paper absorbent is cut into small pieces to fill the drying tube.

Step3. Connect the drying tube filled with adsorbent between the humidifier and the flow pump. The flow pump is connected to the drying tube for smooth humidification. In order to match the measurement conditions, control the humidification amount, humidification time, and air flow rate of flow pump identically.

Step4. When experiment is complete, it measures the weight of the adsorbent and the water remaining in the humidifier. The humidifier was filled with the same amount of water, and the humidification rate was set to 70 ml/h. A flow rate of an air flow pump was set to 6 LPM and experiment time is for 1 hour for each experiment. Figure 2 is a schematic diagram for the experiment. The moisture absorption efficiency of each adsorbent is calculated as Equation 1.

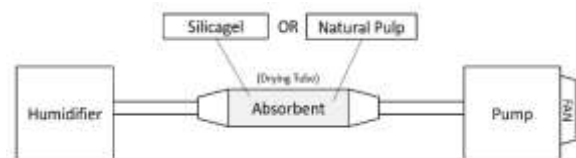


Figure 2. Experiment schematic diagram

$$eff = \frac{Absor(1h_{mass} - initial_{mass})}{Water(initial_{mass} - 1h_{mass})} \times 100 - (eq1.)$$

where Absor_{initial}_{mass}: Absorbent weight before humidification.
Absor_{1h}_{mass}: Absorbent weight after 1 hour of humidification
Water_{initial}_{mass}: Water weight before humidification
Water_{1h}_{mass}: Water weight after 1 hour of humidification

2.2 Results

The change of weight was confirmed for each absorbent before and after humidification, and the results of measuring the weight of the sample are summarized in Table 1.

Table 1. The weight change of silica gel and paper absorbent before and after humidification

Measuring Condition	Silica gel		Paper absorbent	
	Before	After	Before	After
Absorbent	19.29g	24.48g	7.24g	17.55g
Water	466g	448g	466g	450g

Using silica gel, the absorption amount was 5.19 g and the humidification amount of 18 g. In case of paper absorbent experiment, there was a weight change of 10.31 g for the paper, and there was a change of 16 g for water of humidifier. The amount of water weight change (a) before and after humidification is the amount of water that passed through the drying tube filled with each adsorbent during humidification. And the weight change of each adsorbent (b) before and after humidification is the difference in weight changed as the silica gel and paper adsorbent absorb the amount (a) of water supplied to the drying tube. As a result of comparing the moisture absorption amount and water weight change of each adsorbent before and after humidification, it was confirmed that the paper adsorbent had a higher moisture absorption amount.

Based on the measurement results, the moisture absorption efficiency of the silica gel and paper adsorbent was calculated using Equation 1. As a result of the calculation, the moisture absorption efficiency was 28.82% for silica gel and 64.43% for paper absorbent.

Therefore, it was confirmed that the moisture absorption efficiency of the paper adsorbent was approximately 2.23 times higher.

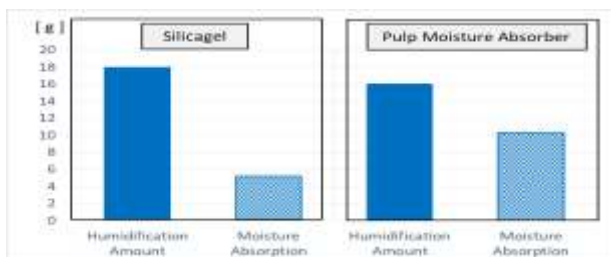


Figure 3. Comparison of weight change before and after humidification for each adsorbent

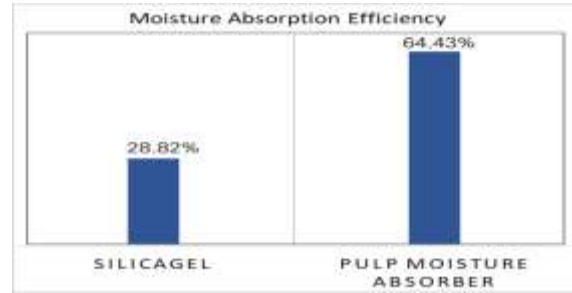


Figure 4. Moisture absorption efficiency of silica gel and paper absorbent

3. Conclusions

To analyze tritium contained in the air, an absorbent is required to absorb moisture in the air. Absorbents such as silica gel or zeolite, which are currently widely used, have some disadvantage which is weak hardness, easily damaged by impact and are not easy to process.

In addition, caution is required when handling and disposing of it because silica gel contains hazardous substances depending on the type. In case of zeolite, there are no harmful ingredient. But the diffusion rate of adsorbed substances is slow because its microstructure is small. In order to overcome these disadvantages, substitute materials were searched. The first requirement for a desiccant is what has excellent adsorption properties. And second, the tritium extraction rate from the absorbent must be high. As a result of the search, paper absorbent was selected as a substitute material [2]. Because paper absorbent is made from natural pulp as its main raw material, it is harmless to the human body. It is easy to process and causes almost no damage from external impacts. In this paper, an experiment was conducted to compare the moisture absorption efficiency of silica gel and paper absorbent. As a result of the experiment, the moisture absorption efficiency of the paper absorbent was more than twice that of silica gel.

We will check the extraction rate of tritium using a paper adsorbent and determine whether it can be replaced as an adsorbent for analyzing tritium in the air. [3]

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