

## Effect of adsorbent layer height on instantaneous adsorption capacity

Animesh Pal<sup>1,2</sup>, Kyaw Thu<sup>1,2</sup>, Bidyut Baran Saha<sup>2,3</sup>

<sup>1</sup>*Kyushu University Program for Leading Graduate School, Green Asia Education Center, Interdisciplinary Graduate School of Engineering Sciences, Kyushu University, Japan*

<sup>2</sup>*International Institute for Carbon-Neutral Energy Research, Kyushu University, Japan*

<sup>3</sup>*Mechanical Engineering Department, Kyushu University, Japan*

### Abstract

This study experimentally investigates the effect of adsorbent layer height on adsorption capacity rate of ethanol onto activated carbon (AC) based consolidated adsorbents. Consolidated adsorbents have been prepared using polyvinyl alcohol (PVA) (10 wt%) and 90 wt% Maxsorb III (AC). Apparent packing density of consolidated AC adsorbents is kept nearly constant by changing the height and mass percentages of AC and PVA. Two different heights adsorbent have been prepared to investigate the instantaneous adsorption capacity variation. Instantaneous adsorption experiment are conducted at various evaporator pressures and adsorption temperature at 30°C using magnetic suspension adsorption measurement unit. It is found that there is no significant difference in equilibrium adsorption capacity. However, significant difference of instantaneous adsorption capacity between two different heights of same composition consolidated AC has been observed.

### 1. Introduction

Consolidated composite adsorbents have attracted great attention as next generation adsorbents in adsorption heat pump (AHP) application because of their some salient features, such as improved uptake to volume ratio and high thermal conductivity [1]. Distinguished researchers have been employed a number of binding material such as expanded graphite [2], polyvinyl alcohol (PVA) [1], polytetrafluoroethylene (PTFE) [3], polyvinylpyrrolidone (PVP) [4] to synthesis composites with good thermal conductivity and high volumetric adsorption capacity. However, literatures review indicated that still composite adsorbents are not much efficient as expected and there is a dearth of accurate data on the adsorption characteristics of refrigerant onto consolidated composite adsorbents. Among various characteristics, instantaneous adsorption capacity is one of key characteristics of adsorbent, which is necessary to know the actual cycle performance of AHP system.

Consequently, the motivation of this study is to investigate the effect of adsorbent layer height on instantaneous adsorption capacity of ethanol onto activated carbon (AC) based

consolidated adsorbents. Instantaneous adsorption capacity are measured gravimetrically at various evaporator pressures and adsorption temperature at 30°C using magnetic suspension adsorption measurement unit.

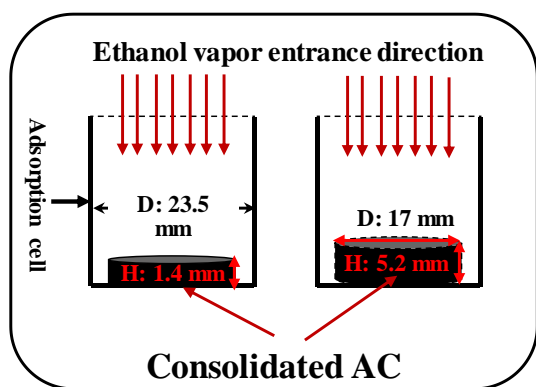
### 2. Experiments

#### 2.1. Synthesis of consolidated AC

Consolidated AC adsorbents have been prepared by mixing of Maxsorb III (AC) and binder (PVA)-water solution with certain ratios. The process can be explained as follows; firstly, Maxsorb III are dried in the oven at 120 °C. Secondly, granular type polyvinyl alcohol (PVA) used as a binding material put into the water for 1 hour to make solution. After that dried Maxsorb III is added to the water-binder solution and compressed using pressing machine at 10 MPa. Finally, the samples are dried in the oven at temperature of 120 °C about several hours to remove water. Two samples have been prepared with 90 wt% Maxsorb III + 10 wt% PVA and nearly same packing density ( $316 \pm 4 \text{ kgm}^{-3}$ ). However, sample height are different (1.4 mm and 5.2 mm) with 17 mm diameter.

### 2.2. Adsorption characteristics experiment

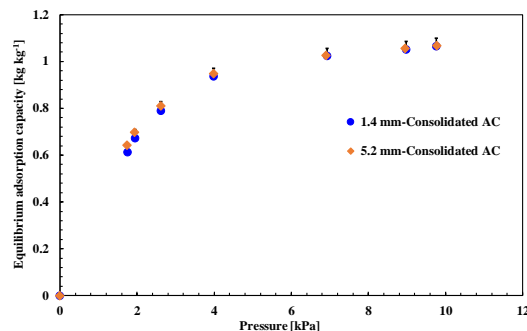
Instantaneous adsorption characteristics of ethanol as a refrigerant onto two studied sample have been measured gravimetrically using magnetic suspension adsorption measurement unit. The system executes the whole experiment automatically by following the instruction given in the software. It can be mentioned that buoyancy effect on the measurements is considered automatically by the system. Experiments have been conducted at adsorption temperature 30°C with various evaporator pressures. Figure 1 shows the schematic diagram of sample with ethanol vapor entrance direction inside the adsorption cell of measurement unit.



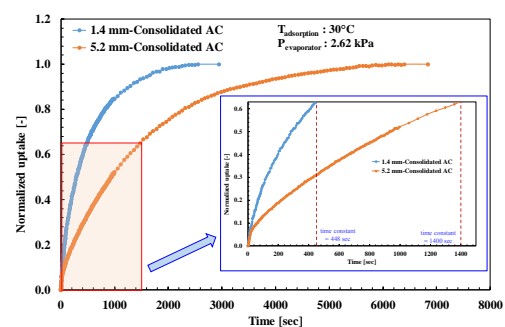
**Figure 1.** Schematic representation of sample with ethanol vapor entrance direction inside the adsorption cell of measurement unit.

### 3. Results and discussion

Two different heights (1.4 mm and 5.2 mm) at fixed packing density consolidated AC (90 wt% Maxsorb III+ 10 wt% PVA) have prepared by changing the mass ratio with applying the same pressure. Instantaneous adsorption experiments are conducted at various evaporator pressures and adsorption temperature at 30°C using magnetic suspension adsorption measurement unit. Both samples show similar equilibrium adsorption capacity (Figure 2), as it was expected because of same compositions. However, instantaneous adsorption capacity varies for different heights sample with same packing density. This is due to increasing the vapor diffusion resistance with increasing the height of same sample. It is observed that time constant for 1.4 mm height sample is 448 sec whereas 1400 sec is for 5.2 mm height consolidated AC (Figure 3).



**Figure 2.** Equilibrium adsorption capacity of ethanol onto 1.4 mm and 5.2 mm height of consolidated AC.



**Figure 3.** Instantaneous adsorption capacity of ethanol onto 1.4 mm and 5.2 mm height of consolidated AC.

### 4. Conclusions

The consolidated adsorbents have been prepared using polyvinyl alcohol (PVA) (10 wt%) and 90 wt% Maxsorb III (AC) with height 1.4 mm and 5.2 mm. Apparent packing density of consolidated AC adsorbents is  $(316 \pm 4 \text{ kgm}^{-3})$ . It is found that there is no significant difference in equilibrium adsorption capacity. However, significant difference of instantaneous adsorption capacity between two different heights of same sample has been observed. To reach 63% of maximum value, 1.4 mm height sample takes 448 sec whilst 1400 sec is for 5.2 mm height consolidated AC.

### References

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Email: animesh@kyudai.jp