

Adsorption enhancement induced by rotation

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Gas adsorption by porous solids is an extensively studied process. However, adsorption dependence seems not to be limited to pressure and temperature. As a continuation to a previous work on the effect of rotation on vapor adsorption[1], the current study investigates the effect of gas state. External rotational energy is provided to a closed adsorbent/adsorbate system being in adsorption equilibrium state. The important finding of this work is that a short time rotation at adsorption equilibrium state leads to further uptake of the adsorbate.

A special device has been developed allowing rotation at a maximum speed of 5,000rpm while the pressure change is recorded by a pressure transducer. The experiment was conducted isothermally at three different temperatures (20°C, 5°C and -20°C). For all cases, CO₂ is adsorbed on 3,6g of commercial activated carbon with BET surface area of ~1000m²/g. After loading the cell with the adsorbent, the system is evacuated overnight, achieving a vacuum of 10⁻³bar. Then CO₂ is introduced for 60s at an initial pressure of 5bar. The system is left for 24h to ensure equilibration and then the first rotation takes place for 30s, the system is left to reach a new equilibrium and then a second rotation of 60s is performed. Finally, the system is left for additional 24h, where the last equilibrium is recorded. The results are shown in Fig. 1.

In all cases the rotation increases the adsorbed amount of gas. At 20°C rotation doubles the (weak) uptake. As temperature decreases to 5°C rotation increases the amount adsorbed by 50%. At -20°C adsorption process dominates against rotation. Rotation increases the amount adsorbed because it increases the number of gas molecule which strike per unit area per second on the adsorbent surface[2].

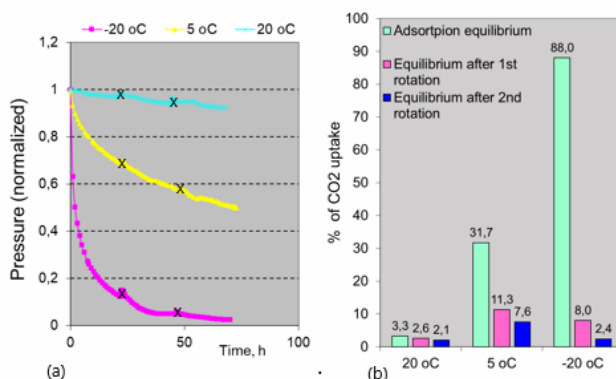


Fig.1: (a) presents experimental values of pressure vs time for all 3 cases; X marks the time of rotation, (b) is a bar chart of CO₂ percentage uptake, prior to and after rotation.

References:

[1] Kosheleva R.I., et al, Rev. Sci. Instr., 89, 2018.

[2] Langmuir I., J. Am. Chem. Soc., 40, 1918.

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