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Adsorption Phenomena of Nitrogen, Argon, Carbon Monoxide…on Charcoal, Silica Gel Adsorbents at Different Temperatures

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Extended Abstract

For the understanding of the adsorption phenomena, it will be important and interesting to study heat and matter transfer that occur during the adsorption phase as the released heat, the energy variation, the quantity of diffused molecules; and all the laws that govern such phenomenon.

The understanding of different heat and matter transfer phenomenon that take place will allow controlling processes and improving adsorption in its various applications.

The objective of this work is to study the adsorption phenomena of such different gases such as nitrogen, argon, carbon monoxide, oxygen on different adsorbents as silica gel and charchoal. Various models of Braumer, Emmet and Teller are applied. Investigations are established on different results and graphs. The adsorption is better when the temperature is the lowest and the adsorbents have a good affinity with the gases such as polarity, porosity, energy of adsorption.

When a solid is brought into contact with a gas or liquid compound, forces are exerted between the surface of the solid and the compound, causing a bonds formation: this phenomenon is called adsorption. These connections are more or less strong and depending on the solids nature and the compounds nature, and can lead, in the case of mixtures, to selective adsorption. This selectivity can also result from steric hindrance or kinetic phenomena.

Various microporous solids are characterized by a large specific surface area and, therefore, have a significant adsorption capacity. They allow the mixtures splitting by using this specific selectivity of adsorption.

The main application of adsorption is the recovery of GHGs, the purification (in order to obtain the unadsorbed fraction with high purity) and the splitting of mixtures which are difficult to separate by distillation, separation of isomer mixtures with a neighboring boiling points, compounds with various structures, and gases (alternative to cryogenic distillation).

There are two important characteristics of adsorbents: polar adsorbents (such as Silica gel) and nonpolar adsorbents (such as Activated Carbon). Therefore, the adsorption of polar molecules (such as H_2O, CO) is better on polar adsorbents, and adsorption of nonpolar molecules (such as CO_2, N_2, Ar, O_2) is better on nonpolar adsorbents.

When the saturation vapor pressure of a gas is higher (above atmospheric pressure), the gas is more volatile, and it is more difficult to be adsorbed.

Usually, the adsorption is better (large adsorbed quantities) when there is coexistence of liquid-gas phase (Web-1).

More the pore diameter is larger, the mechanical strength is higher and the pore is used to gases adsorption (Sourav PATEL). Moreover, adsorption of liquids is better on micropores, the penetration of liquid molecules is more easy, and thus, the displacement of molecules toward the center of the adsorbent is faster.

The adsorbed amount increases with the gas pressure, therefore it may vary from a few molecules on the surface, and then a monolayer to several layers forming a true liquid phase, especially in the micropores. It explains the usefulness of microporous solids, characterized by a large

internal surface, in order to obtain large fixed amounts in a small porous volume (Georges Gréviot and Valéry Prévost).

Adsorption is an exothermic phenomenon, so it is favored when the temperature is lower. Keesom forces fade quickly with distance. Furthermore, the Keesom forces are related to the molecular arrangement, and thus, related to the temperature. When the temperature increases, the Keesom forces fade. Keesom forces are mainly related to the electronegativity. They appear between at least two polar molecules and they are a part of the Van der Waals forces.

Keesom forces often help to explain the evolution of certain physical properties depending on the dipole moment in molecules of similar structure. Indeed, the Keesom forces have a large role in the arrangement of the molecules. To break the Keesom forces between polar molecules, it is necessary to bring greater energy, comparing to the case of nonpolar molecules with the same molecular weight. Hence, polar components often have high boiling point comparing to nonpolar components, and this for the same molecular weight.

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