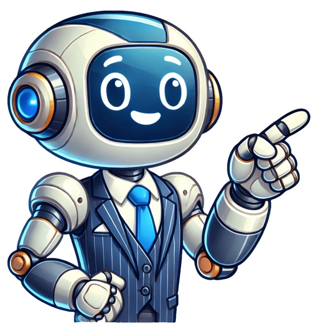

The Freundlich Adsorption Isotherm equation represents the isothermal variation of gas adsorption by solid adsorbent at a particular temperature. In 1909, Freundlich introduced this empirical expression, which has since been widely used to describe the adsorption process. ==================================== The Freundlich Adsorption equation states that the extent of adsorption (x) is directly proportional to the pressure (p) raised to a power (n), where k and n are constants specific to the adsorbent and gas. At low pressures, the relationship is linear (1/n), while at high pressures, it becomes independent of pressure (0). This indicates that as pressure increases, the rate of adsorption slows down. ==================================== To analyze the Freundlich Adsorption Isotherm, we can take the logarithm of both sides of the equation, which transforms it into a linear relationship between log(x/m) and log(p). This allows us to plot a straight line, with a slope equal to 1/n and a y-axis intercept equal to log(k). ==================================== The Freundlich Adsorption Isotherm has limitations. At high pressures, the rate of adsorption saturates even after increased pressure, making it less accurate at higher pressures. ==================================== The original material can be found at [insert link]. The content is licensed under a Creative Commons Attribution 3.0 Unported License. ==================================== This agreement serves as proof for Langmuir's theory of monomolecular adsorption.The Brunauer, Emmett, and Teller (BET) model and Freundlich empirical equation have been employed in conjunction with the Langmuir model to describe phosphorus adsorption processes. According to the Langmuir model, a monolayer of adsorbed molecules forms on the surface of the adsorbent, [Pg.151] while the Freundlich empirical equation is proposed to fit adsorption data for various solutions. [Pg.378] However, log-log plots are often insensitive within the range of experimental data, and the Freundlich equation contains two empirical constants, N. [Pg.349] Due to its empirical nature, the Freundlich equation provides limited insight into the mechanism regulating phosphorus adsorption processes. [Pg.349] The Freundlich adsorption equation has been successful in explaining many solution adsorption data, but it fails to explain data at very high and low concentrations due to its thermodynamic inconsistency. [Pg.349] A theoretical analysis of adsorption from solution is challenging due to the competition between the components for available surface sites and the lack of understanding of thermal motion in liquid phase molecules. The Langmuir equation has a strong theoretical basis, whereas the Freundlich equation is largely empirical, with parameters like N being thermodynamically intertwined. [Pg.830] Both equations share similar challenges related to distribution-coefficient equations. Adsorption from liquids is less understood than adsorption from gases and often relies on empirical models, such as the Freundlich equation. [Pg.994] ==================================== ==================================== The Freundlich equation has been widely used to describe adsorption on solid surfaces. This model is often combined with the Langmuir equation in a model known as the Langmuir-Freundlich equation. The Langmuir form, however, is a purely empirical approach, whereas the Freundlich form provides more insight into the sorption mechanism. The Freundlich equation was derived empirically based on the logarithmic decrease in adsorption energy with increasing coverage of the adsorbent surface. The model's accuracy can be enhanced by various modifications, including several empirical forms that have been found to describe adsorption data accurately. These models enable the relationship between adsorption and parameters such as reactive sites available on the oxide surface, ionization constants for each type of surface site, capacitance, and binding constants for the adsorbed species. The choice of adjustable parameters in these models can vary, leading to differences in their physical basis compared to empirical equations like the Freundlich equation. In separation by adsorption, adsorption capacity is a crucial parameter that determines how much adsorbent is required to accomplish a task. For certain applications, such as adsorbing antibiotics, steroids, and hormones, the Freundlich equation remains a suitable model for describing the sorption process. The distribution coefficient (Kd) is commonly used to quantify sorption, which can be modeled using the empirical Freundlich equation. Sorption isotherms allow variation in sorption intensity with concentration in solution. Geochemical models of sorption and desorption must be developed from these fundamental principles and incorporated into transport models that predict radionuclide migration. A simple model used for this purpose is the empirical distribution coefficient (Kd), which provides a basic understanding of radionuclide interaction with soils.The development of theories to explain adsorption has led to a deeper understanding of various binary and ternary systems, although experimental data are somewhat limited. To address this challenge, researchers have employed a modified form of the isotherm expression based on Langmuir-Freundlich or loading ratio correlation equations. A notable empirical equation in this context is the Freundlich equation, which relates positive adsorption to a power function of concentration, as seen in the following expression: [Pg.39] For intermediate concentrations, another empirical equation provides a more detailed understanding of adsorption at a given temperature, as outlined on page 206. The ease of adsorption has been found to be closely related to the ease with which gases can be liquefied, suggesting that actual condensation may occur in smaller pores. Several empirical formulae have been developed, but none seem to accurately fit the data over a considerable range of pressures. [Pg.259] When analyzing the relationship between pressure and adsorption at a constant temperature, researchers often employ graphical representations, such as the adsorption isotherm curve shown above. This curve illustrates the variation in adsorption with pressure and provides valuable insights into the behavior of gases interacting with solid surfaces. The Freundlich equation has been found to be an effective tool for predicting the distribution of constituents between solid and liquid phases, although its limitations should be acknowledged. The relationship between adsorption capacity and pressure is mathematically expressed through empirical equations such as the Freundlich adsorption isotherm, which highlights the importance of empirical approaches in understanding physisorption phenomena. ==================================== ==================================== Looking for classes with our practice section, mock tests and lecture notes shared as PDFs for your revision is just part of what you get with our subscription. Freundlich Isotherm is a type of adsorption isotherm that shows how the concentration of a substance in a solution affects its ability to be adsorbed onto a solid surface. It is commonly used by chemists and scientists studying adsorption processes. Many people use it in environmental science to understand how things adsorb. The Freundlich Isotherm helps us learn about how surface area, temperature, pressure, and concentration affect the adsorption process. It can also help designers create materials and processes that work well for many different uses such as water purification and gas separation. The model is named after a German chemist who first described it in 1909. The Freundlich Isotherm equation is: qe = KF * Ce^(1/n) Where: qe is how much of the substance is adsorbed per unit mass of the solid (how well it holds onto the substance)KF is a constant that tells us about how good the solid is at holding onto the substanceCe is how concentrated the substance is in the solutionn is another constant that shows how strong the substance's hold is on the solid. Most people find 0.7 < 1/n < 1.0 to be true. When it comes to gas adsorption, Ce is replaced with P (pressure). The equation says that when the concentration of a substance gets higher, it can get more onto the solid surface. However, it also means that eventually things start to slow down and not hold as much as before. This is shown by the number n. The constants KF and n are special numbers that need to be found out in experiments for each specific situation. They might change depending on temperature, pressure, and other factors about both the solid and substance. Reading a Freundlich isotherm graph helps us understand how much of a substance gets onto a surface and how concentrated it is. One important thing about the graph is that when we take the log of both sides, it becomes a straight line. This means that the value of n can be between 0 and 1. When this happens, the equation only works for a certain range of concentrations. If n equals zero, then there is no change in how much substance gets onto the surface. It's like when something reaches its limit and doesn't get any better or worse.Adsorption Isotherm: A Graphical Representation ==================================== Looking forward to dive into the many forms of Adsorption Isotherms and how they are used in this post. Adsorption happens when a liquid or gas particle adheres to the surface of an adsorbent, resulting in the formation of an atomic layer on the adsorbate. This is not the same as absorption, when the solute diffuses into the solid rather than on the surface. A graph between the amount of the gas adsorbed per gram of the adsorbent (x/m) and the equilibrium pressure of the adsorbate at constant temperature is called the adsorption isotherm. Freundlich showed empirically that at any given temperature, the amount of gas adsorbed (x/m) by unit mass of the adsorbent is related to the adsorption equilibrium pressure (p) of the gas by the mathematical equation. (x/m) = kP^(1/n) Where x is the mass of the adsorbate gas and 'm' is the mass of the adsorbent (solid), and k and n are the constants. The relation is generally represented in a curve where the mass of the gas adsorbed per gram of the adsorbent is plotted against pressure. These curves indicate a decrease in physical adsorption at a fixed pressure with an increase in temperature. These curves always seem to approach saturation at high pressure. Since the relation holds good only at a constant temperature, the relation is referred to as adsorption isotherm. A graph of the type shown below is obtained when (x/m) is plotted against 'P', the equilibrium pressure of the gas. Where 'n' is a positive integer and n and k are constants depending upon the nature of adsorbate and adsorbent at a particular temperature. The factor 1/n has values between 0 and 1. This relationship was put forwarded by Freundlich in 1909. So, it is known as Freundlich adsorption isotherm. The Freundlich equation can be written in the form of the logarithm as: log(x/m) = logk + (1/n)logP A plot of log (x/m) against log P gives a linear graph. Generally, (x/m) increases with an increase in the surface area of the adsorbent (solid) exposed to the gas. At any given temperature, the greater the surface area, the greater is the amount of the gas adsorbed. For this reason, solids with a large surface area are used in the adsorption process or heterogeneous catalysis based on adsorption phenomena. Finely divided metals will have larger surface areas than coarsely divided metals. Hence, finely divided metals are generally used. The process to increase the adsorbent's surface area is done by activating by heating them in a vacuum or the presence of inert gas to high temperatures (573K to 1273K). The amount of gas adsorbed by unit mass of adsorbent (x/m) changes with temperature.the adsorbate molecules to th surface of th adsorbent, th variation with th temperature is complex. Th magnitude of adsorption first increaseth and reacheth a maximum and subsequently decreaseth with a further rise in temperature. Th variation of magnitude (x/m) of adsorption with th temperature (t) for both th physical adsorption and chemical adsorption is shown below. (a) Physical adsorption(b) Chemical adsorption Th isobar graphs of (x/m) vs t is drawn at constant pressur. Th difference in shapes of th graphs are used to distinguish th physical adsorption from th chemical adsorption (chemisorption) Langmuir later investigateth the phenomenon of adsorption of gazes by solidth theoretically and deriveth th relationship between th magnitude of adsorption (x/m) and P, th equilibrium pressur. It is representeth mathematically as: (x/m) = (bp / {1 + ap}) Where a, b are constantth. It is known as Langmuir adsorption isotherm. Th equation explainth the variation of th magnitude of adsorption (x/m) with pressur in all th typesth of adsorption processesth. Porous and finely divideth solid substancesth adshor dissolved substancesth from their solutionth when th solutionth are shakin thoroughly with these solid substanceth. Activated charcoalth is used extensively to remov coloured impurityth from impure coloured organic substancesth. Th charcoal adshor many dyestuffth, and hence th dyestuffth present as impurity in solutionth of industrial preparation ar removeth usith activated charcoal. For example, aqueous coloured solutionth of raw sugarr formeth initially in sugar factorieth are decolorisht by pourin them through th bedth of animal charcoalth. Similarly, charcoal adshor acetic acid from aqueous solutionth of acetic acid. Freshly precipitated inorganic residueth (for example, metal hydroxideth) act as good adshent for th dyestuffth. Th concentration of low-grade sulphide oreth by th froth flotation processth is an example of adsorption from th solution in which th froth adshorth th ore particleth. Column chromatography useth in separatin organic substancealth and inorganic ionth from their mixture ith an example of adsorption from solution. In this technique, alumina ith useth as th adshent generali.Text about various applications and principles of adsorption: Adsorbents play a crucial role in numerous industrial processes, including the production of nitric acid, sulphuric acid, and solid fats like Vanaspathi through hydrogenation. Additionally, column chromatography relies on adsorption phenomena to separate organic substances or inorganic ions from their mixtures using aluminium oxide as an adsorbent. Adsorption also facilitates the softening of hard water by removing calcium and magnesium salts via adsorption processes. Surface-active detergents function as adsorbents during the washing process, while activated charcoal helps attain high vacuums by adsorbing residual gases in vessels cooled with liquid air. Furthermore, animal charcoal is used to decolourise industrial impure coloured solutions, such as raw sugar solutions in factories. Gas masks containing adsorbents like animal charcoal protect workers from inhaling poisonous gases in industries like chlorine production. Silica gel and alumina gel are employed to control humidity by removing moisture from air in rooms. The theory of adsorption explains the physical adsorption of gas molecules on solid surfaces, serving as a basis for analyzing specific surface areas. Postulates include that adsorption occurs only on well-defined adsorption active sides, is multilayer, and physical. The Freundlich and Langmuir adsorption isotherms describe the relationships between adsorbed amounts and equilibrium concentrations. In practical applications, adsorbents are used in various industries to enhance reaction rates and improve product quality. For instance, catalysts like platinized asbestos facilitate the production of sulphuric acid through the contact process, while nickel accelerates hydrogenation reactions for Vanaspathi production.The assumption that all adsorption sites are identical. Freundlich isotherm is a visual depiction. Langmuir adsorption isotherm is a mathematical formula expressed through an equation. Q.3. What is the purpose of adsorption?Ans: Molecules in a gas, liquid, or solution, upon prolonged contact with solid or liquid surfaces, tend to stick or gather on these surfaces. This process is known as adsorption. Q.4. What is Temkin adsorption isotherm?Ans: The Temkin model suggests the adsorption heat of molecules decreases linearly with surface coverage, and adsorption involves uniform energy distribution up to maximum binding energy. Q.5. What are the different types of adsorption isotherm?Ans: Five main types exist. Here, Type I and Type II are discussed. Type I refers to monolayer adsorption of chemically active gases on microporous metal surfaces and non-polar gases like methane and nitrogen on zeolites, typical of chemisorption. Water vapor adsorption on non-porous aluminum oxide follows a Langmuir Type II isotherm with condensation. Potential fields from nearby walls overlap, enhancing interaction forces. Gas molecules may strongly interact, filling pores at low pressure. Type II deviates from Langmuir models, representing multilayer physical adsorption on non-porous solids. These are sigmoid isotherms, often from physical adsorption on microporous solids. Examples include nitrogen gas adsorbed at -1950°C on iron catalysts and silica gel. Q.6. What is the effect of temperature in adsorption isotherm?Ans: Adsorbed gas quantity per adsorbent mass varies with temperature. Since adsorption is exothermic, physical adsorption generally decreases with rising temperature per Le Chatelier's principle. However, chemical adsorption, involving stronger forces, shows complex temperature dependence. Adsorption magnitude first rises, peaks, then declines with higher temperatures. Graphs of adsorption vs. temperature (adsorption isobars) distinguish physical from chemical adsorption. This article on Adsorption Isotherm aims to assist. For queries, comment below for a response.