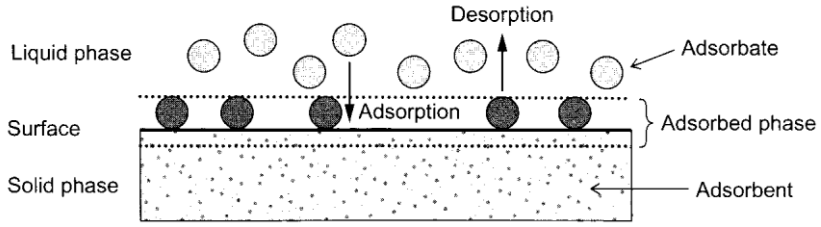
ADSORPTION EXPERIMENT

Adsorption is a phase transfer process that is widely used in practice to remove substances from fluid phases (gases or liquids) and collection on solid phase. Some examples of adsorbents commonly used in experiments of this kind are charcoal, silica gel, alumina, zeolites, and molecular sieves.

In adsorption theory, the solid material that provides the surface for adsorption is referred as *adsorbent*; the species that will be adsorbed are named as *adsorbate*. By changing the properties of the liquid phase (e.g. concentration, temperature, pH) adsorbed species can be released from the surface and transferred back into liquid phase. This reverse process is referred as **desorption**.



Basic terms of adsorption.

Adsorption can result either from the universal van der Waals interactions *physical adsorption, physisorption* or it can have the character of a chemical process *chemical adsorption or chemisorption*. Contrary to physisorption, chemisorption occurs only as a monolayer. Physical adsorption can be compared to the condensation process of the adsorptive. As a rule, it is a reversible process that occurs at a temperature lower or close to the critical temperature of an adsorbed substance.

The adsorption isotherm is one of the most important criteria for an adsorption process. The amount or pressure of reactant adsorbed for a given temperature is described by adsorption isotherms. The adsorption of dissolved substances in liquid solutions by solids may be formulated (within certain concentration limits) by the equation for the adsorption isotherm proposed by Freundlich.

The ***Freundlich isotherm*** is introduced as an empirical model where ***qe*** represents the amount of adsorbate adsorbed at equilibrium, ***Ce*** represents the concentration of adsorbate in the bulk fluid at equilibrium, and ***k*** and ***n*** are parameters that depend on the adsorbate and adsorbent.

$$qe = k\, Ce^{1/n}$$

The equation can be linearized as:

$$\log qe = \log k + \frac{1}{n} \log Ce$$

The ***Langmuir isotherm*** assumes a uniform surface, which is reasonable with many fabrics. The isotherm represented by the equation:

$$qe = \frac{QbCe}{1+bCe}$$

which can be linearized as:

$$\frac{1}{qe} = \frac{1}{Q} + \frac{1}{QbCe}$$

Ce= the equilibrium concentration of adsorbate in liquid phase (mg/L)
qe= the equilibrium concentration of adsorbate on solid phase (mg/g)
Q= Adsorption capacity (mg/g)
b=Adsorption energy (L/mg)

The amount of adsorbate adsorbed on the adsorbent (***qe***) is calculated from a mass balance:

$$qe = (C_0 - C_e)\frac{V}{W}$$

Where C_0 is the initial adsorbate concentration (ppm), ***Ce*** is the final adsorbate concentration (ppm) ***V*** is the volume of the solution (L), and ***W*** is the mass of the adsorbent (mg).

Experimental Procedure

- Prepare 1L of methlyene blue (MB) stock solution (20 ppm) and measure the absorbance of 20,10,5,2,1 ppm MB concentrations with UV Spectrophotometer.
- Weigh different amounts of activated carbon (1g-5g) and place it in to flasks.
- Add 30 mL 20 ppm of methlyene blue solution on to activated carbons.
- Each sample is shaken for 15 min at shaker and 15 min to centrifugation to obtain pure solution.
- The solutions are analyzed with UV Spectrophotometer for residual methlyene blue concentration.
- Calculate the quantity of methlyene blue that was adsorbed by the activated carbon (mg of methlyene blue adsorbed / gram of carbon) for each sample.

Calculations

- Plot the calibration curve by using absorbance data of standard solutions (concentration vs absorbance) and obtain the regression equation for calibration curve.
- Calculate the final concentration of MB (Ce, mg/L) for each sample. Calculate the residual MB concentration using this model.
- Prepare tables shoving the values of C_0, V, W, Ce, qe, log Ce, log qe.
- Plot adsorption isotherms of MB on Activated Carbon.
- Apply Freundlich and Langmuir adsorption model to the experimental data and find the constants and regression coefficients.
- Determine which one is applicable for the investigated system.

Questions

- Give information about adsorption theory, and effective parameters of adsorption process and applied isotherms.
- Discuss the most applicable adsorption isotherm for the systems and explain why.