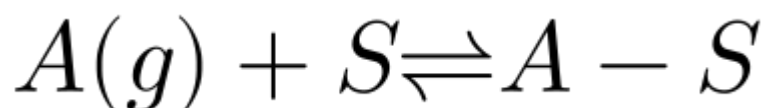


Desorption

Desorption is the process by which atoms, ions, or molecules that are present on a surface leave the surface and return to the surrounding phase. It is therefore the reverse of adsorption. When a gas molecule is adsorbed on a solid surface, the adsorbed species is in equilibrium with molecules in the gas phase. Removal of the adsorbed species from the surface is called desorption.

For a gas molecule A , the adsorption-desorption process may be represented as



where S represents an available surface site and $A - S$ represents the adsorbed species. The forward direction represents adsorption, while the reverse direction represents desorption.

Desorption requires energy because the adsorbed molecule must overcome its interaction with the surface. The required energy depends on the nature and strength of the surface-adsorbate interaction. A weakly adsorbed molecule can leave the surface relatively easily, whereas a chemically adsorbed species may require considerably more energy because a strong surface bond has to be broken.

Temperature has an important effect on desorption. On increasing the temperature, the thermal energy of the adsorbed molecules increases. A greater number of molecules can then overcome the energy barrier associated with leaving the surface, so the rate of desorption increases. This is one reason why heating is commonly used to remove adsorbed gases from a solid.

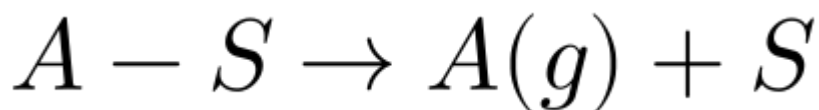
The pressure of the surrounding gas also influences the observed adsorption-desorption equilibrium. At a high gas pressure, collisions of gas molecules with the surface are frequent and adsorption is favoured. At a low pressure, molecules that leave the surface are less likely to be replaced immediately, so the surface coverage tends to decrease.

Desorption may occur as a simple molecular process in which the adsorbed molecule leaves the surface without changing its chemical identity. It may also follow a chemical pathway in which the adsorbed species first undergoes a surface reaction or recombination before leaving the surface. Thus, the nature of desorption depends upon whether the original adsorption was physical or chemical.

In physical adsorption, the adsorbed molecule is held mainly by weak intermolecular forces. Consequently, desorption generally occurs comparatively easily and is often achieved simply by increasing the temperature or reducing the pressure. In chemisorption, the adsorbate is strongly

attached to the surface through chemical interaction, so desorption generally requires a larger energy input.

For molecular adsorption, desorption can be represented as



For a dissociatively adsorbed species, desorption may involve recombination before the molecules return to the gas phase. For example, if hydrogen atoms are present on a metal surface, molecular hydrogen can be formed during desorption:



Here, two surface hydrogen atoms combine to form a hydrogen molecule, which then leaves the surface and restores two vacant surface sites.

Desorption is important in heterogeneous reactions because a catalytic cycle cannot continue indefinitely if the products remain permanently attached to the surface. After the surface reaction has produced the desired products, those products must leave the active sites so that new reactant molecules can be adsorbed. Thus, adsorption and desorption together determine the surface coverage and contribute directly to the overall rate of a heterogeneous reaction.

At equilibrium, adsorption and desorption are opposing processes occurring simultaneously. The rate of adsorption becomes equal to the rate of desorption, and the amount of material present on the surface remains constant with time. This is a **dynamic equilibrium**; adsorption and desorption do not stop, but their rates become equal.