Powder dispensing & Storage
Flowability and properties protection

Powders and particles may be affected by environment different interactions during dispensing and storage.

Interparticles forces

Van der walls Forces

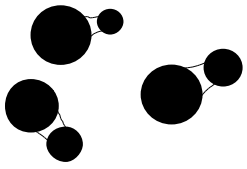
there exist between all solids molecularly based attractive forces collectively known as Van Der Walls forces. The energy of these forces is of the order of 0,1 electron-volt and decrease with the sixth power of the distance between molecules. The range of Van Der Walls forces is large compared with that of chemical bonds.

Forces due to liquid adsorbed

Particles in the presence of a condensable vapour will have a layer of adsorbed vapour on their surface. If these particles are in contact, a bonding force results from the overlapping of the adsorbed layers. The strenght of the bond is dependant on the area of contact and the tensile strenght of the adsorbed layers. The thickness and the strenght of the layers increase with increasing partial pressure of the vapour in the surrounding atmosphere. There is a critical partial pressure at which the adsorbed layer bonding gives way to liquid bridge bonding.

Forces due to liquid bridges

In addition to the interparticle forces resulting from adsorbed liquid layers, as described above, even in very small proportions the presence of liquid on the surface of particles affects the interparticle forces by the smoothing effect it has on the surface imperfections (increasing particle / particle contact) and its effect of reducing interparticle distance. However, these forces are usually negligible in magnitude compared with forces resulting when the proportion of liquid is sufficient to form interparticles liquid bridges. In the first case, the liquid is held as a point contact in a bridge neck between particles. The liquid bridges are all separate and independent of each other. The strong boundary forces resulting from the surface tension of the liquid draw the particles together. In addition there is capillary pressure resulting from the curve liquid surfaces of the bridge.If the pressure in the liquid bridge is less than the ambient pressue, the capillary pressure and the surface tensions boundary attractive force are additive.



Electrostatic Forces

Electrostatic charging of particles and surface occurs as a result of friction caused by interparticle collisions and frequent rubbing of particles against equipment surfaces during processing. The charge is caused by the transfer of electrons between the bodies.The force between two charged spheres is proportional to the product of their charges. Electrostatic forces may be attractive or repulsive, do not require contact between particles and can act over relatively long distances compared to adhesional forces which require contact. During dispensing processes, interparticle collisions increase the electrostatic charges, especially during fluidization (descending order :shaking, vibrations, rotation ...) and all other mechanical stress. The ionization during the dispensing partly reduce the adhesion particle / particle and particle / container. In any case it is better to disperse electrostatic charges before the dispensing and to reduce the machanical stresses.

Solid Bridges

Permanent bonding within the granule is created by solid bridges formed as liquid is removed from the original granule. If the material of the particles is soluble in the liquid absorbed, crystalline bridges may be formed when the liquid evaporates. The evaporation reduces the proportion of liquid, producing high strenght pendular bridges before crystals form. Repeated liquid absorption and evaporation may produce a solid cement to hold the particles together.
In a compound storage, repeated opening / closing of vials or powder containers, increase the moisture absorption, variation of natural humidity in the surrounding atmosphere will lead to solid bridges formation. Additionally, the storage of powders is submitted to a natural contraction of interparticle spaces, this parameter is increased by mechanical vibrations generated by automated storage systems.

Comparison and Interaction between forces

In practice, all interparticle forces act simultaneously. The relative importance of the forces varies with changes in particle properties and with changes in the himidity of the surrounding atmosphere. There is considerable interaction between the bonding forces. For example, in aqueous systems adsorbed moisture can considerably increase Van Der walls forces. Adsorbed moisture can also reduce interparticle friction and potential for interlocking, making the powder more free-flowing. Electrostatic forces decay rapidly if the humidity of the surrounding air is increased.
A powder which in a dry atmosphere exhibits cohesivity due to electrostatic charging may become more free-flowing as humidity of the atmosphere is increased. If humidity is further increased liquid bridge formation can result to cohesive behaviour.
In practice, Van der Walls forces become important only for particles below 1µm in size, adsorbed vapour forces are relevant below 80 µm and liquid bridge forces are active below about 500 µm.
The more your particles are small, the more interaction forces will act together to reduce the powder flowability.