

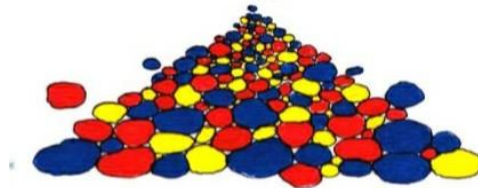
What is segregation ?

Gabrie Meesters



Outline of the presentation

- What is segregation
- Types of segregation
- Do's and don'ts with respect to segregation





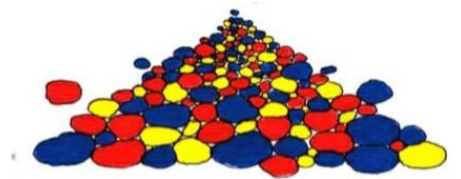
....so what is segregation

- Segregation results when particles separate due to differences in their **size, shape, or density**. Bulk solids can separate by **different segregation mechanisms**.
- The key to avoiding segregation is to determine the **segregation behavior** of a material.
- One needs to understand how **products** will **transfer** through your **process** in bins, hoppers, chutes, or conveyors.
- Knowing this behavior will allow equipment designers to either **prevent** particle segregation or **recombine** the separated material to maintain product quality.

The big five; The five major segregation mechanisms

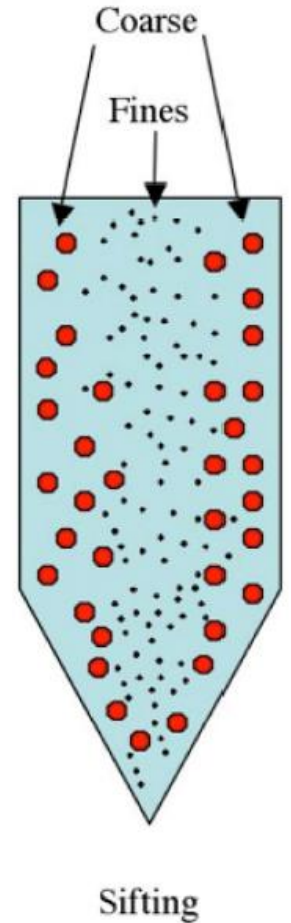
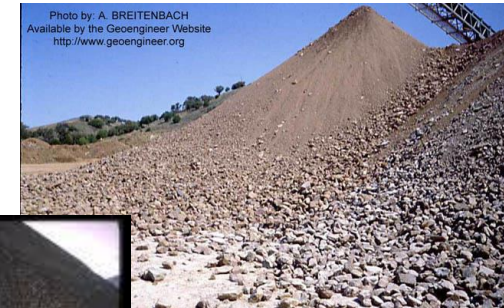
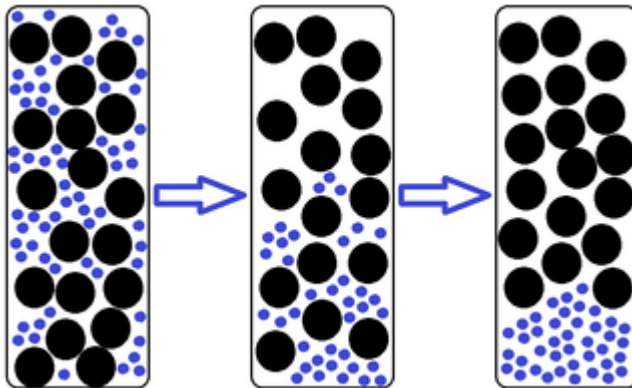
The major causes of segregation are by:

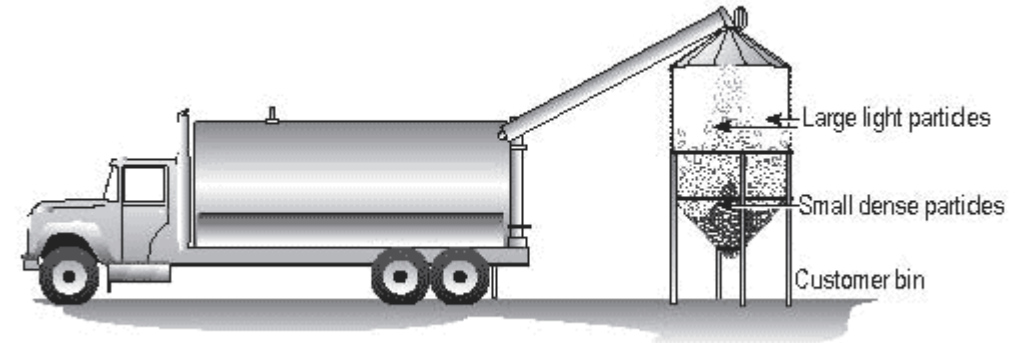
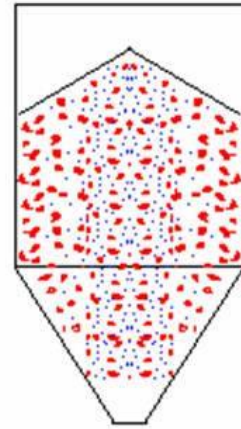
- Sifting
- Angle of repose
- Fines fluidisation
- Air currents and attrainment
- Chute trajectories



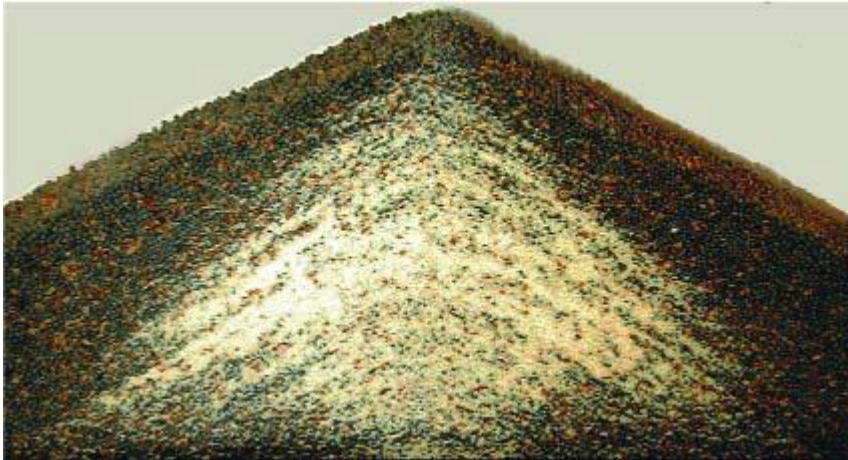
Sifting segregation

- Sifting segregation occurs when there is a significant variation of **particle diameters** in a mix
- Interparticle motion causes the finer particles to sift through the coarser ones
- side-to-side mechanism of segregation where the **fine particles** concentrate **under the point of impact** in a pile, while the **coarse particles** roll off the pile and locate at the **periphery**

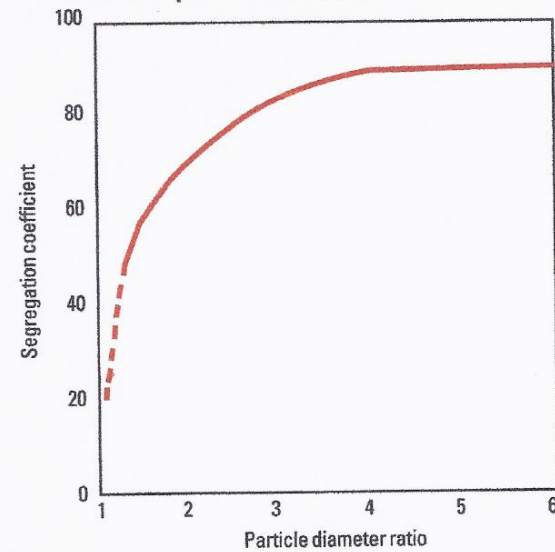




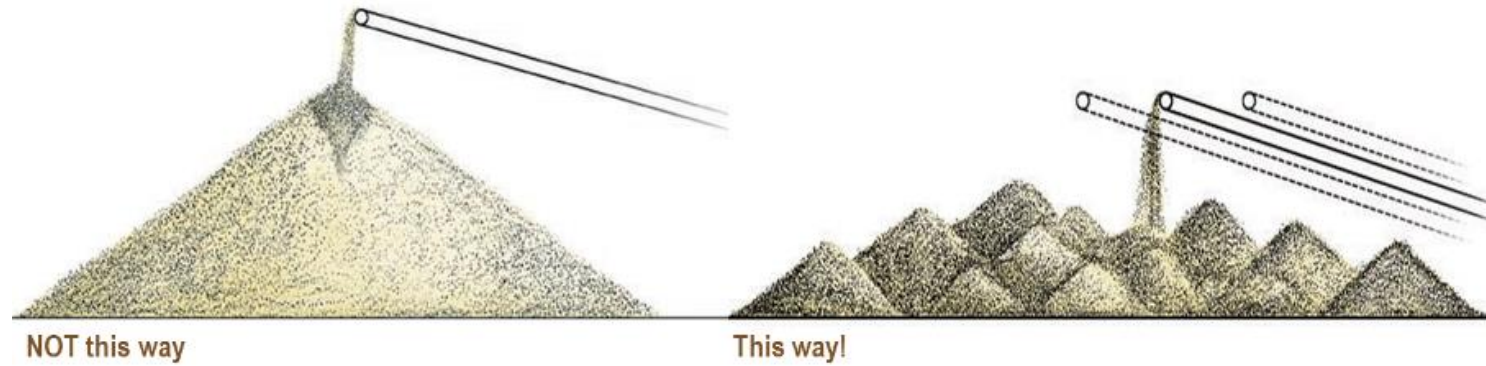
Sifting segregation in a stockpile



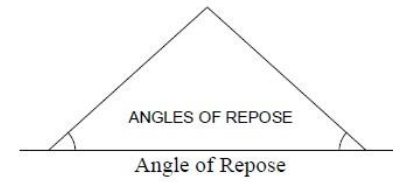
a. Variation of segregation coefficient in binary mixtures with various particle diameter ratios²



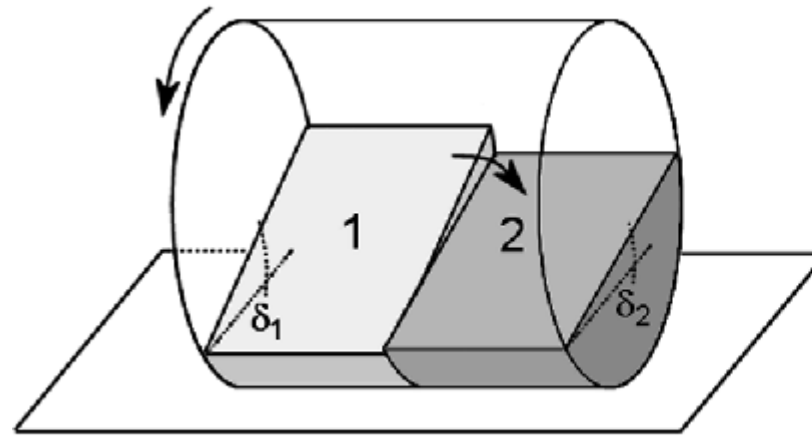
...possible solution



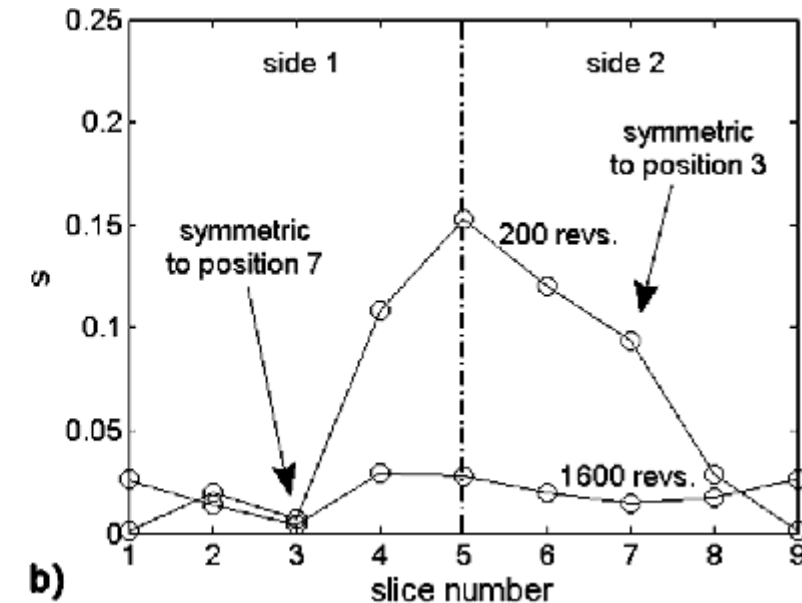
Angle of repose



- Differences in the angles of repose among different particles in a mix may give rise to segregation.
- Particles with a greater angle of repose will when deposited on the top of a pile will form a steep pile under the depositing point
- Particles with the lower angle of repose will roll away from that point

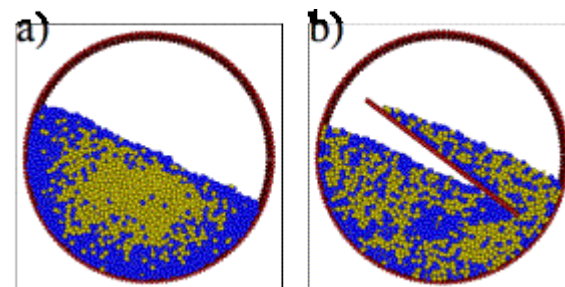
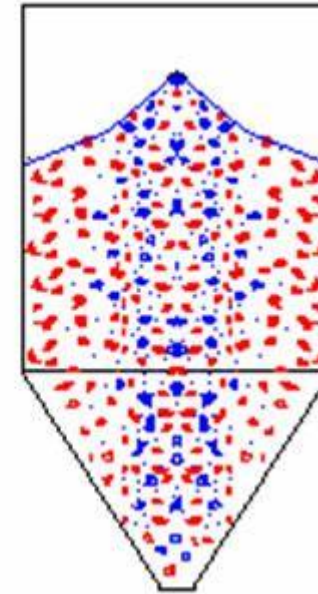
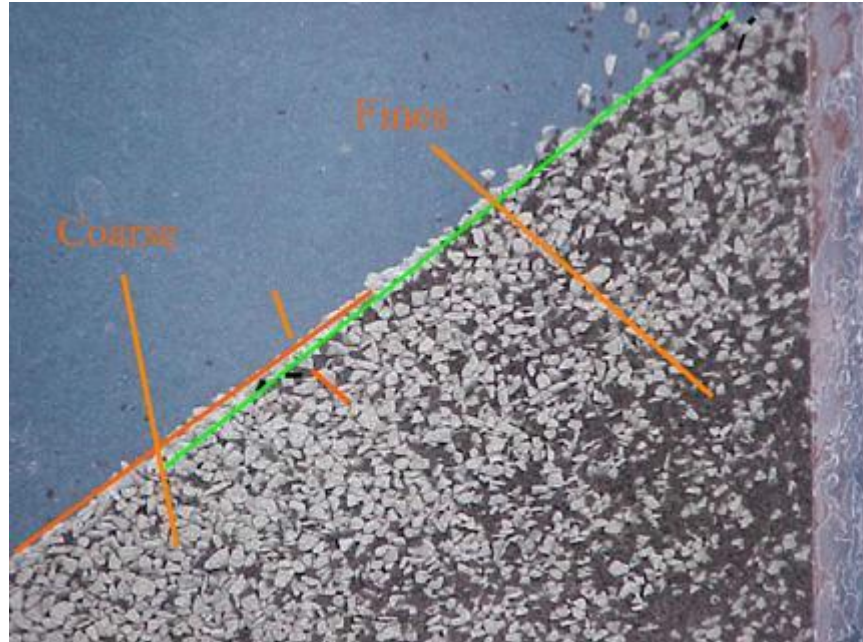


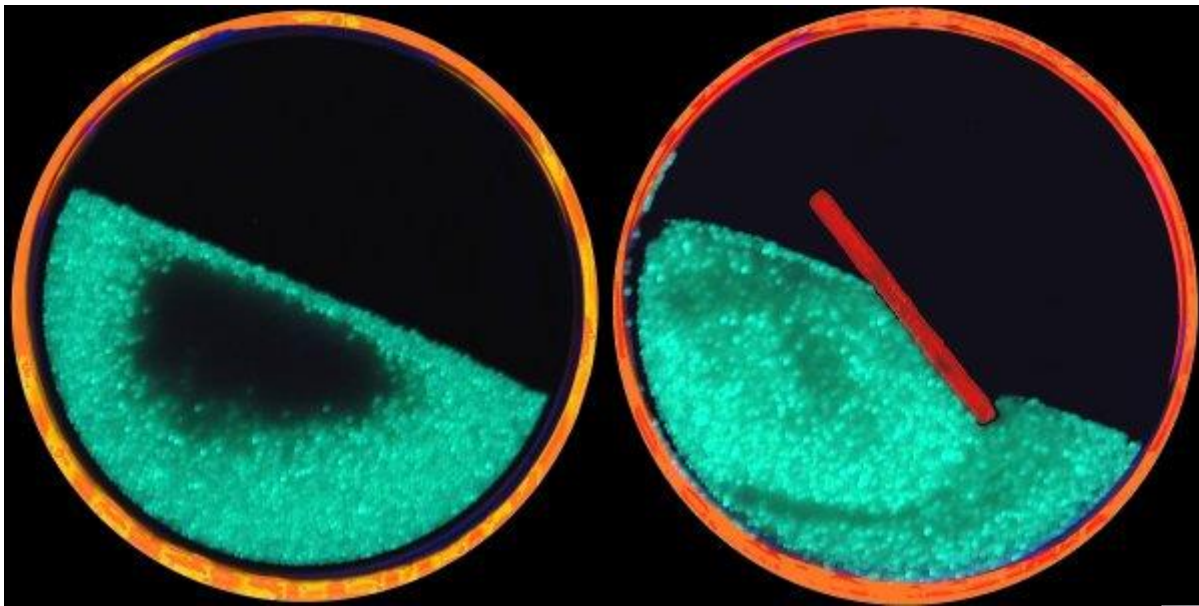
a)



b)

Angle of repose segregation

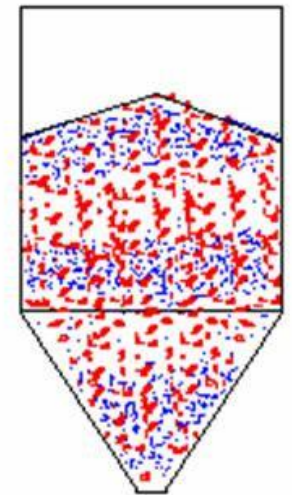
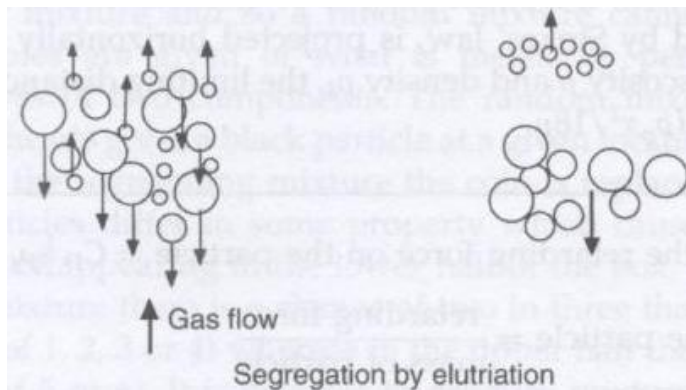






Fluidisation segregation

In this mechanism, the **lighter** or **fluffier** particles form a 'fluidized' layer. Only coarser particles can penetrate the fluidized fines and the finer particles remain in the top layer.



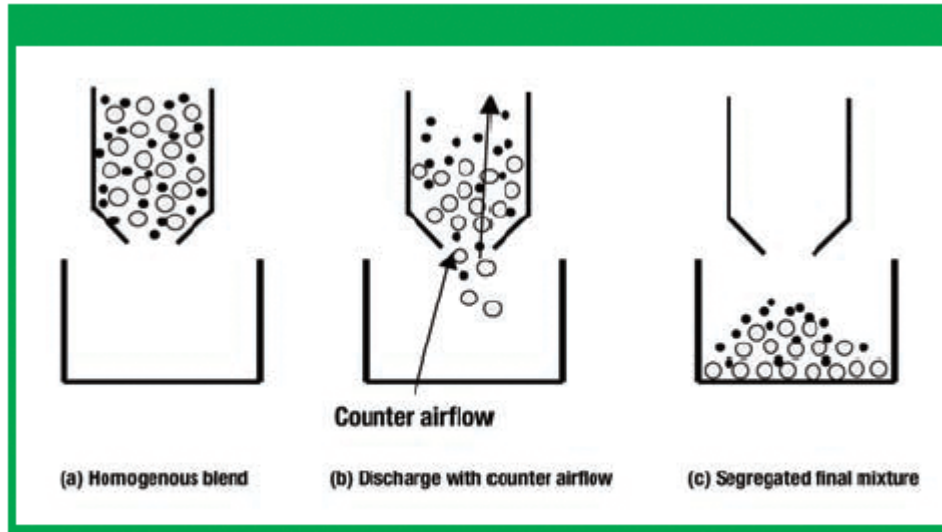
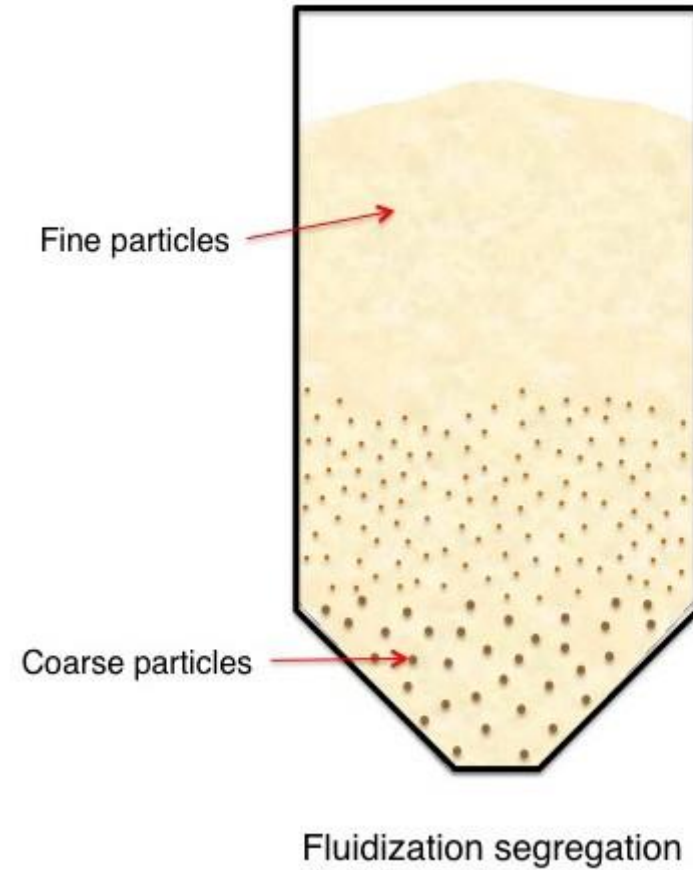
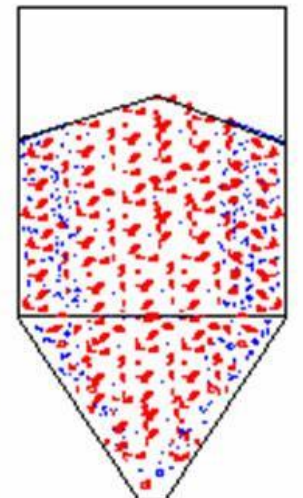
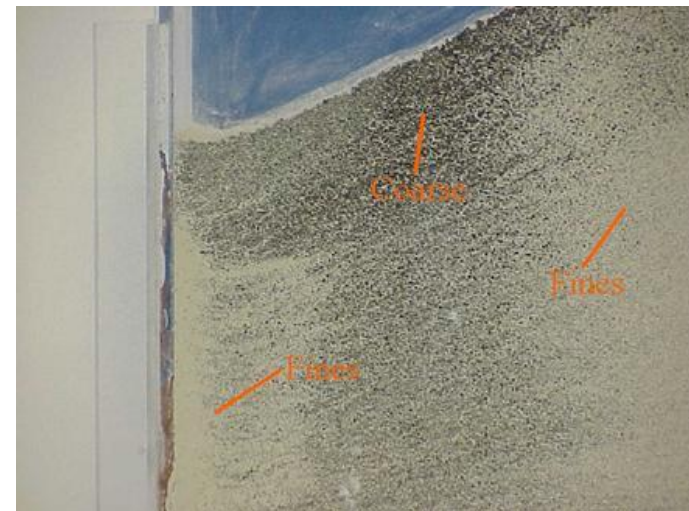


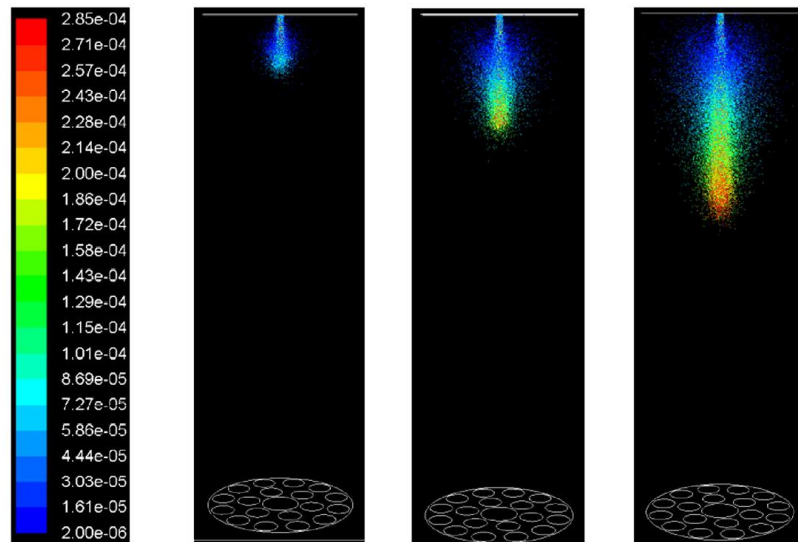
Figure 1: Fluidization segregation mechanism illustrated for bin discharge into a receiving container.



Air currents and entrainment

- **Air currents** caused during **filling** may carry fine material to regions where the air currents **decrease** sufficiently to **deposit** the fine material.
- This air entrainment segregation can produce a **radial pattern** or a side to side pattern depending on the
- **Position** of the inlet, outlet and the geometry of the vessel are important. Generally, fines accumulate near process **vessel walls** with this segregation.

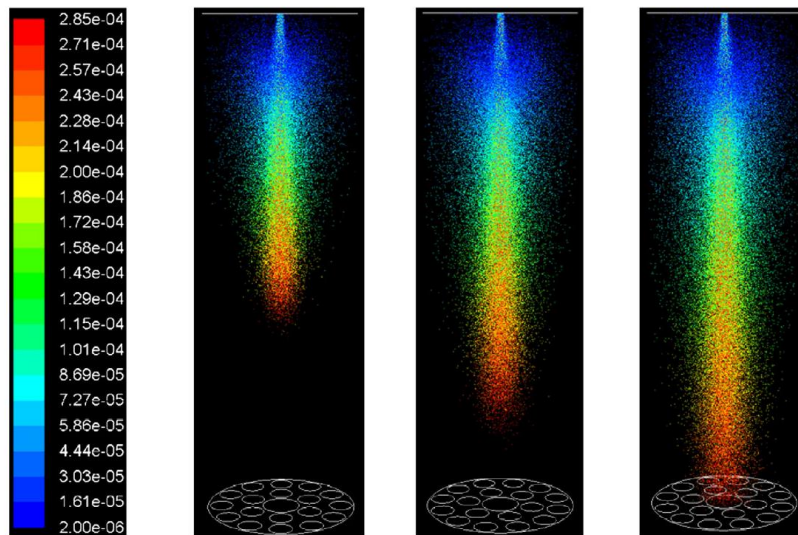


(particle diameter
in meter)

0.4 s

0.5 s

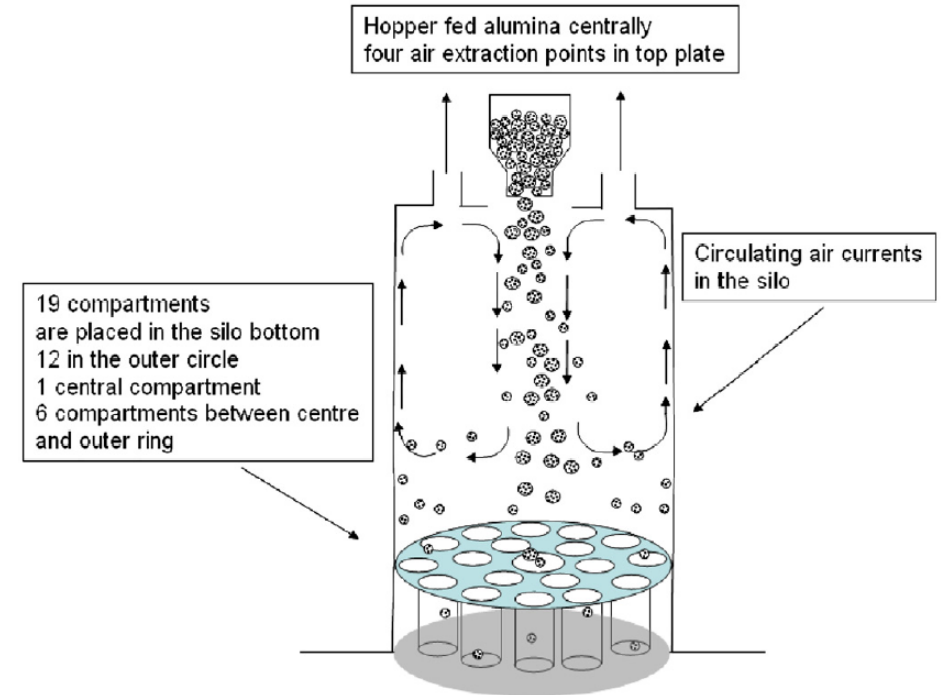
0.6 s

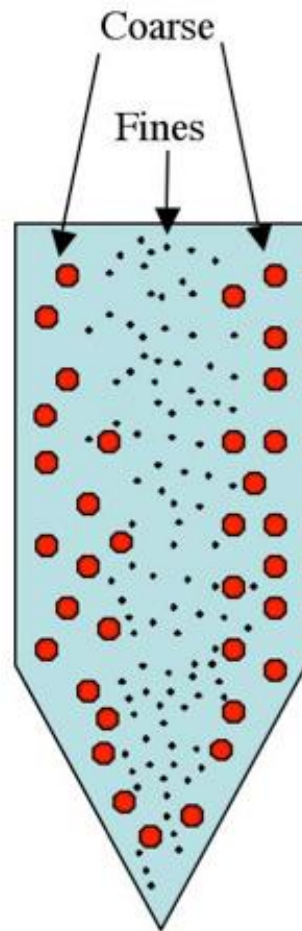
(particle diameter
in meter)

0.7 s

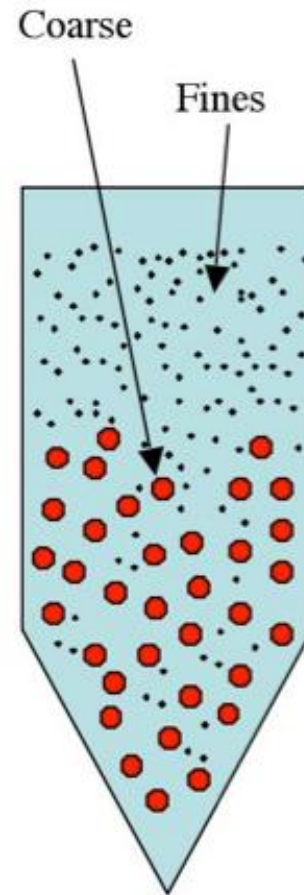
0.8 s

0.9 s

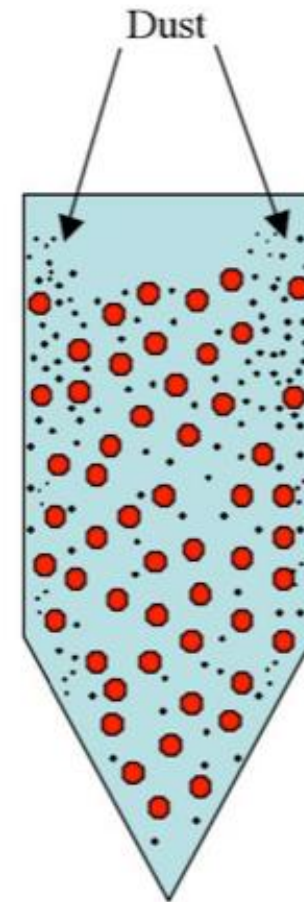




Sifting



Fluidization

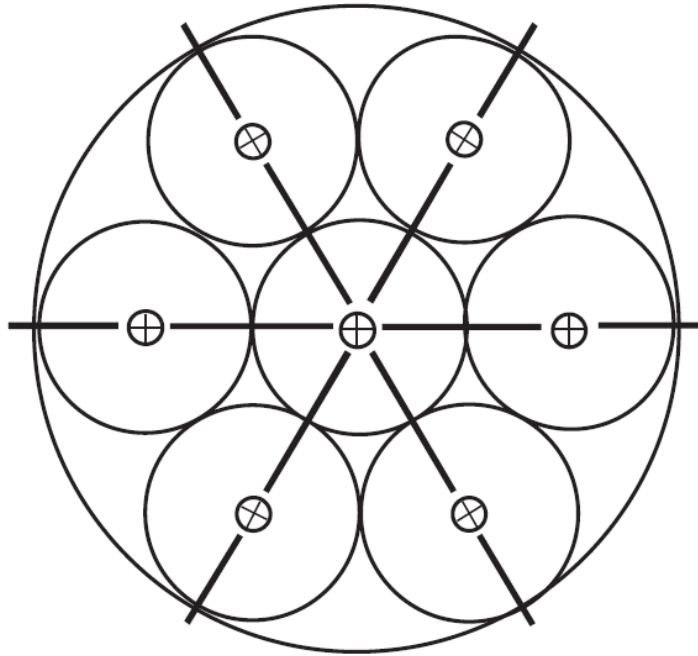


Dusting

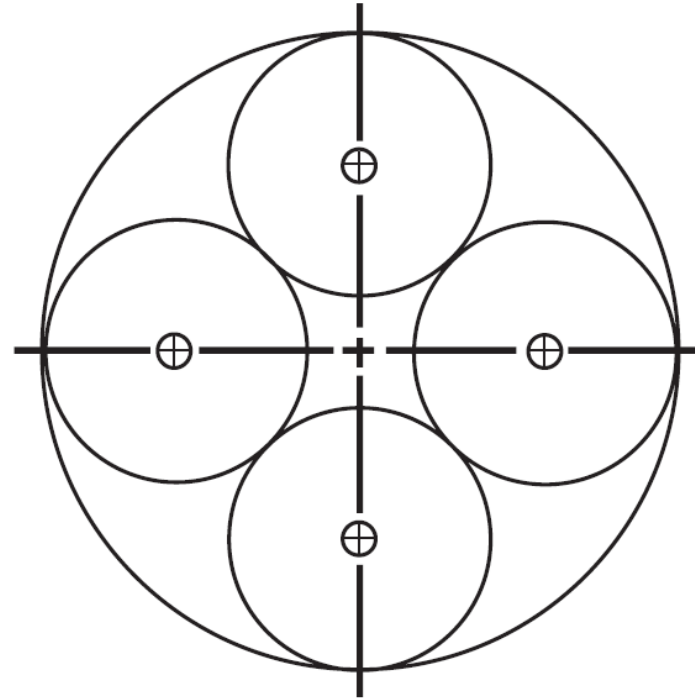
CLEVER HOPPER FILLING DESIGN

Improper and proper multiple-outlet designs for center-filled bins (plan views)

a. Nonsymmetrical outlets (segregated fines
flow through center outlet)

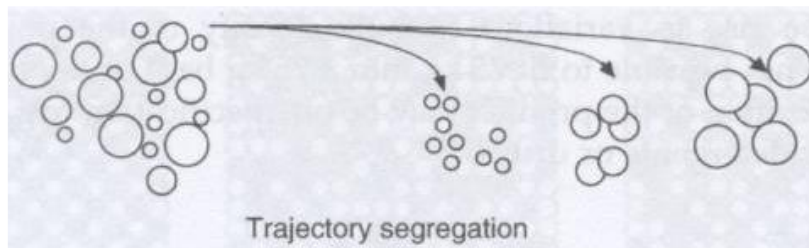


b. Symmetrical outlets (mixture flows through all outlets
without segregating)



Chute trajectory segregation

- The **difference of friction** coefficients of different particles in a mix results in **different discharge trajectories** as the mix slides down a chute.
- Particles with **high friction coefficients** show **lower discharge angles** to the end close to the chute,
- the trajectory of particles with **low friction coefficients** deviate **further away** from the chute



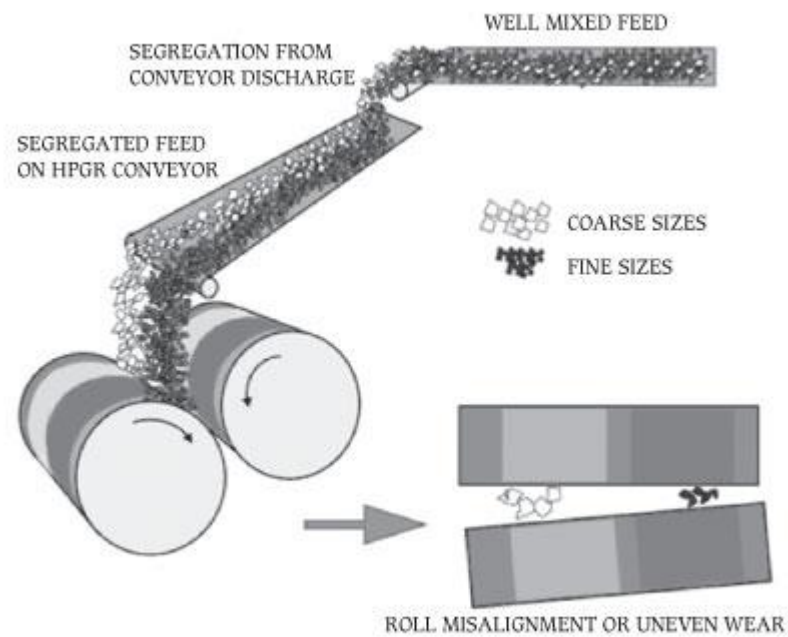
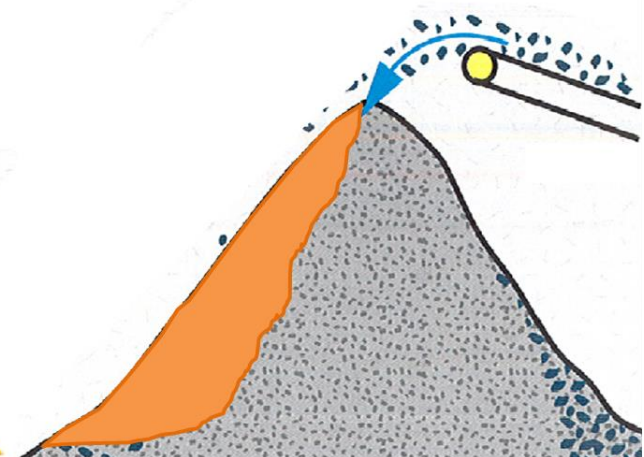
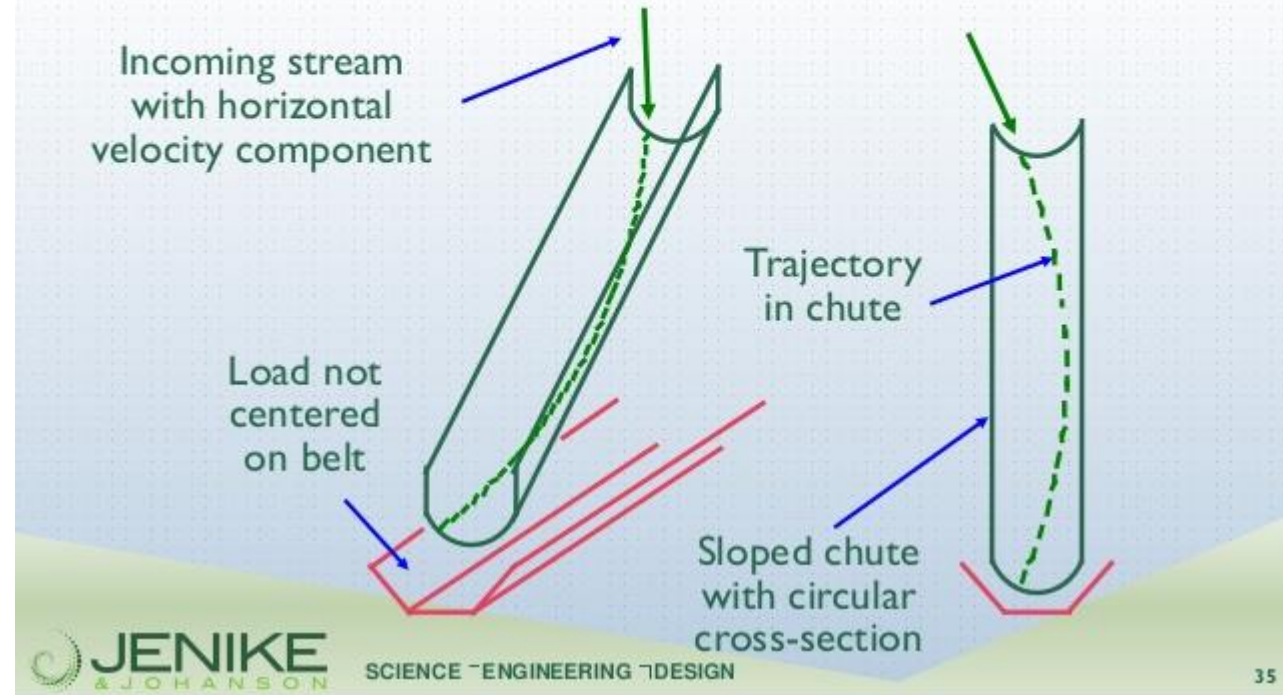


Figure 12—Schematic sketch of feed size segregation



TRAJECTORY ON IMPROPERLY DESIGNED CHUTE



Reduction of Segregation

Segregation occurs primarily as a result of **size difference**

- Difficulty of mixing two components can be reduced by making the **size of the components as similar as possible** and by reducing the absolute size of both components
- Segregation is generally not a serious problem when all particles are **less than 30 mm** (for particle densities in the range 2000 – 3000 kg/m³)
- In fine powders, **interparticle forces** generated by **electrostatic** charging, **van der Waals forces** and forces due to **moisture** are large compared with gravitational and inertial forces
- Fine particles may **stick together** preventing segregation as particles are not free to move relative to one another
- The **mobility of particles** in free-flowing powders can be reduced by addition of small quantities of liquid (e.g. oil)
- The **reduction in mobility** reduces segregation and permits better mixing
- **Agglomeration** reduces segregation

When segregation occurs, intensive or extensive mixing will not help.

Any segregating material will segregate when mixed or moved around

.....sometimes we just have to deal with segregation
as a given fact

...think about clever solutions

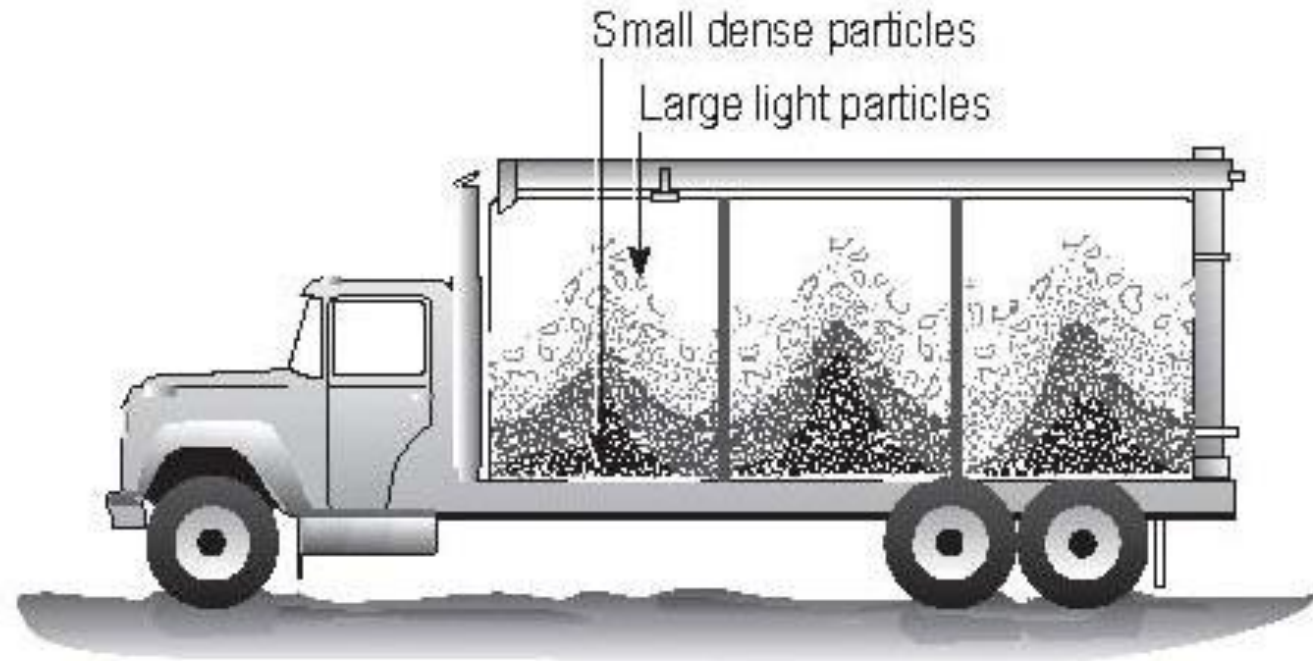
Impossible to mix



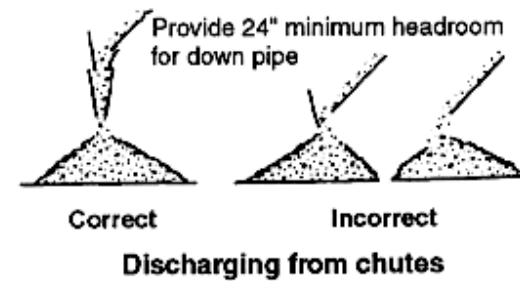
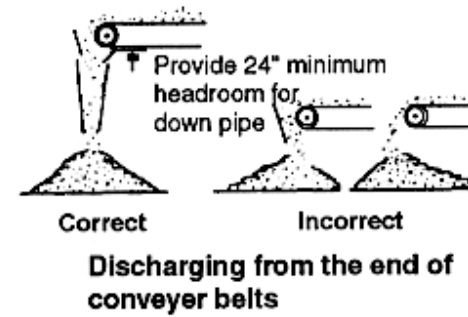
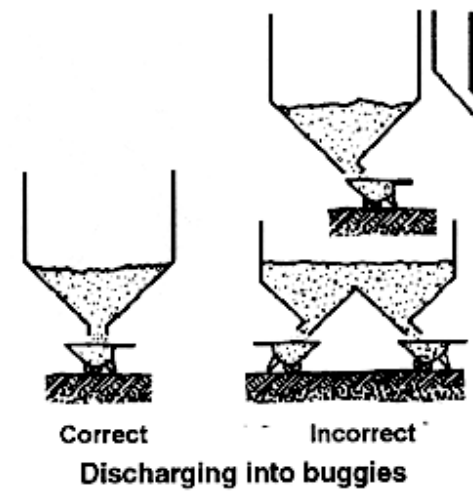
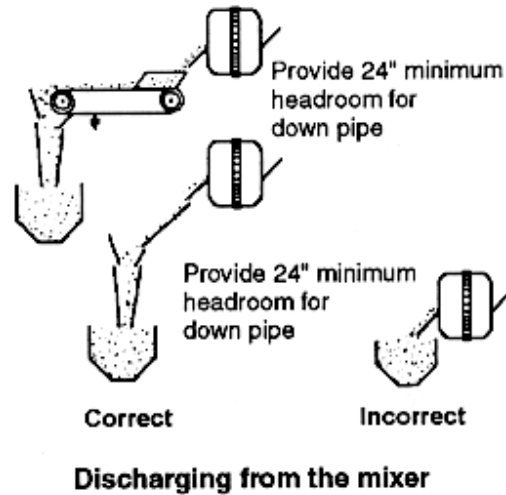
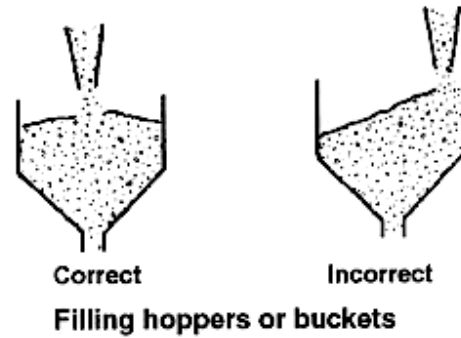
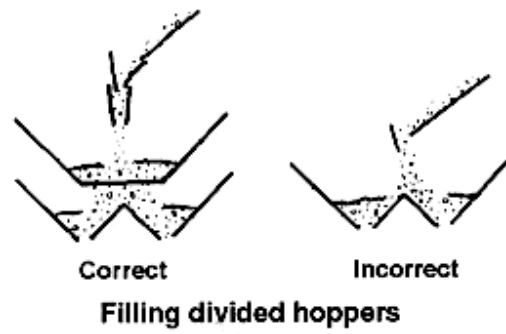
....reduce mobility



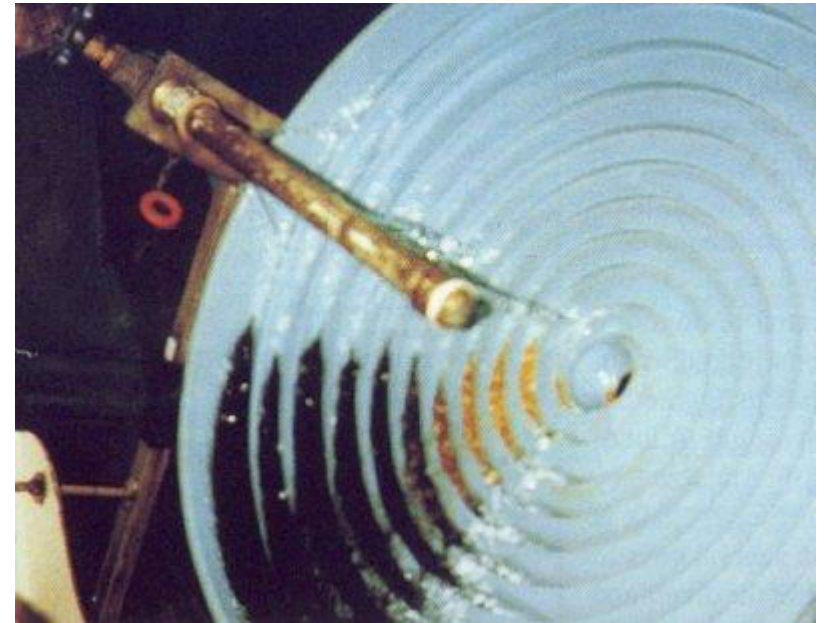
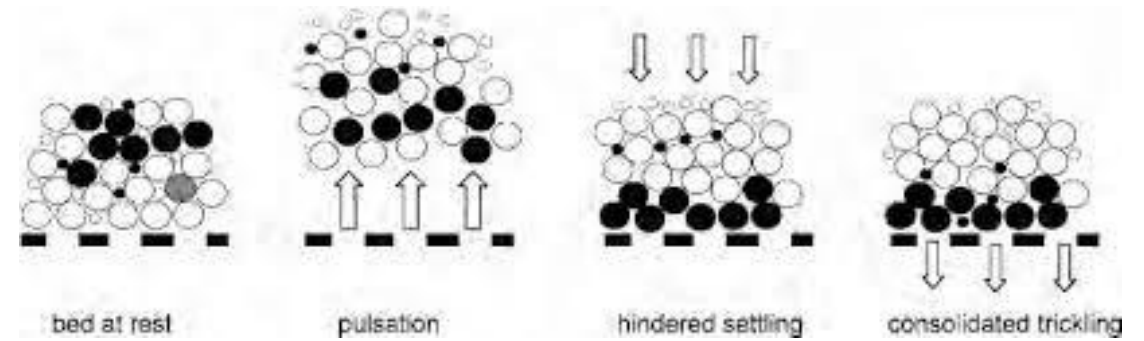
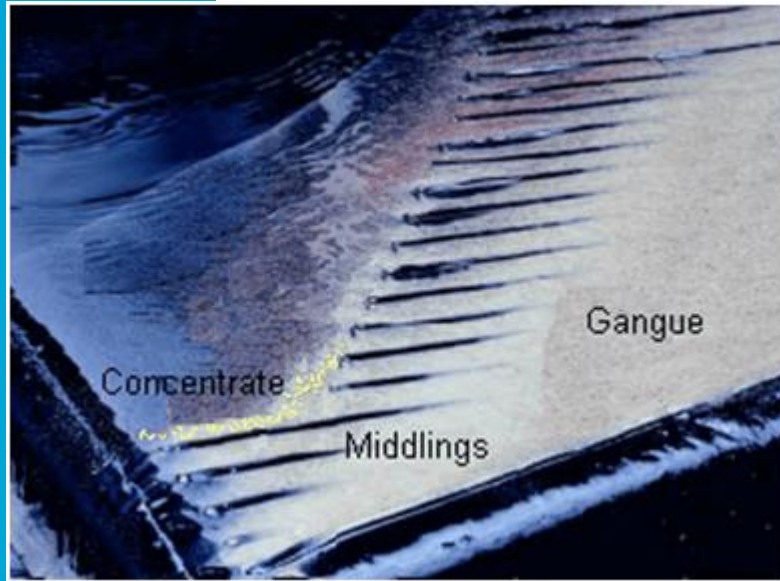
TRANSPORT SEGREGATION.



Many segregation mechanisms combined



USE OF SEGREGATION IN MINING



Thanks for your
attention

